Boost to ground evaluation kit

TLD5098EP

About this document

Product description

The TLD5098EP is an AEC qualified DC/DC boost controller, especially designed to drive LEDs.

- Built-in diagnosis and protection features
- External pulse width modulator to implement a dimming function with reduced color shifting
- Designed to support multiple topologies such as Boost, Buck, Buck-Boost, SEPIC and Flyback

Scope and purpose

Scope of this user manual is to provide to the audience instructions on usage of TLD5098EP boost to ground evaluation board.

Intended audience

This document is intended for engineers who need to perform measurements and check performances with TLD5098EP boost to ground evaluation board.

Table of contents

1 Description

Evaluation board for high power LED application with TLD5098EP product in boost to ground topology.

Default configuration of the board is boost to ground topology without any additional features enabled. In this configuration, it can deliver up to 13 W to the load with an efficiency above 91 %. Auxiliary circuits to protect the DC/DC and the load during short to ground are present.

The board is also equipped with the following features, enabled by jumpers:

- Output current adjustment trimmer
- Power Derating Circuitry
- Cold Crank Survival Circuit (**CCSC**)

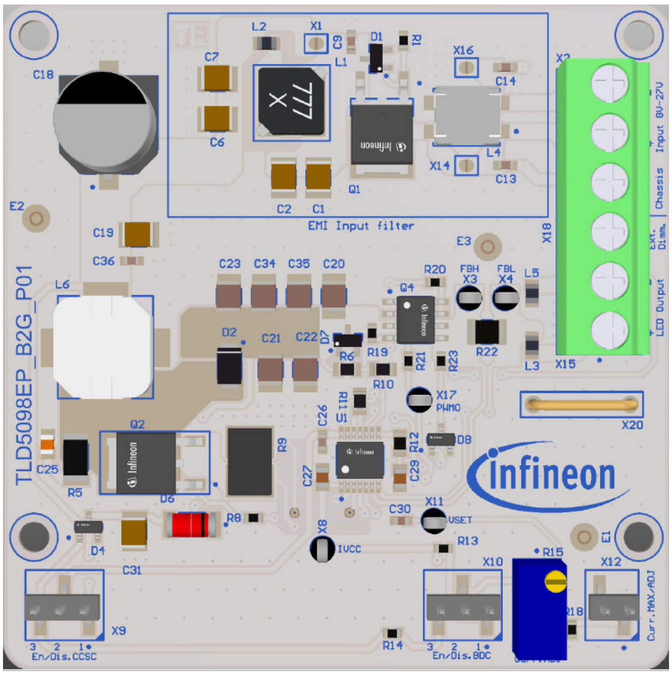

Figure 1 Board picture

1 Description

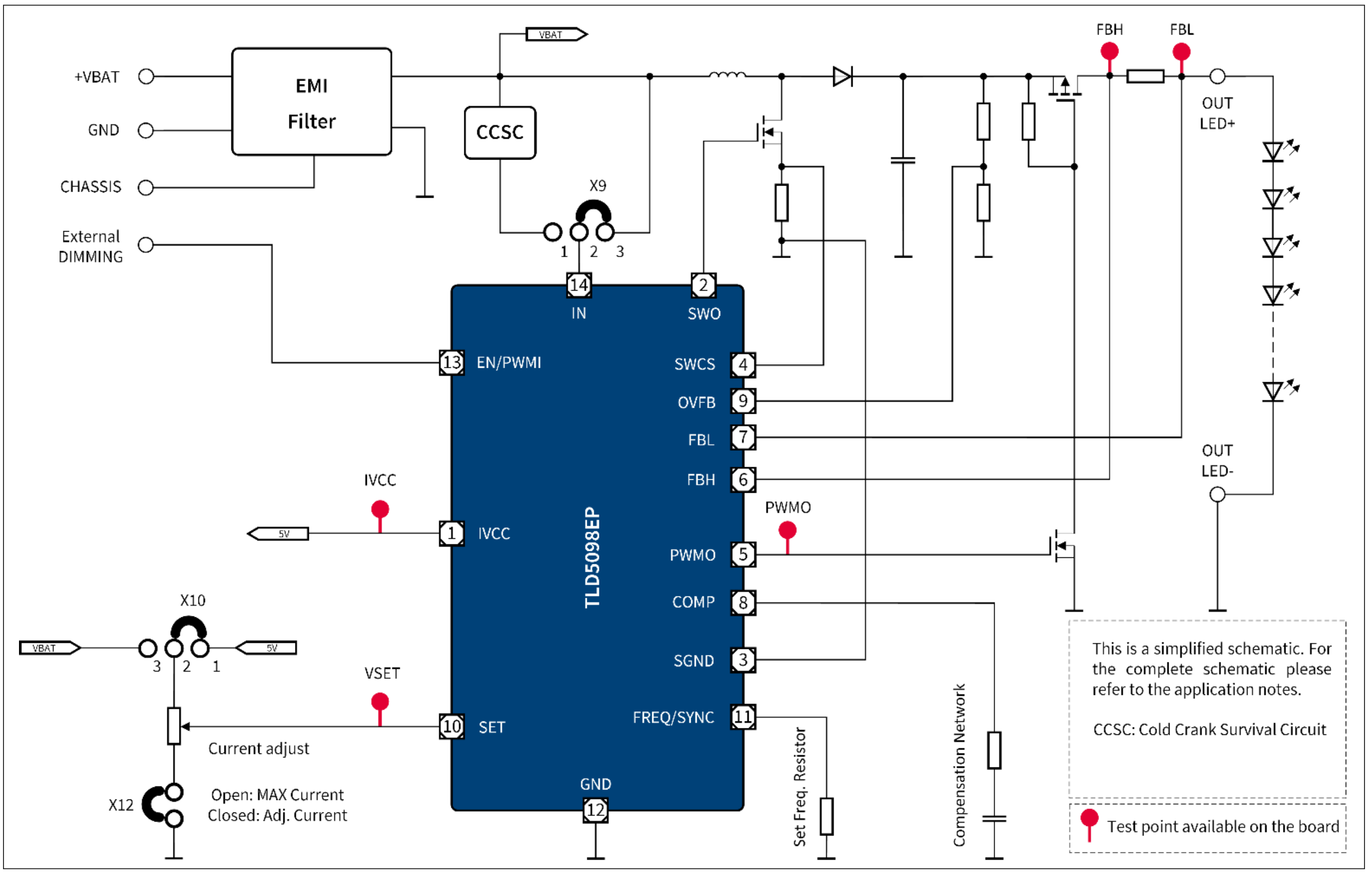

Figure 2 Simplified schematic

Table 1 Performance summary

Parameter	Conditions	Value
