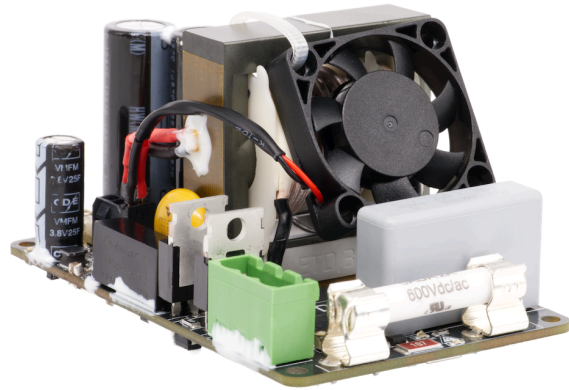


### Description

The DCDCv9-3 is a galvanically isolated DC/DC converter, designed to convert voltages from 200 V to 600 V down to 24 V with max. 500 W continuous output power. The low weight of 167 grams and the small footprint of a credit card (85.6 x 54 mm) are well suited to the automotive industry for supplying low-voltage systems from HV Batteries. The dynamic operating frequency between 90 and 200 kHz ensures high efficiency for various loads as well as good EMI compliance due to the resonant LLC soft switching topology. Customized versions allow output voltages from 12 V to 48 V.



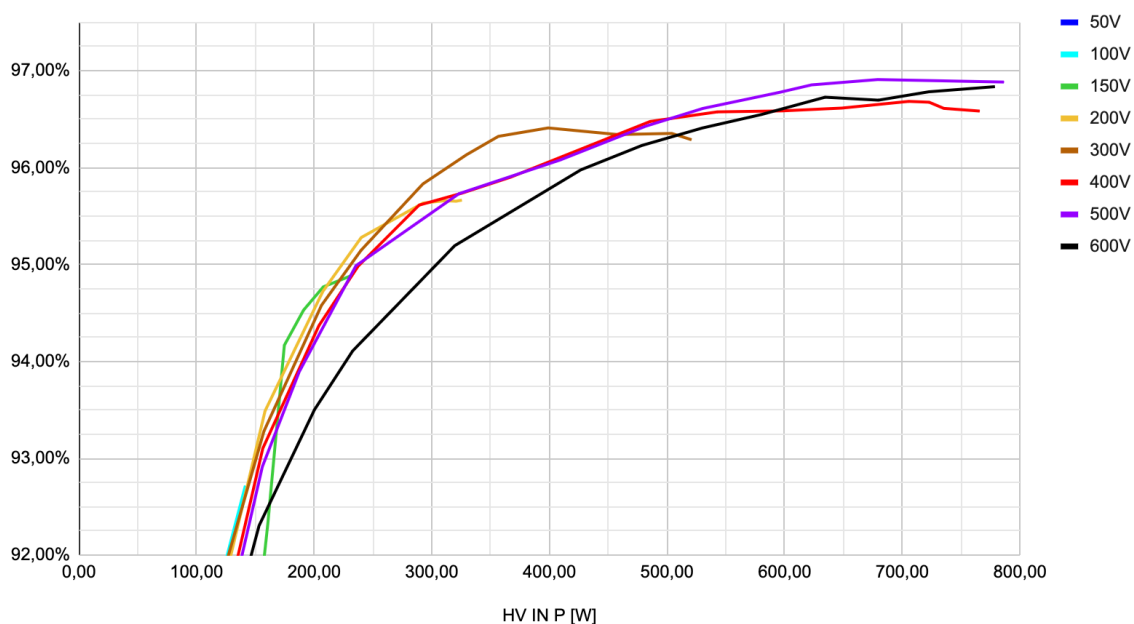
### Features

- Maximum output power (400 V to 600 V): 750 W for 60 seconds, 600 W for 180 seconds, 500 W continuous, max. output power (200 V): 300 W, max. output power (300 V): 500 W
- Efficiency up to 96.9 % at 500 W and 500 V Input Voltage
- active rectification (NCP4305AMTTWG)
- undervoltage, overvoltage and overcurrent protection
- low no-load power dissipation (7 W - 9 W)
- built-in solid-state precharge
- very low standby leakage current (75 nA at 600 V)
- isolated enable pins with self recharging start-up capacitor
- cost efficient UCC25600 LLC controller
- reliable 4 A/6 A UCC21520 Gate Driver
- optional back side connectors for on-PCB mount
- minimum isolation distance 4.5 mm (According to rule EV 4.3.6, Table 5, Conformal Coating: 600 V DC min. 4 mm spacing required)
- *FSG-Rules 2025 conform*

### Applications

- Low-Voltage System supply for 400V/600V battery powered electric vehicles
- CV Benchtop power supply

### Efficiency vs. Input Voltage (92-97%)



## Absolute Maximum ratings

Ambient Temperature = 21 °C (unless otherwise noted)

| Symbol    | Parameter  | Typ.     | Unit     |
|-----------|--|----------|----------|
| $V_{in}$  | Input Voltage                                      | 610      | V        |
| $I_{in}$  | Input Current                                      | 2000     | mA       |
| $V_{out}$ | Output withstand Voltage                           | 35       | V        |
| $I_{out}$ | Output Current for 1 Minute                        | 31.25    | A        |
| $P_{out}$ | Output Power for 1 Minute                          | 750      | W        |
| $P_{out}$ | Continuous Output Power                            | 500      | W        |
| $P_{tot}$ | Total Power Dissipation at $T_{amb} = 21^{\circ}C$ | 25       | W        |
| $f_{sw}$  | Switching Frequency                                | 350      | kHz      |
| $T_{op}$  | Operating Ambient Temperature Range                | 0 to 60  | °C       |
| $T_{stg}$ | Storage Temperature Range                          | 0 to 125 | °C       |
| $V_{iso}$ | Isolation Voltage between HV and LV for 1 Minute   | 3000     | V AC RMS |