Input supply voltage	Jumper X9 in position 2-3 (CCSC deactivated) Parameter degradation below 6.5 V	8 V to 27 V (Down to 6.5 V for less than 2 s)
Input supply voltage	Jumper X9 in position 1-2 (CCSC active)	8 V to 27 V (Down to 3.0 V for less than 2 s)
Output current	Jumper X12 open	350 mA
Switching frequency	V_{IN} = 13.2 V	400 kHz
Efficiency	Measured with 12 white standard LED 3 V @ 350 mA output current	> 91%
Output voltage range	Output voltage related to ground	30 V to 54 V
Output overvoltage protection	Output voltage related to ground	60 V

2 Quick start procedure

The default configuration of the board has all additional features disabled. In this configuration the output current cannot be adjusted. PWM signal has to be applied as digital signal on X18 (max. 45 V).

Jumpers are populated as follows:

Table 2 Jumper population

Jumper number	Condition	Meaning
X9	Close 2-3	Disable CCSC
X10	Close 2-1	Disable battery dependent current

The default configuration is depicted below:

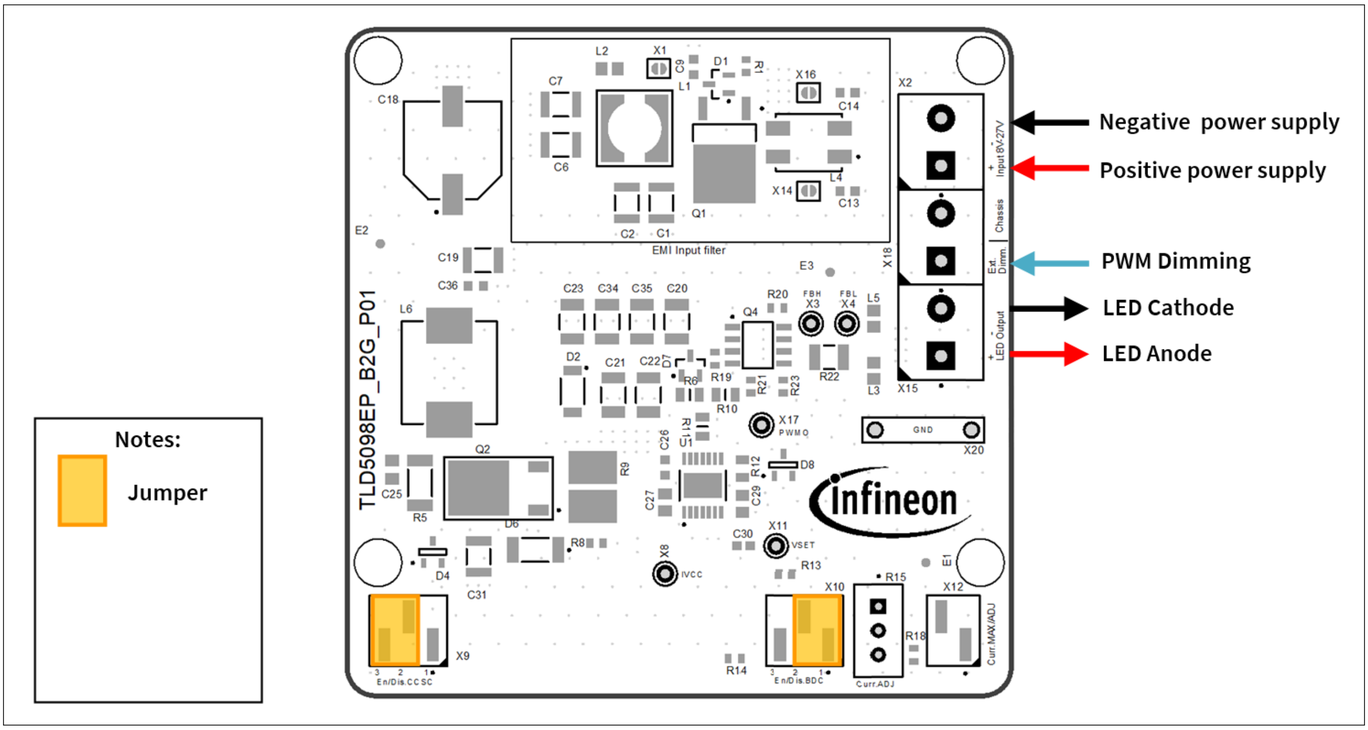

Figure 3 Default configuration of the board

3 Current adjustment

Output current adjustment can be performed by changing the value of trimmer R15 with a screwdriver, when X10 is closed in position 1-2 and X12 is closed. Output current can vary from 0 to 100% of the maximum output current (in this evaluation board from 0 to 350 mA). By removing the X12 jumper, output current will reach its maximum value. PWM signal has to be applied as digital signal on X18 (max. 45 V).

Jumpers are populated as follows:

Table 3 Jumper population

Jumper number	Condition	Meaning
X9	Close 2-3	Disable CCSC
X10	Close 2-1	Disable battery dependent current
X12	Closed	Adjustable output current enabled

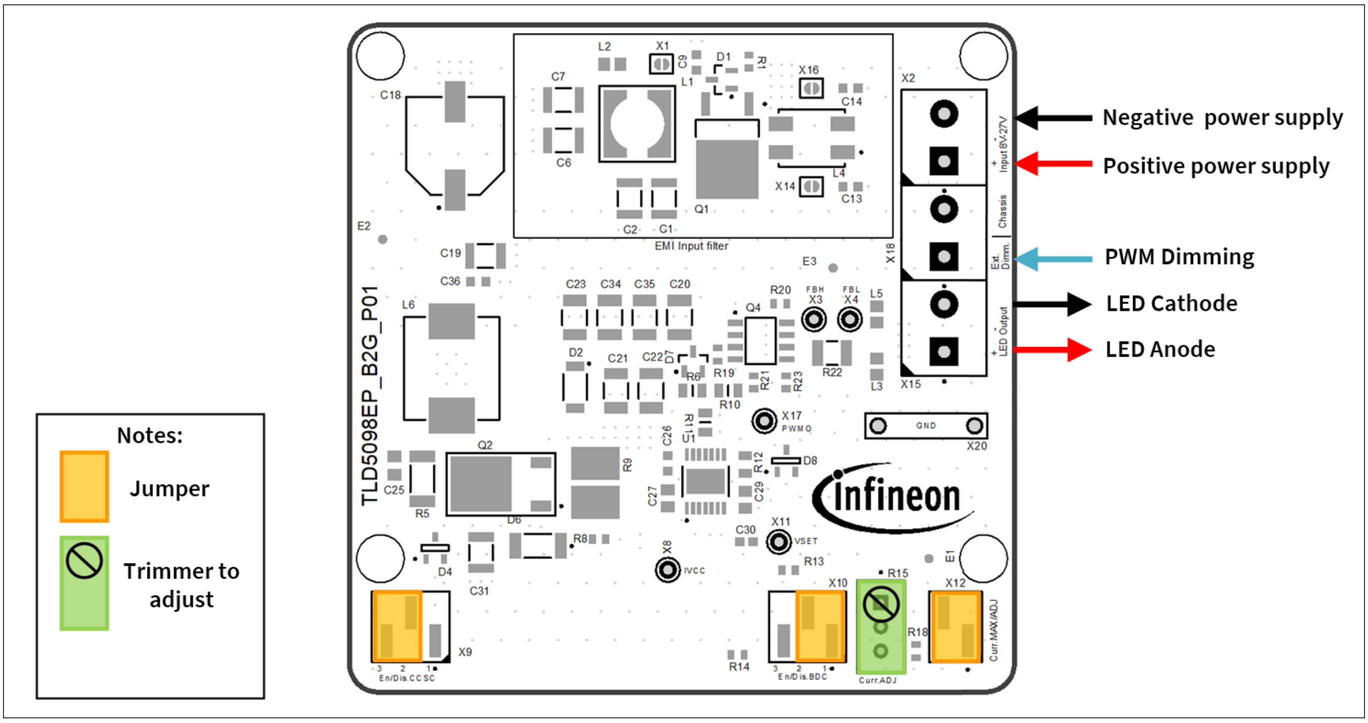

Figure 4 Current adjustment

4 Power derating (battery dependent current)

Power derating acts by reducing V_{SET} (and thus the output current) when the battery voltage drops below 8 V. It works better when R15 is trimmed to its maximum value, otherwise a different derating profile is applied. If a different derating profile is needed, R14 has to be changed accordingly, in order to have 1.6 V on pin SET when the battery voltage reaches the desired threshold below which the output current must decrease proportionally. A quick formula to calculate R14 is:

$$R14 = \left(R15 + R18\right) \cdot \left(\frac{V_{BATT}}{1.6} - 1\right)$$

where R15 = 10 kΩ and R18 = 560 Ω.

For example, if the power derating should start when the battery voltage drops under 12 V, R14 must be replaced with a 68 kΩ 0603 resistor (please refer to the TLD5098EP datasheets for more information).

PWM signal has to be applied as digital signal on X18 (max. 45 V).

Jumpers are populated as follows:

Table 4 Jumper population

Jumper number	Condition	Meaning
X9	Close 2-3	Disable CCSC
X10	Close 2-3	Enable battery dependent current
X12	Closed	Adjustable output current enabled