## Electrical Characteristics

All Values are Measurements from a sample size of 1

### Input Characteristics

| Parameter                          | Test Conditions  |                  | Typ.  | Unit    |
|------------------------------------|--|------------------|-------|---------|
| Under Voltage Protection           | enable, R67+R68 = 1.7 M $\Omega$                               |                  | 199   | V       |
|                                    | disable, R67+R68 = 1.7 M $\Omega$                              |                  | 206   | V       |
|                                    | enable delay<br>R67+R68 = 1.7 M $\Omega$<br>C47 = 22 nF        | $V_{in} = 200$ V | 234   | ms      |
|                                    |  | $V_{in} = 300$ V | 52    | ms      |
|                                    |  | $V_{in} = 400$ V | 28    | ms      |
|                                    |  | $V_{in} = 500$ V | 19    | ms      |
|                                    |  | $V_{in} = 600$ V | 14    | ms      |
| Over Voltage Protection            | enable, R65+R66 = 543 k $\Omega$                               |                  | 609   | V       |
|                                    | disable, R65+R66 = 543 k $\Omega$                              |                  | 598   | V       |
| Leakage Current<br>DCDC = Disabled | $V_{in} = 200$ V   |                  | 15    | nA      |
|                                    | $V_{in} = 300$ V   |                  | 28    | nA      |
|                                    | $V_{in} = 400$ V   |                  | 41    | nA      |
|                                    | $V_{in} = 500$ V   |                  | 56    | nA      |
|                                    | $V_{in} = 600$ V   |                  | 75    | nA      |
| Input Current                      | DCDC = Enabled<br>$V_{in} < UVP$                               | $V_{in} = 50$ V  | 75    | $\mu$ A |
|                                    |  | $V_{in} = 100$ V | 151   | $\mu$ A |
|                                    |  | $V_{in} = 150$ V | 228   | $\mu$ A |
|                                    |  | $V_{in} = 200$ V | 305   | $\mu$ A |
|                                    | DCDC = Enabled<br>$V_{in} > UVP$<br>no Fan<br>dead time = 80 ° | $V_{in} = 200$ V | 40.0  | mA      |
|                                    |  | $V_{in} = 300$ V | 27.2  | mA      |
|                                    |  | $V_{in} = 400$ V | 20.8  | mA      |
|                                    |  | $V_{in} = 500$ V | 16.7  | mA      |
|                                    |  | $V_{in} = 600$ V | 11.34 | mA      |

| Parameter             | Test Conditions          |                          | Typ.  | Unit |
|-----------------------|--------------------------|--------------------------|-------|------|
| Reverse Input Voltage | reverse polarity         | $I_{in} = 0.1 \text{ A}$ | -4.48 | V    |
|                       |                          | $I_{in} = 0.5 \text{ A}$ | -5.04 | V    |
|                       |                          | $I_{in} = 1 \text{ A}$   | -5.34 | V    |
|                       |                          | $I_{in} = 2 \text{ A}$   | -5.83 | V    |
| Input Voltage Ripple  | $V_{in} = 400 \text{ V}$ | $I_{out} = 0 \text{ A}$  | 0.741 | Vrms |
|                       |                          |                          | 7.1   | Vpp  |
|                       |                          | $I_{out} = 10 \text{ A}$ | 0.96  | Vrms |
|                       |                          |                          | 8.51  | Vpp  |
|                       |                          | $I_{out} = 20 \text{ A}$ | 0.52  | Vrms |
|                       |                          |                          | 7.86  | Vpp  |
|                       |                          | $I_{out} = 30 \text{ A}$ | 0.73  | Vrms |
|                       |                          |                          | 6.97  | Vpp  |
|                       | $V_{in} = 500 \text{ V}$ | $I_{out} = 0 \text{ A}$  | 5.56  | Vpp  |
|                       | $V_{in} = 600 \text{ V}$ | $I_{out} = 0 \text{ A}$  | 3.0   | Vpp  |

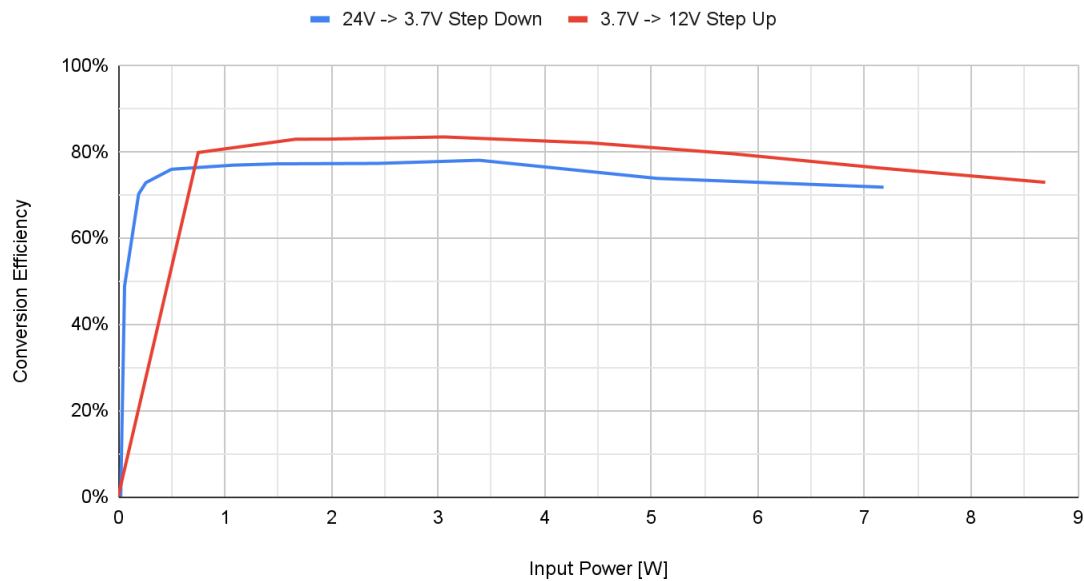
### Output Characteristics

| Parameter          | Test Conditions  |                          | Typ.           | Unit  |
|--------------------|--|--------------------------|----------------|-------|
| Output             | Voltage Ripple<br>$V_{in} = 400 \text{ V}$   | $I_{out} = 0 \text{ A}$  | 5.1            | mVrms |
|                    |  | $I_{out} = 0 \text{ A}$  | 152            | mVpp  |
|                    |  | $I_{out} = 10 \text{ A}$ | 9.1            | mVrms |
|                    |  | $I_{out} = 10 \text{ A}$ | 189            | mVpp  |
|                    |  | $I_{out} = 20 \text{ A}$ | 13.2           | mVrms |
|                    |  | $I_{out} = 20 \text{ A}$ | 230            | mVpp  |
|                    |  | $I_{out} = 30 \text{ A}$ | 18.9           | mVrms |
|                    |  | $I_{out} = 30 \text{ A}$ | 310            | mVpp  |
| Voltage Regulation | output Voltage   |                          | 24.09 to 24.16 | V     |
|                    | minimum HV input for 24 V Output, set by $f_{min} = 94 \text{ kHz}$                                    |                          | 180            | V     |
|                    | Overshoot test with 4700 $\mu\text{F}$ Load (uncharged), see Documentation Chapter <i>Control loop</i> | $V_{in} = 400 \text{ V}$ | 1.7            | Vp    |
|                    |  | $V_{in} = 500 \text{ V}$ | 0.83           | Vp    |
|                    |  | $V_{in} = 600 \text{ V}$ | 0.34           | Vp    |
|                    | Undershoot test with 300 W Load drop, see Documentation Chapter <i>Control loop</i>                    | $V_{in} = 400 \text{ V}$ | 38             | mVp   |
|                    |  | $V_{in} = 500 \text{ V}$ | 38             | mVp   |
|                    |  | $V_{in} = 600 \text{ V}$ | 43             | mVp   |

## Internal Power Supply

| Parameter                                | Test Conditions   |   | Typ.   | Unit |
|--|---|---|--------|------|
| Start-up Supply                          | Charging Voltage with $C_{start1}$ installed  | DCDC = Disabled   | 3.71   | V    |
|  |   | DCDC = Enabled, $V_{in} = 600\text{ V}$ , 3.7 V Fan OFF | 3.69   | V    |
|  |   | DCDC = Enabled, $V_{in} = 600\text{ V}$ , 3.7 V Fan ON  | 3.68   | V    |
|  | $C_{start1}$ Shipping Voltage   |   | 3.65   | V    |
|  | $I_{out}$ with fully charged $C_{start1}$<br>$V_{out} = 24\text{ V}$                    | DCDC = Disabled   | -1.05  | mA   |
|  |   | DCDC = Enabled  | -22.3  | mA   |
|  |   | DCDC = Enabled with 3.7 V Fan                           | -50    | mA   |
|  | $C_{start1}$ Discharge current,<br>DCDC = Enabled, $U_{Cstart1} = 3.7\text{ V}$         | $V_{in} = 0\text{ V}$ (UVP)                             | 101    | mA   |
|  |   | $V_{in} = 200\text{ V}$                                 | 198    | mA   |
|  |   | $V_{in} = 300\text{ V}$                                 | 207    | mA   |
|  |   | $V_{in} = 400\text{ V}$                                 | 219    | mA   |
|  |   | $V_{in} = 500\text{ V}$                                 | 236    | mA   |
|  |   | $V_{in} = 600\text{ V}$                                 | 215    | mA   |
|  | Hold-Up time, DCDC = Enabled, $V_{in} = 0\text{ V}$ , $V_{out} = 0\text{ V}$            |   | 114    | s    |
|  | $V_{out}$ Buck-Converter disable threshold  |   | 3.5    | V    |
|  | 5 V LED / Buck-Converter disable time by discharging C11+C13 from 24 V, DCDC = Disabled |   | 172    | s    |
| Boost-Converter                          | UVP   |   | 2.535  | V    |
| LV Current                               | DCDC = Enabled, $P_{out} = 0\text{ W}$ , $V_{in} = 0\text{ V}$                          | $I_{LV}$ LV Side  | 27.8   | mA   |
| LV Voltage                               | DCDC = Enabled, $P_{out} = 0\text{ W}$ , $V_{in} = 0\text{ V}$                          | $U_{LV}$ LV Side  | 12.204 | V    |
|  |   | 9 V LDO   | 9.055  | V    |
|  |   | HV Side   | 12.475 | V    |
|  |   | HV Side after D11                                       | 11.79  | V    |
|  |   | HV Side after D14                                       | 12.108 | V    |
| MOSFET top supply<br>Voltage (VDDA-VSSA) | DCDC = Enabled, $P_{out} = 0\text{ W}$  | $V_{in} = 0\text{ V}$                                   | 11.71  | V    |
|  |   | $V_{in} = 300\text{ V}$                                 | 11.82  | V    |
|  |   | $V_{in} = 400\text{ V}$                                 | 11.96  | V    |
|  |   | $V_{in} = 500\text{ V}$                                 | 11.40  | V    |
|  |   | $V_{in} = 600\text{ V}$                                 | 10.66  | V    |

Buck- and Boost Converter Efficiency



High Voltage Precharge and Discharge

| Parameter         | Test Conditions  |                         | Typ.       | Unit |
|-------------------|--|-------------------------|------------|------|
| Precharge         | Close delay  |                         | 5.0 to 5.3 | ms   |
|                   | Close Voltage Jump   |                         | 9          | V    |
|                   | Open Delay   |                         | 7          | ms   |
|                   | Mad-Scruti-Test (Enable/Disable as fast as possible)                 |                         | PASS       |      |
|                   | Precharge Time<br>$V_{DC\_link} = 0\text{ V to }V_{in}$              | $V_{in} = 200\text{ V}$ | 68         | ms   |
|                   |  | $V_{in} = 300\text{ V}$ | 103        | ms   |
|                   |  | $V_{in} = 400\text{ V}$ | 141        | ms   |
|                   |  | $V_{in} = 500\text{ V}$ | 180        | ms   |
|                   |  | $V_{in} = 600\text{ V}$ | 221        | ms   |
| Passive Discharge | Discharge Time<br>$V_{in} \text{ to } V_{DC\_link} \leq 60\text{ V}$ | $V_{in} = 200\text{ V}$ | 1.592      | s    |
|                   |  | $V_{in} = 300\text{ V}$ | 2.120      | s    |
|                   |  | $V_{in} = 400\text{ V}$ | 2.540      | s    |
|                   |  | $V_{in} = 500\text{ V}$ | 2.795      | s    |
|                   |  | $V_{in} = 600\text{ V}$ | 3.045      | s    |

## Oscillator (UCC25600)

| Parameter              | Test Conditions  |   | Typ.  | Unit |
|------------------------|--|---|-------|------|
| Soft Start             | $f_{sw}$   | without C42/R59                                 | 190.6 | kHz  |
|                        |  | C42 = 22 $\mu$ F, R59 = 1 k $\Omega$            | 347   | kHz  |
|                        | length<br>$f_{sw}$ 350 kHz to 94 kHz   | without C42/R59                                 | 263   | ms   |
|                        |  | C42 = 22 $\mu$ F, R59 = 1 k $\Omega$            | 242   | ms   |
| Dead time              | potentiometer position   | min.  | 119   | ns   |
|                        |  | middle  | 274   | ns   |
|                        |  | max.  | 505   | ns   |
|                        |  | dead-room                                       | 60    | °    |
|                        |  | efficiency optimum<br>$V_{in}$ = 200 V to 600 V | 80    | °    |
| min. $f_{sw}$          | frequency Potentiometer shipped  |   | 40    | kHz  |
|                        | Adjustable minimum   |   | 20    | kHz  |
|                        | Adjustable maximum   |   | 330   | kHz  |
|                        | Adjusted for operation   |   | 90    | kHz  |
| Overcurrent Protection | Voltage measured over $C_{res}$ = 22.4 nF, R60 = 82 k $\Omega$ , C44 = 22 nF |   | 290   | V    |