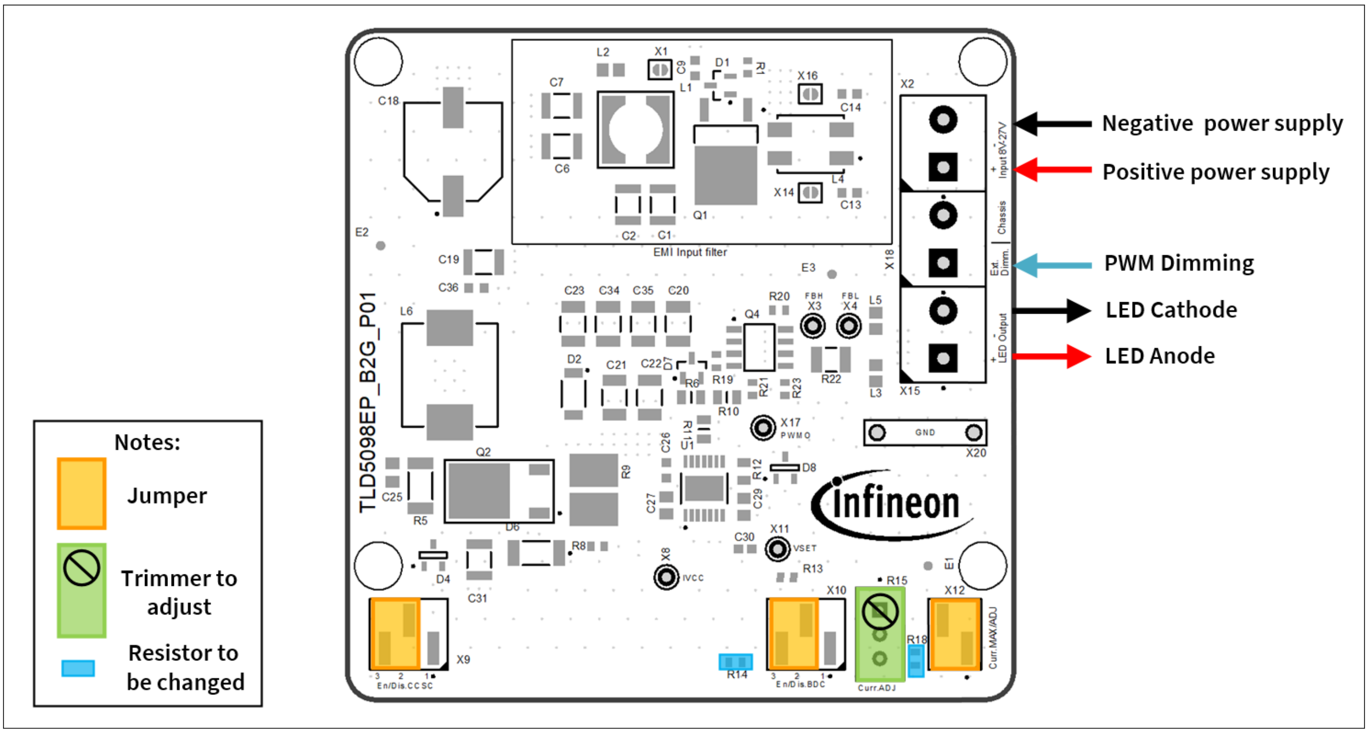

Figure 5 Power derating

5 Cold crank survival circuit

This feature helps the system to survive LV124 test E11 "severe test pulse", when input voltage drops below 4.5 V, that is the minimum input voltage for the TLD5098EP. This circuit feeds back the device with the output voltage when the input voltage drops. To activate this feature, close X9 in position 1-2. Other settings can be left as preferred.

Note: The CCSC uses a Zener diode to adapt the output voltage to the required voltage for the TLD5098EP, so that it can derate the efficiency performance.