## Thermal Properties

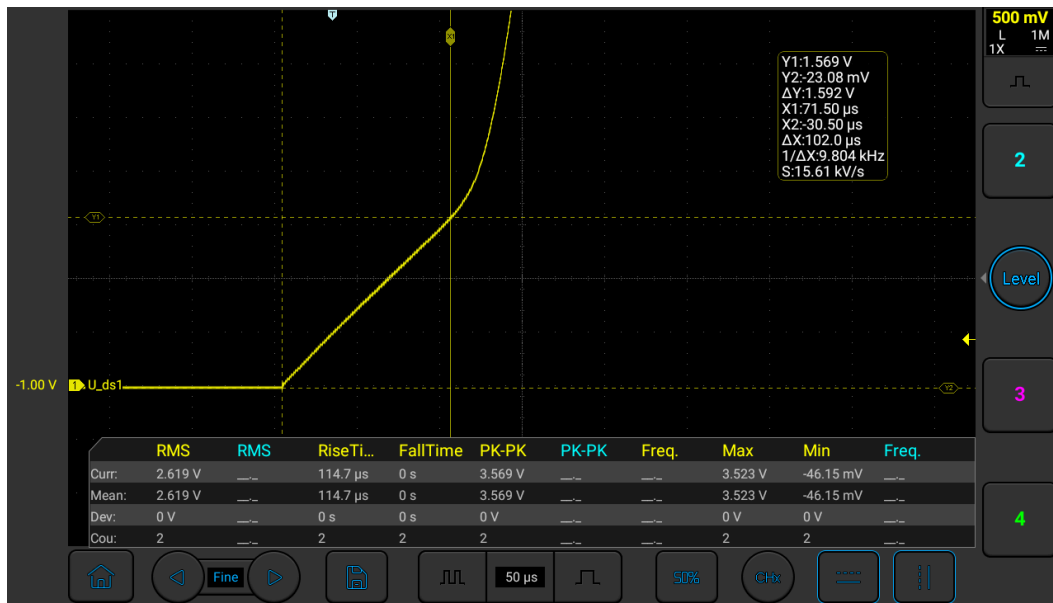
| Module                     | Parameter  |                                | Typ.      | Unit |
|----------------------------|--|--------------------------------|-----------|------|
| Overtemperature protection | U6 = TL072<br>R35 = 330 k $\Omega$ , R36 = 4.7 k $\Omega$<br>C28 = 100 nF, C48 = 10 nF   | Lock-out while operation       | 106.9     | °C   |
|                            |  | Lock-out at start-up           | 104.0     | °C   |
| Fan control                | U6 = TL072<br>R31 = 4.7 k $\Omega$ , R18 = 470 k $\Omega$  | enable                         | 71        | °C   |
|                            |  | disable                        | 61        | °C   |
|                            | Sensor Loss behavior   |                                | always on |      |
| Fan current                | Manufacturer: UltraFan<br>Type: XD3007D5H  | $V_{Fan}$ = 3.7 V              | 150       | mA   |
| SR Temperature             | open Air, $V_{Fan}$ = 3.7 V<br>$V_{in}$ = 500 V  | $I_{out}$ = 0 A, after 10 min  | 53.4      | °C   |
|                            |  | $I_{out}$ = 10 A, after 10 min | 65.5      | °C   |
|                            |  | $I_{out}$ = 20 A, after 10 min | 77.6      | °C   |
|                            |  | $I_{out}$ = 25 A, after 5 min  | 101.7     | °C   |
|                            |  | $I_{out}$ = 25 A, after 10 min | 102.9     | °C   |
|                            |  | $I_{out}$ = 30 A, after 1 min  | 102       | °C   |
| SR Temperature Hotbox Test | converter inside a box with $T_{amb}$ = 60 °C<br>must be able to deliver $P_{out}$ = 500 W at $V_{in}$ = 500 V<br>for 30 minutes, restarted after 5 seconds must be possible |                                | 104.7     | °C   |

## Transformer

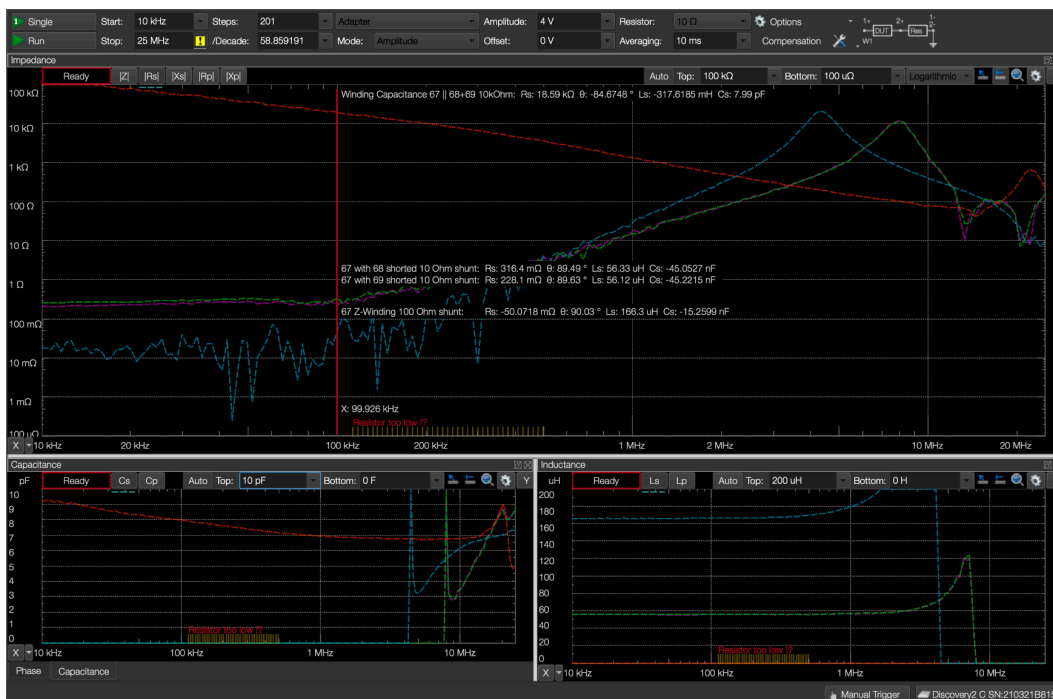
| Module                       | Parameter  |                | Typ.       | Unit       |
|------------------------------|--|----------------|------------|------------|
| Turns Ratio                  | W1, W2, W3   |                | 28 : 2 : 2 |            |
| Litz Wire Length W1 (SN: 67) | Type: 120 x 0.1 mm $\varnothing$ 0.92 mm <sup>2</sup> 1.4 mm   |                | 1780       | mm         |
| Litz Wire Length W2 (SN: 68) | Type: 600 x 0.071 mm $\varnothing$ 2.38 mm <sup>2</sup> 2.4 mm |                | 185        | mm         |
| Litz Wire Length W3 (SN: 69) | Type: 600 x 0.071 mm $\varnothing$ 2.38 mm <sup>2</sup> 2.4 mm |                | 165        | mm         |
| Inductance W1                | 100 kHz 4 Vpp sine, AD2 Shunt = 10 $\Omega$                    |                | 166.3      | $\mu$ H    |
| Leakage Inductance W1        | 100 kHz 4 Vpp sine,<br>AD2 Shunt = 10 $\Omega$                 | W2 shorted     | 56.32      | $\mu$ H    |
|                              |  | W3 shorted     | 56.11      | $\mu$ H    |
|                              |  | W2+W3 shorted  | 53.85      | $\mu$ H    |
| Inductance                   | 100 kHz 4 Vpp sine<br>AD2 Shunt = 10 $\Omega$                  | W2             | 1.057      | $\mu$ H    |
|                              |  | W3             | 1.014      | $\mu$ H    |
| Leakage Inductance           |  | W2, W1 shorted | 0.3557     | $\mu$ H    |
|                              |  | W3, W1 shorted | 0.3496     | $\mu$ H    |
| Saturation Current W1        | DC   |                | 7.9        | A          |
| Resistance W1                | DC, 20 °C, 32.895 mV, 1008 mA                                  |                | 32.63      | m $\Omega$ |
|                              | DC, 100 °C, 445.4 mV, 10504 mA                                 |                | 42.40      | m $\Omega$ |
|                              | 4 Vpp sine,<br>AD2 Shunt = 10 $\Omega$ ,<br>W2+W3 shorted      | 10 kHz         | 140.2      | m $\Omega$ |
|                              |  | 100 kHz        | 145.4      | m $\Omega$ |
|                              |  | 200 kHz        | 552.6      | m $\Omega$ |
|                              |  | 350 kHz        | 1081       | m $\Omega$ |
|                              |  | 1000 kHz       | 14540      | m $\Omega$ |
| Resistance W2                | DC, 21 °C, 6.740 mV, 5012 mA                                   |                | 1.345      | m $\Omega$ |
|                              | DC, 57 °C, 30.46 mV, 19990 mA                                  |                | 1.524      | m $\Omega$ |
|                              | 4 Vpp sine,<br>AD2 Shunt = 10 $\Omega$ ,<br>W1 shorted         | 10 kHz         | 2.4        | m $\Omega$ |
|                              |  | 100 kHz        | 15.1       | m $\Omega$ |
|                              |  | 200 kHz        | 6.2        | m $\Omega$ |
|                              |  | 350 kHz        | 16.7       | m $\Omega$ |
|                              |  | 1000 kHz       | 100.8      | m $\Omega$ |
| Resistance W3                | DC, 21 °C, 5.884 mV, 5010 mA                                   |                | 1.174      | m $\Omega$ |
|                              | DC, 66 °C, 27.175 mV, 19986 mA                                 |                | 1.360      | m $\Omega$ |
|                              | 4 Vpp sine<br>AD2 Shunt = 10 $\Omega$ ,<br>W1 shorted          | 10 kHz         | 2.4        | m $\Omega$ |
|                              |  | 100 kHz        | 18.3       | m $\Omega$ |
|                              |  | 200 kHz        | 13.7       | m $\Omega$ |
|                              |  | 350 kHz        | 3.5        | m $\Omega$ |
|                              |  | 1000 kHz       | 94.3       | m $\Omega$ |
| Winding Capacitance          | 4 Vpp sine<br>1000 kHz,<br>AD2 Shunt = 10 k $\Omega$           | W1    W2       | 6.1        | pF         |
|                              |  | W1    W3       | 5.9        | pF         |
|                              |  | W1    W2+W3    | 6.9        | pF         |
|                              |  | W2    W3       | 26.3       | pF         |

| Module                  | Parameter   |                    | Typ.       | Unit               |
|-------------------------|---|--------------------|------------|--------------------|
| Resonant Frequ. W1      | 4 Vpp sine, AD2 Shunt = 100 $\Omega$  |                    | 8.0        | MHz                |
| Typ. Frequency Range    | $V_{in}$ = 200 to 600 V   | $P_{out}$ = 0 W,   | 95 to 200  | kHz                |
|                         |   | $P_{out}$ = 250 W, | 90 to 170  | kHz                |
|                         | $V_{in}$ = 400 to 600 V   | $P_{out}$ = 750 W, | 115 to 160 | kHz                |
| Resonant Half Bridge    | Max. Input Voltage W1   |                    | 300        | V                  |
|                         | Typ. Output Voltage W2, W3  |                    | 24.0       | V                  |
|                         | Typ. LLC Gain   |                    | 1.1 to 3.4 |                    |
| Isolation               | 1 minute DC, no Isolation breakdown   |                    | 5000       | V RMS              |
|                         | Isolation Resistance (DC)   |                    | $\geq 200$ | G $\Omega$         |
|                         | 1 minute AC, 50 Hz, no Isolation breakdown  |                    | 3000       | V RMS              |
| Typ. Current W1         | $V_{in}$ = 200 to 600 V   | $P_{out}$ = 0 W,   | 1.6 to 2.8 | A RMS              |
|                         |   | $P_{out}$ = 250 W, | 2.4 to 3.6 | A RMS              |
|                         | $V_{in}$ = 400 to 600 V   | $P_{out}$ = 750 W, | 4.2 to 4.8 | A RMS              |
| Typ. Current W2 + W3    | equal load share  | $P_{out}$ = 750 W, | 31.25      | A RMS              |
| Coil Former             | Material: Liqcreate Flame Retardant HDT   | Temp. Rating       | 250        | $^{\circ}\text{C}$ |
|                         |   | FR Level           | UL94 V-0   |                    |
| Prim. and Sec. Windings | Temp. Rating  |                    | 155        | $^{\circ}\text{C}$ |
| Core                    | Material  |                    | N27 + N97  |                    |
|                         | Form  |                    | ETD39      |                    |
|                         | typ. Temperature  |                    | 80 to 120  | $^{\circ}\text{C}$ |
|                         | Saturation Flux density at 100 $^{\circ}\text{C}$   |                    | 410        | mT                 |
|                         | Relative Losses 100 kHz, 200 mT   |                    | 0.30       | W/cm <sup>3</sup>  |
|                         | Air Gap length between cores  |                    | 1.000      | $\mu\text{m}$      |
| W1 Power Dissipation    | Passive Convection, DC, 445.4 mV, 10504 mA<br>Hotspot = 100 $^{\circ}\text{C}$ unlimited time, RT 21 $^{\circ}\text{C}$   |                    | 4.7        | W                  |
|                         | Active Convection, DC, 603.9 mV, 13998 mA<br>Fan: 0.5 W @ 3.75 V, 30 x 30 x 7 mm, 5 m <sup>3</sup> /h,<br>Manufacturer: UltraFan, Type: XD3007D5H, 5 V,<br>200 mA, Top Cooled<br>Hotspot = 100 $^{\circ}\text{C}$ unlimited time, |                    | 8.5        | W                  |
| W2 Power Dissipation    | Passive Convection, DC, 30.46 mV, 19990 mA<br>Hotspot = 57 $^{\circ}\text{C}$ , unlimited time  |                    | 0.61       | W                  |
|                         | Active Convection, DC, 28.96 mV, 19986 mA<br>Fan: 0.5 W @ 3.75 V, 30 x 30 x 7 mm, 5 m <sup>3</sup> /h,<br>Manufacturer: UltraFan, Type: XD3007D5H, 5 V,<br>200 mA, Top Cooled<br>Hotspot = 46 $^{\circ}\text{C}$ unlimited time   |                    | 0.58       | W                  |
| W3 Power Dissipation    | Passive Convection, DC, 27.175 mV, 19986 mA<br>Hotspot = 66 $^{\circ}\text{C}$ , unlimited time   |                    | 0.54       | W                  |
|                         | Active Convection, DC, 26.07 mV, 19986 mA<br>Fan: 0.5 W @ 3.75 V, 30 x 30 x 7 mm, 5 m <sup>3</sup> /h,<br>Manufacturer: UltraFan, Type: XD3007D5H, 5 V,<br>200 mA, Top Cooled<br>Hotspot = 53 $^{\circ}\text{C}$ unlimited time   |                    | 0.52       | W                  |