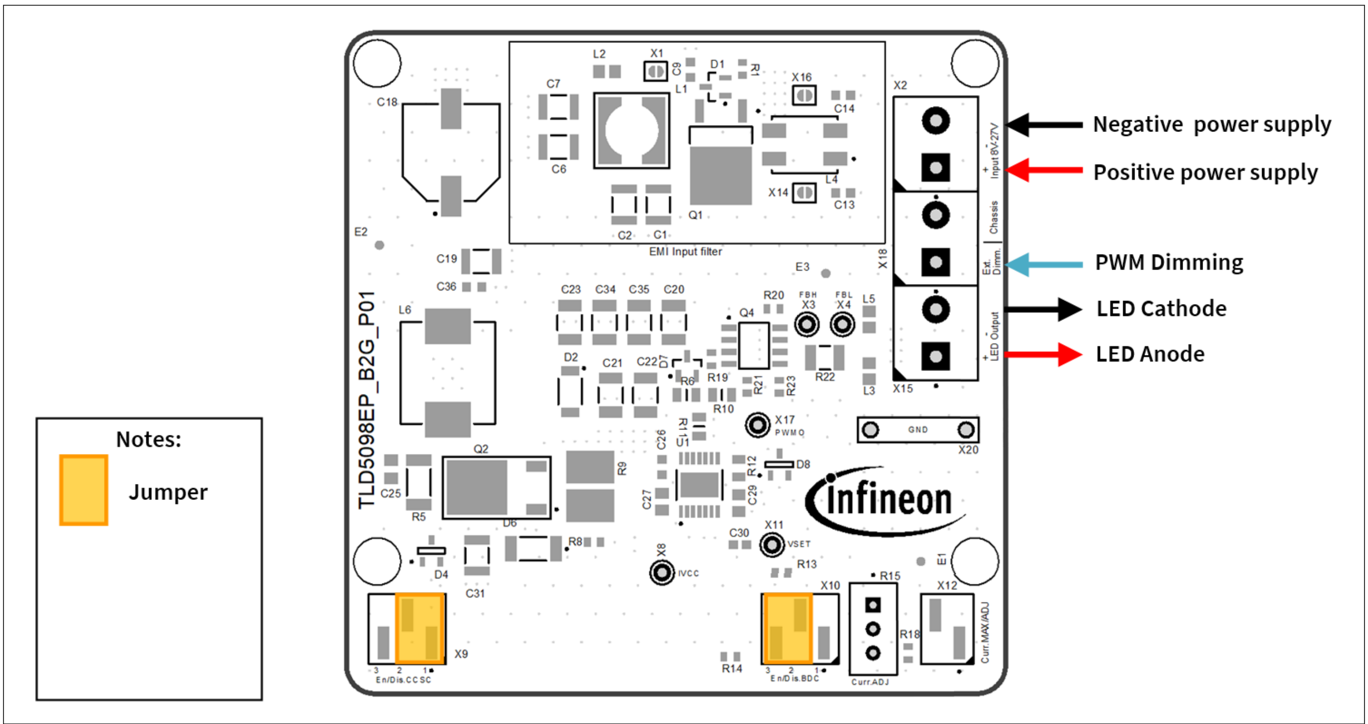

Figure 6 **Cold crank survival circuit**

6 Schematics

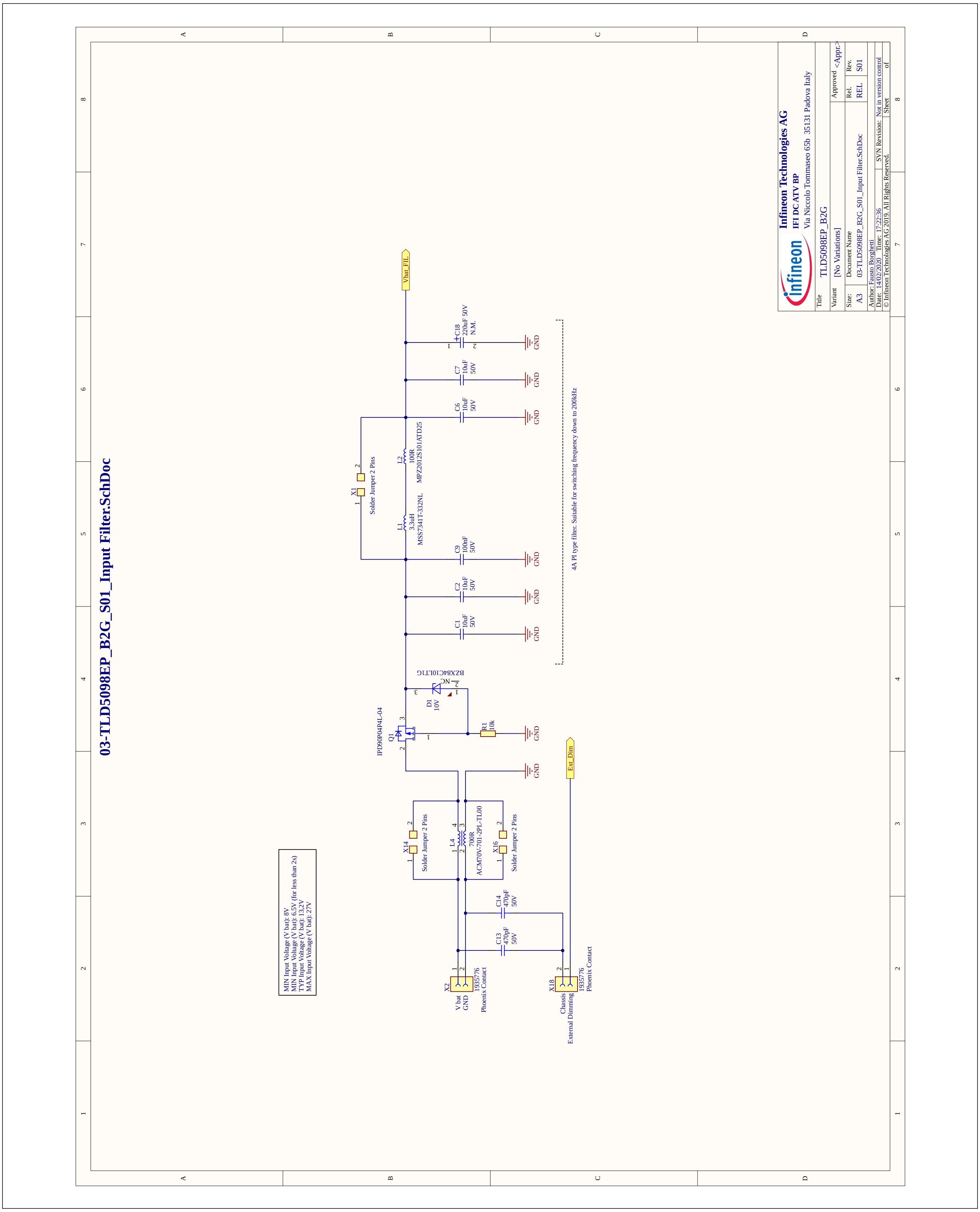

Figure 7 **Input filter**

6 Schematics

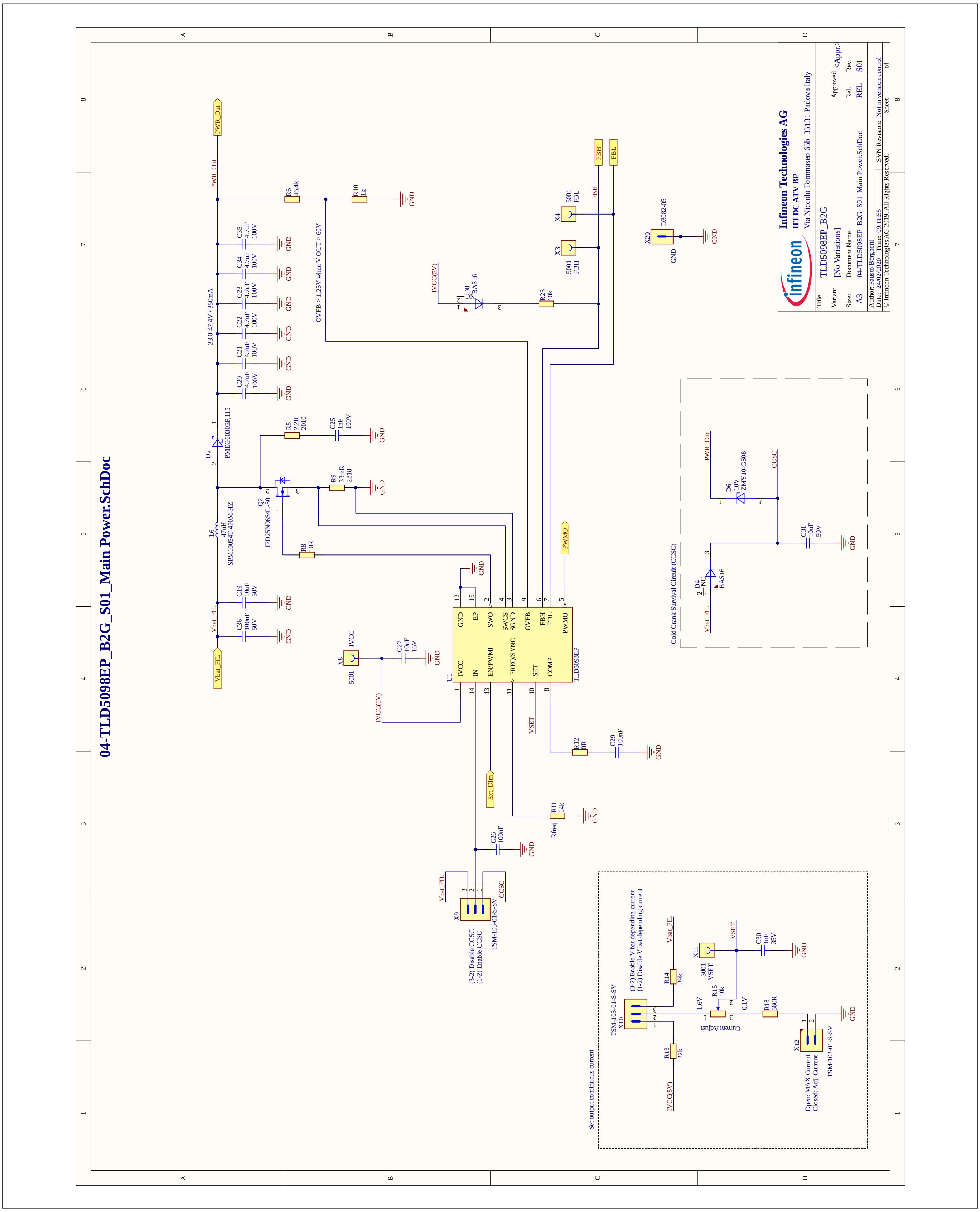

Figure 8 **Main power**

6 Schematics

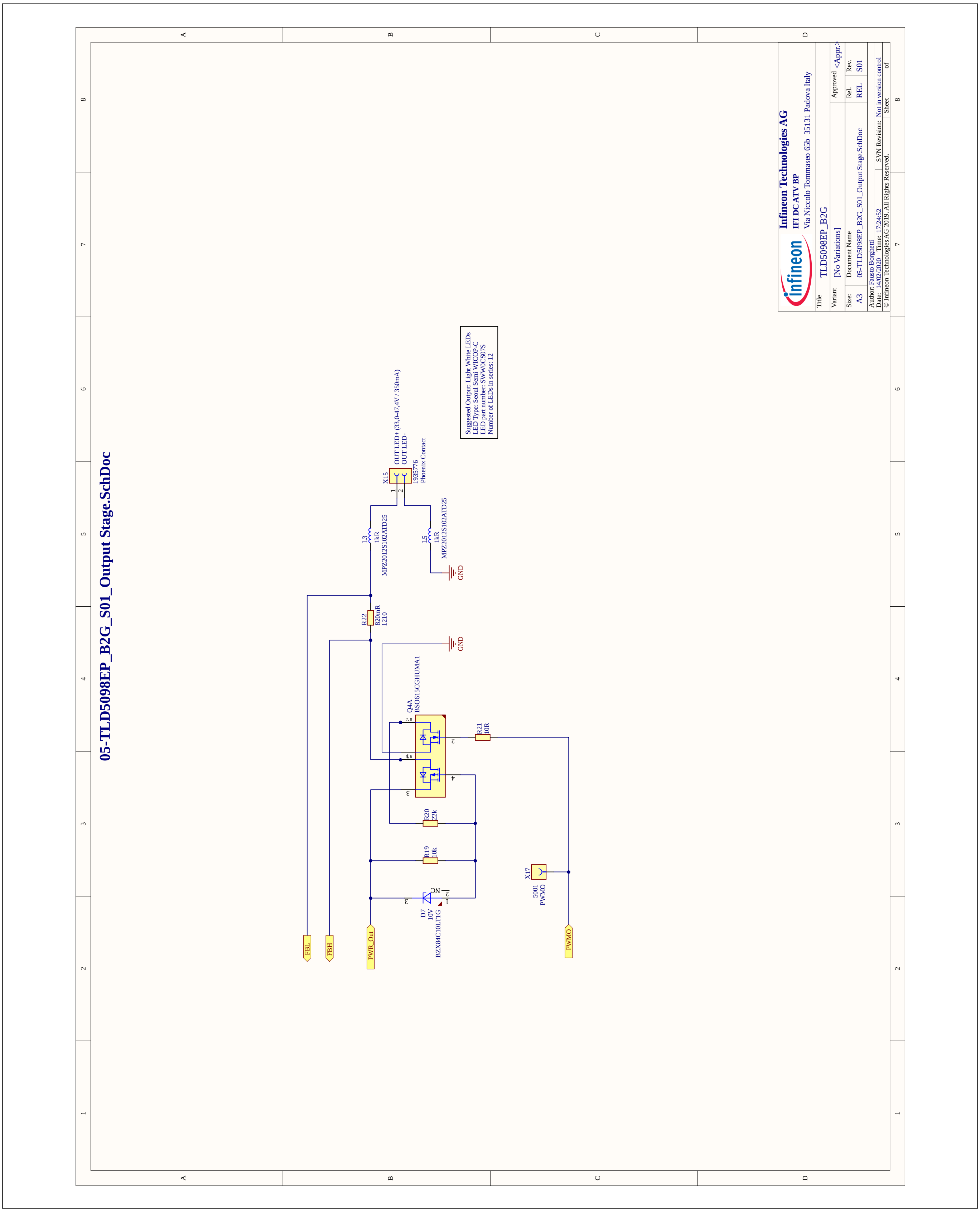

Figure 9 **Output stage**

7 PCB layout

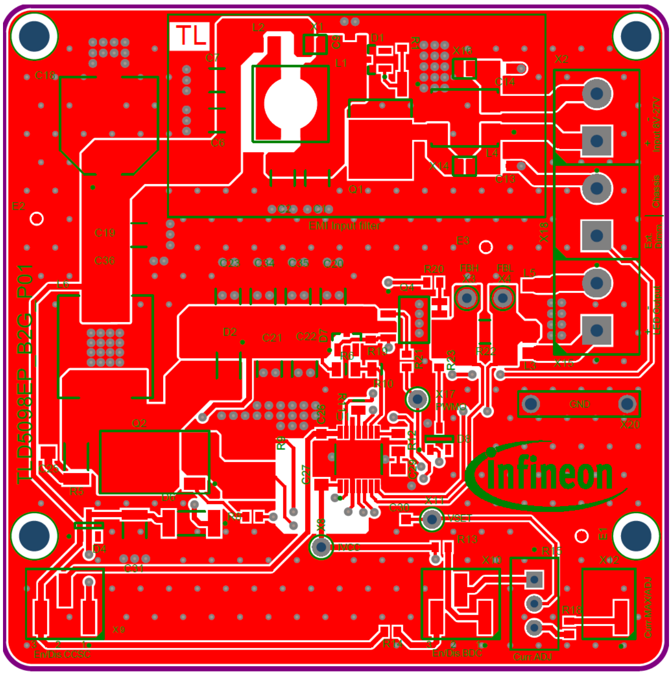

Figure 10 **PCB layout top view**

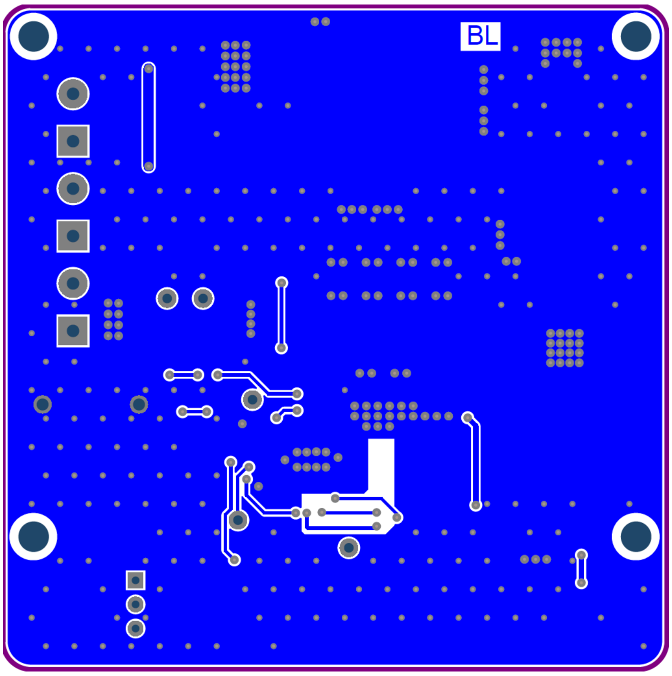

Figure 11 **PCB layout bottom view**

8 Bill of material

Table 5 Bill of material

Designator	Value	Manufacturer	Manufacturer order number
C1, C2, C6, C7, C19, C31	10uF	muRata	GCM32EC71H106KA03
C9, C26, C36	100nF	AVX	06035C104K4Z2A
C13, C14	470pF	muRata	GCM1885C1H471JA16
C18	220uF	Panasonic	EEEFK1H221P