Saturation current on primary Coil (W1) using a 201.2 mΩ Shunt resistor



## Resistance Measurement:

Blue: Primary Coil W1 Resistance vs. Frequency, secondary Coils open

Green: Primary Coil W1 Resistance vs. Frequency, secondary Coil W2 shorted

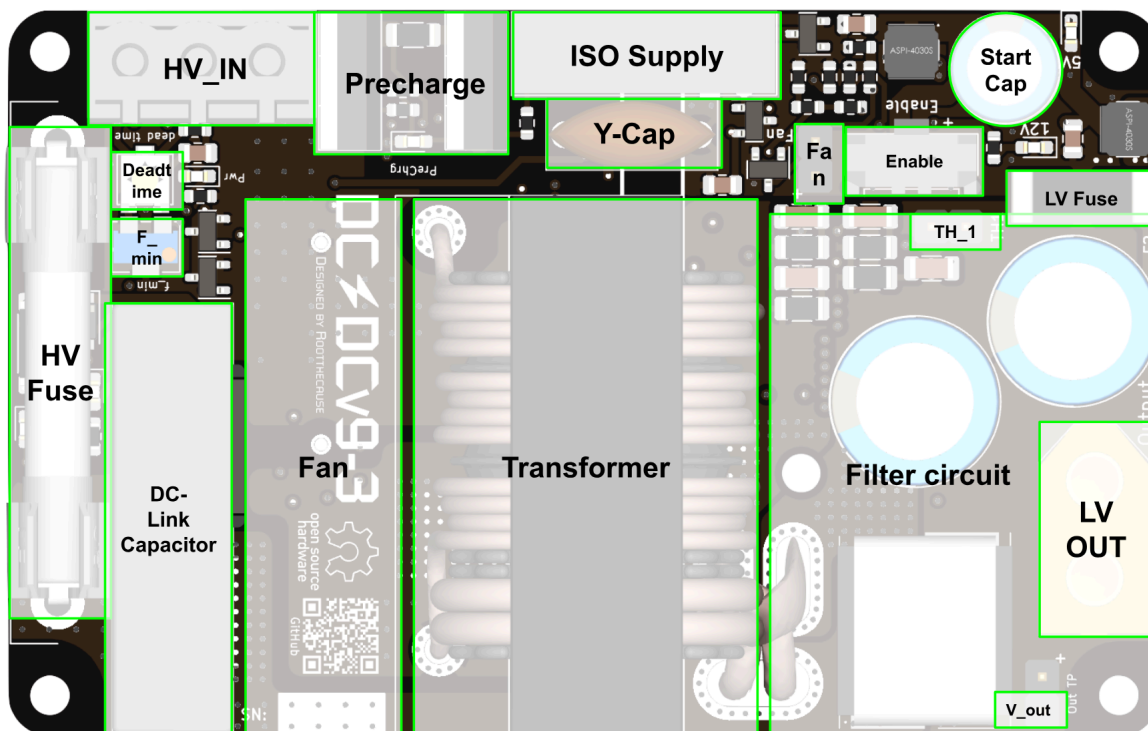
Purple: Primary Coil W1 Resistance vs. Frequency, secondary Coil W3 shorted

Red: Capacitance Measurement between primary Coil W1 and secondary Coils W2+W3

## Dimensions and Weight

| Module     | Parameter                 |                | Typ. |
|------------|---------------------------|----------------|------|
| Dimensions | L x W x H                 | 85.6 x 54 x 48 | mm   |
| DCDCv9-3   | PCB only                  | 17.55          | g    |
| DCDCv9-3   | PCBA only                 | 20.46          | g    |
| DCDCv9-3   | Weight with Fan and Fuses | 167.2          | g    |

## Front



**Boost converter**

**Buck converter**

Please do not release the magic smoke. It is necessary for operation.

Date Tested:

Result:

|    |     |     |
|----|-----|-----|
| OK | NOK | IDK |
|----|-----|-----|

F3

**Output Fuse**

0.5/0.1 mm  
0.5/0.08 mm  
0.5/0.08 mm  
0.5/0.08 mm  
0.5/0.08 mm  
0.5/0.08 mm

**Filter circuit**

**Temperature Measurement and Fan control**

5V

**Optocoupler**

spacing: 4.5 mm

TS

TS

EV 4.3.6 Table 5 Conformal Coatings:  
600V DC = min. 4 mm spacing

**Precharge**

**Oscillator**

**Resonant Capacitors**

**Under-/Over-voltage Protection**

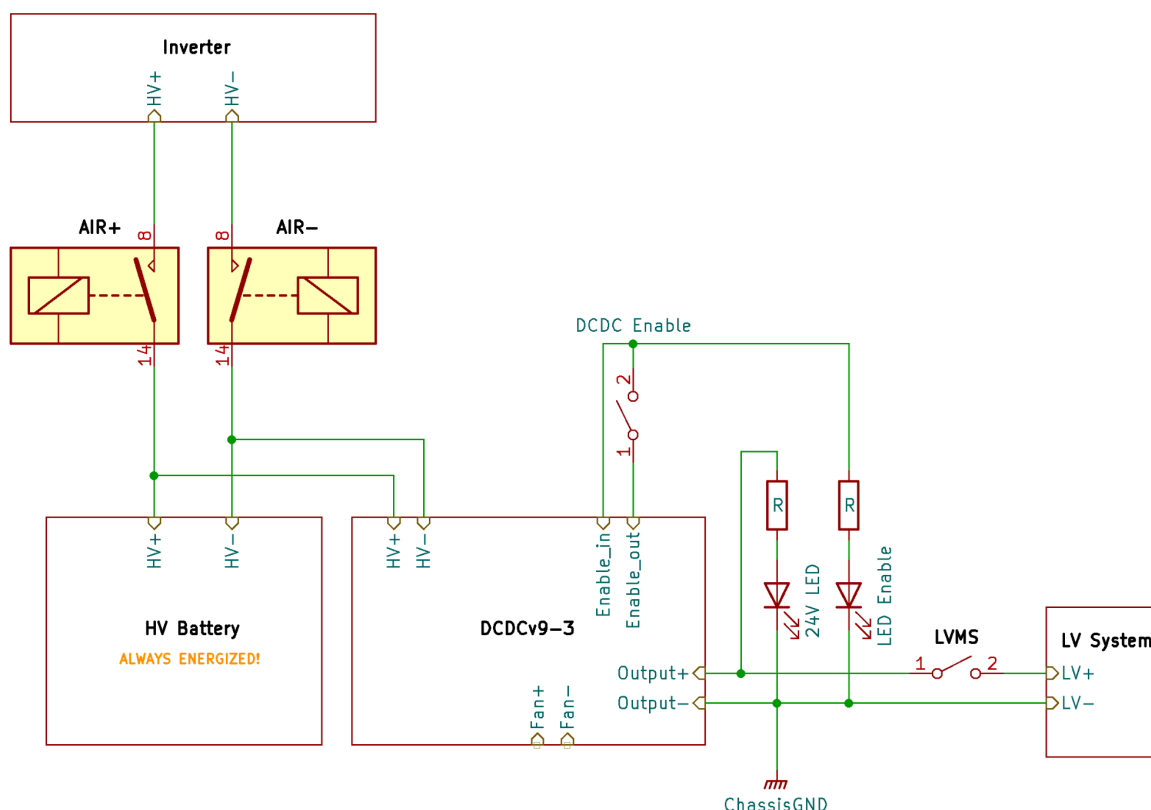
**Gate Driver**

**Halfbridge**

**Active Rectification**

## Installation

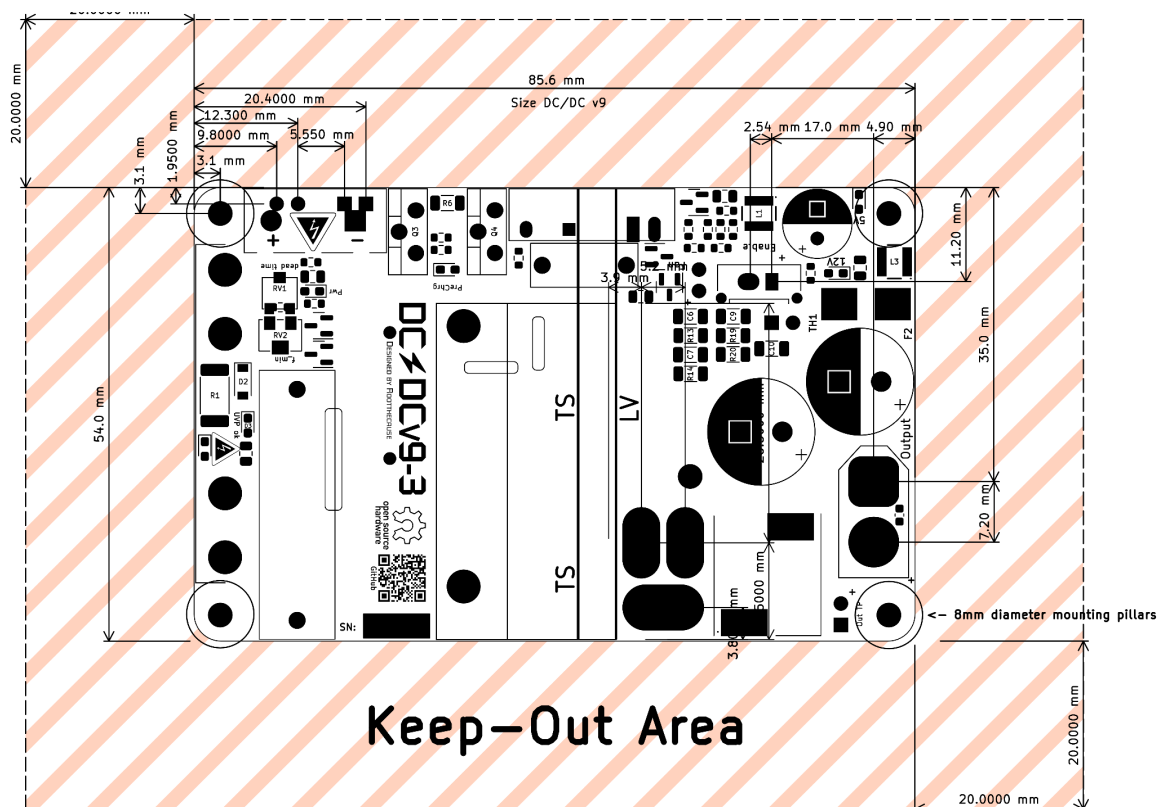
The DCDC is designed for permanent connection to a high-voltage source, such as a high-voltage battery. No pre-charge prior to the DCDC is required, as it is included. The converter can be connected while high voltage is present at the input, as long as safety measures are observed (personal protective equipment to prevent accidental contact with high-voltage).



The enable switch establishes a connection between the two enable lines. This switch must be designed as an ON/OFF switch (latching). When switched off, the supply line has a nominal voltage of 3.7 V measured against ground (between 2.5 V and 3.8 V depending on the SOC of the start capacitor) and the return line has 0 V. An LED can be connected to ground on the return line to indicate the active DCDC. The enable lines and switches should have a low resistance ( $< 0.5 \Omega$ ) and withstand at least 0.5 A. An LED with series resistor between 24V and ground is also recommended to indicate operational readiness at the output (and thus the permitted switch-on of the LV system).

A fan is required for continuous outputs above 300 W (if not already installed on the circuit board). This can be connected to the corresponding pin headers or soldered permanently. A solder bridge (JP1) for the fan voltage selection must be soldered at the back of the converter. This can be either 3.7 V or 12 V. The fan should not have a power consumption of more than 2 W, as otherwise the buck and boost converters will be subject to overload.