C20, C21, C22, C23, C34, C35	4.7uF	TDK	CGA6M3X7S2A475K200AE
C25	1nF	TDK Corporation	CGA4F2X7R2A102M085AE
C27	10uF	TDK	CGA4J1X7S1C106K125AC
C29	100nF	TDK	CGA4J2X7R2A104M125AE
C30	1uF	TDK	CGA3E1X7R1V105K080AC
D1, D7	10V	ON Semiconductor	BZX84C10LT1G
D2	PMEG6030EP,115	Nexperia	PMEG6030EP,115
D4, D8	BAS16	Infineon Technologies	BAS16
D6	10V	Vishay	ZMY10-GS08
L1	3.3uH	Coilcraft	MSS7341T-332NL
L2	100Ω @ 100MHz	TDK Corporation	MPZ2012S101ATD25
L3, L5	1kΩ @ 100MHz	TDK	MPZ2012S102ATD25
L4	700Ω @ 100MHz	TDK	ACM70V-701-2PL-TL00
L6	47uH	TDK Corporation	SPM10054T-470M-HZ
Q1	IPD90P04P4L-04	Infineon Technologies	IPD90P04P4L-04
Q2	IPD25N06S4L-30	Infineon Technologies	IPD25N06S4L-30
Q4	BSO615CGHUMA1	Infineon Technologies	BSO615CGHUMA1
R1, R19, R23	10kΩ	Vishay	CRCW060310K0FK
R5	2.2Ω	Vishay	CRCW20102R20FK
R6	46.4kΩ	Vishay	CRCW080546K4FK
R8, R21	10Ω	Vishay	CRCW060310R0FK
R9	33mΩ	Vishay	WSHM2818R0330FEA
R10	1kΩ	Vishay	CRCW08051K00FK
R11	14kΩ	Vishay	CRCW080514K0FK
R12	0Ω	Yageo	AC0805JR-070RL
R13, R20	22kΩ	Vishay	CRCW060322K0FK
R14	39kΩ	Vishay	CRCW060339K0FK
R15	10kΩ	Vishay	T93YA103KT20
R18	560Ω	Vishay	CRCW0603560RFK
R22	820mΩ	Panasonic	ERJ14BQFR82U

Table 5 **Bill of material (continued)**

Designator	Value	Manufacturer	Manufacturer order number
U1	TLD5098EP	Infineon Technologies	TLD5098EP
X1, X14, X16	Solder Jumper 2 Pins	Infineon Technologies AG	Solder Jumper 2 Pins
X2, X15, X18	1935776	Phoenix Contact	1935776
X3, X4, X8, X11, X17	5001	Keystone	5001
X9, X10	TSM-103-01-S-SV	Samtec	TSM-103-01-S-SV
X12	TSM-102-01-S-SV	Samtec	TSM-102-01-S-SV
X20	D3082-05	Harwin	D3082-05