## Mechanical installation

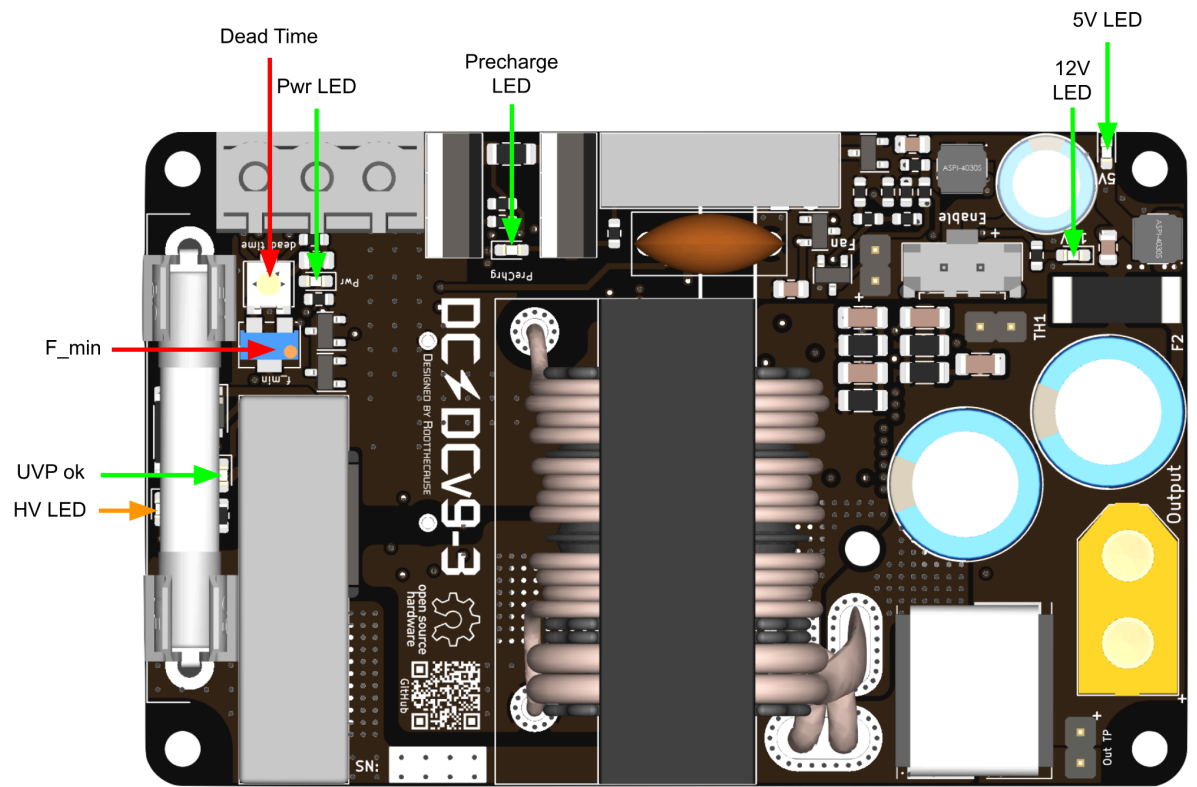


The DCDC Converter must be mounted with four M3 Nylon Screws in each corner onto an isolating Material, like nylon spacers. M3 Screws made from metal and 3D-Printed pillars (max. 8 mm diameter) which use metal inserts are allowable, if sufficient isolation ( $\geq 1800$  V AC RMS) to Low-Voltage potential can be shown. A distance of 10 mm from the PCB backside to any material should be maintained for sufficient heat dissipation. Nearby components must not obstruct the air flow of the fan. When mounted inside an airtight enclosure, the ambient air can reach more than  $60^{\circ}\text{C}$  due to the converter's power dissipation. Long exposure to this temperature can lead to premature component failure or over temperature shutdown. Additional ventilation with cool air or usage of thermally conductive enclosures is advised.

The converter can be mounted in any position. However, an upside down mounting can affect the converter's power dissipation.

The Keep-Out Area must be maintained if no moisture resistant isolating material other than air is used to isolate the converter from Low-Voltage potential.

User Interface



LED Indicators

| LED     | Color  | Function   | Normal Operation                         |
|---------|--------|--|--|
| PreChrg | Green  | active precharging, LED is off after precharging | flashing once for < 500 ms after turn-on |
| 5V      | Green  | active Buck converter                            | ON                                       |
| 12V     | Green  | active Boost converter                           | ON                                       |
| UVP ok  | Green  | Input Voltage is over UVP threshold              | ON                                       |
| HV LED  | Orange | DC-Link Capacitor Voltage is higher than 2 V     | ON                                       |

Adjustment options

| Potentiometer    | Location | Type    | Function  |
|------------------|----------|---------|---|
| Dead time        | top left | 1-Turn  | turn CCW to increase deadtime between halfbridge FETs |
| F <sub>min</sub> | top left | 10-Turn | turn CCW to increase minimum switching frequency      |

## Operation

### Power ON

1. Ensure that an input supply is connected. Do not enable the DCDC without input supply for more than 100 seconds, to avoid completely discharging  $C_{start1}$ .
2. Turn on the converter by closing the Enable switch.
3. Connect the load after the output voltage has reached 90% (see 24V LED indicator). As the converter has a soft start, the nominal output voltage is reached approx. 500 ms after enabling. The converter may be overloaded if it is switched on together with large loads. If the 24V LED indicator does not light up, turn off the converter and check for faults.

### Power OFF

1. Open the enable switch. It is not usually necessary to disconnect the loads prior to this.

## Troubleshooting

| Fault   | Cause  | Solution   |
|---|--|--|
| DCDC cannot be switched on, no LEDs light up                                    | Discharged start capacitor. Measure the voltage of the enable supply line to ground. Must be $> 2.5$ V. otherwise Boost converter may be broken  | By applying a voltage between 5V and 24V to LV-Out, the start capacitor can be recharged via the internal buck converter. Replace boost converter IC if necessary. |
| DCDC cannot be switched on, 5V LED does not light up when recharging via output | Check LV fuse, possibly buck converter overloaded or broken.   | Replace fuse and/or buck converter IC. Remove Fuse before continuity test!   |
| Precharge LED continuously on   | DC link is permanently drained or precharge defective. Measure the resistance of components in the DC link (e.g. half-bridge FETs). Check resistance R6 for the correct value.                     | Replace half-bridge FETs or precharge FETs/OPV/R6 if necessary   |
| Orange HV LED does not light up   |  |  |
| Orange HV LED lights up continuously, even if DCDC = Disabled                   | Precharge defective.   | replace Precharge FETs   |
| PWR LED does not light up   | Precharge not completed or the 12V supply after D11 is overloaded.   | Replace half-bridge FETs or precharge FETs/OPV/R6 if necessary. Check for overheating components.  |
| D3 does not light up  | HV input voltage below the UVP threshold value or HV fuse is blown due to overload. If the HV Fuse is blown, check resistance of the half-bridge FETs before replacement. They might be defective. | Increase voltage above the UVP threshold value or adjust UVP threshold value if necessary. Replace HV fuse if blown.   |
| LEDs light up normally, but no voltage at the output                            | output fuse blown due to overload  | Replace output fuse if blown.  |
| Only 12V LED lights up  | Overttemperature protection active   | Allow to cool down for 10 seconds. If a restart is not possible, the fault lies elsewhere.   |
| Output voltage Oscillates in the lower Hz range                                 | Overcurrent protection active. Load may have been switched on too early.   | Switch off the converter immediately and check the loads for too high currents!  |