9 Efficiency measurements

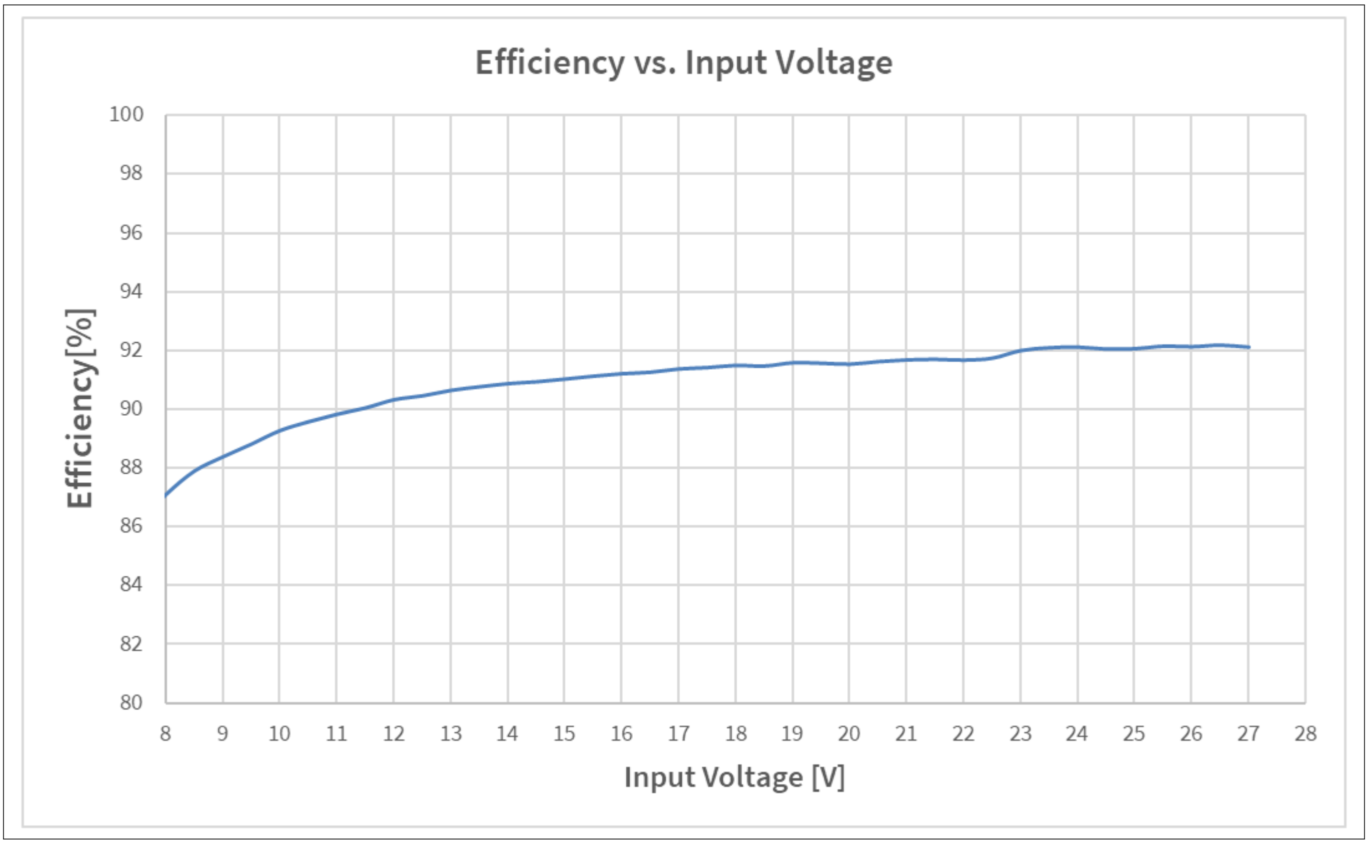

Figure 12 Efficiency vs. input voltage

This efficiency performance has been obtained with:

Table 6 Parameters influencing efficiency

Output load:	Series of 12 white standard LED with V_j = 3 V kept cooled with forced air
EMI filter:	Totally bypassed by closing the jumpers X1, X14 and X16
CCSC:	Off (jumper X9 closed on 2-3)
Current adjustment:	Off (jumper X12 left open)
Dimming:	100% DC
Power derating	Off (jumper X10 closed on 1-2)

Efficiency performances can be increased: refer to ***Chapter 11***.

10 Maximizing efficiency

This evaluation board has been designed to reach a fair compromise between efficiency performance and EMI emissions compliance.

Nevertheless, if the maximum efficiency is needed, the following actions should be considered:

1. Remove the snubber circuit R5, C25 or choose a lower value for the capacitor C25 (for example 470 pF)
2. Bypass the whole EMI filter by bridging the jumpers X1, X14 and X16
3. Bypass the output ferrite beads L3 and L5
4. Replace the main inductor L6 with one that boasts a lower parasitic DC resistance, for example
   - Vishay IHLP6767GZER470M8A
   - Bourns SRP1770TA-470M
5. Turn off the CCSC by placing the jumper X9 on position 2-3
6. Bypass gate resistor R8

11 Minimizing EMI emissions

This evaluation board has been designed to reach a fair compromise between efficiency performance and EMI emissions compliance from 150 kHz to 108 MHz.

Nevertheless, if the minimum EMI emission is required, the following actions should be considered:

1. Choose a higher value for the capacitor C25 (for example 2.2 nF)
2. Include the whole EMI filter by removing bridges from the jumpers X1, X14 and X16
3. Replace the 10 Ω resistor R8 with a higher value such as 22 Ω or 33 Ω
4. Replace the main inductor L6 with a shielded one (for example the Cyntec VCHE106G-470MS6) and connecting the shield to ground
5. Connect the CHASSIS TERMINAL with a short piece of wire to the test ground plane as close as possible to where the board is placed

12 Revision history

Document version	Date of release	Description of changes
Rev. 1.00	2020-03-10	First release related to evalboard S01_P01.

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