SEPIC evaluation kit

TLD5099EP

About this document

Product description

The TLD5099EP is an AEC qualified DC-DC boost controller, especially designed to drive LEDs.

- Built in diagnosis and protection features
- Pulse width modulator to implement a dimming function with reduced color shifting
- Spread spectrum modulator to improve the EMI performance

Scope and purpose

Scope of this user manual is to provide to the audience instructions on usage of TLD5099EP SEPIC evaluation board.

Intended audience

This document is intended for engineers who need to perform measurements and check performances with TLD5099EP SEPIC evaluation board.

Table of contents

1 Description

The Evaluation board for high power LED application with TLD5099EP product in SEPIC topology will be explained.

Default configuration of the board is SEPIC topology without any additional features enabled. In this configuration, it can deliver up to 23 W to the load with an efficiency above 84%. 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
- Embedded PWM engine
- Cold Crank Survival Circuit (**CCSC**)

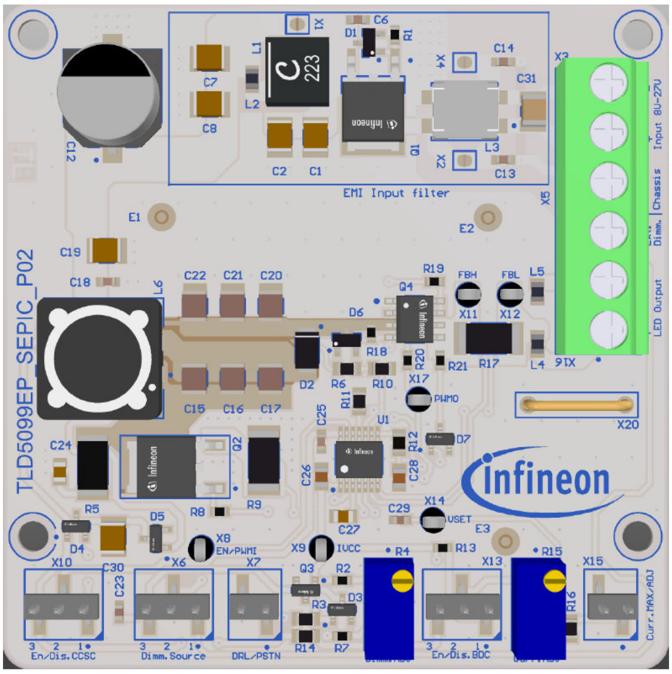

Figure 1 Board picture

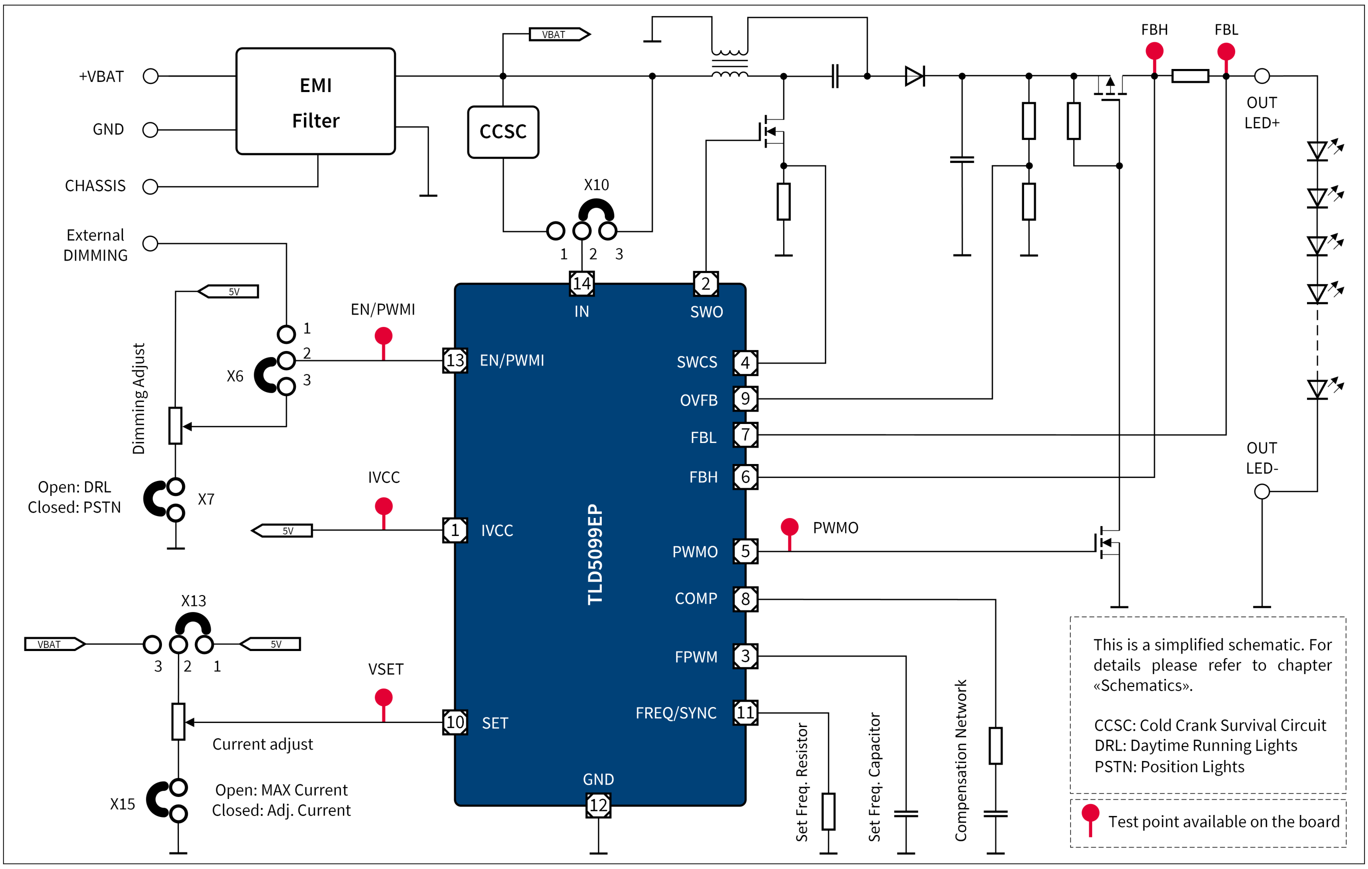

Figure 2 Simplified schematic

Table 1 Performance summary

Parameter	Conditions	Value
Input supply voltage	Jumper X10 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 X10 in position 1-2 (CCSC active)	8 V to 27 V Down to 3 V for less than 2 s
Output current	Jumper X15 open	1 A
Switching frequency	V_{IN} = 13.2 V; spread spectrum "on"	400 kHz
Efficiency	Measured with 7 white standard LED 3 V @ 1 A output current	> 84%
Output voltage range	Output voltage related to ground	6 V to 23 V
Output overvoltage protection	Output voltage related to ground	28 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. The PWM signal must be applied as digital signal on connector X18 (max. 45 V).

Jumpers are positioned as follows:

Table 2 Jumper position

Jumper number	Condition	Meaning
X10	Close 2-3	Disable CCSC
X6	Close 2-1	External dimming enabled
X13	Close 2-1	Disable battery dependent current

The default configuration is depicted below:

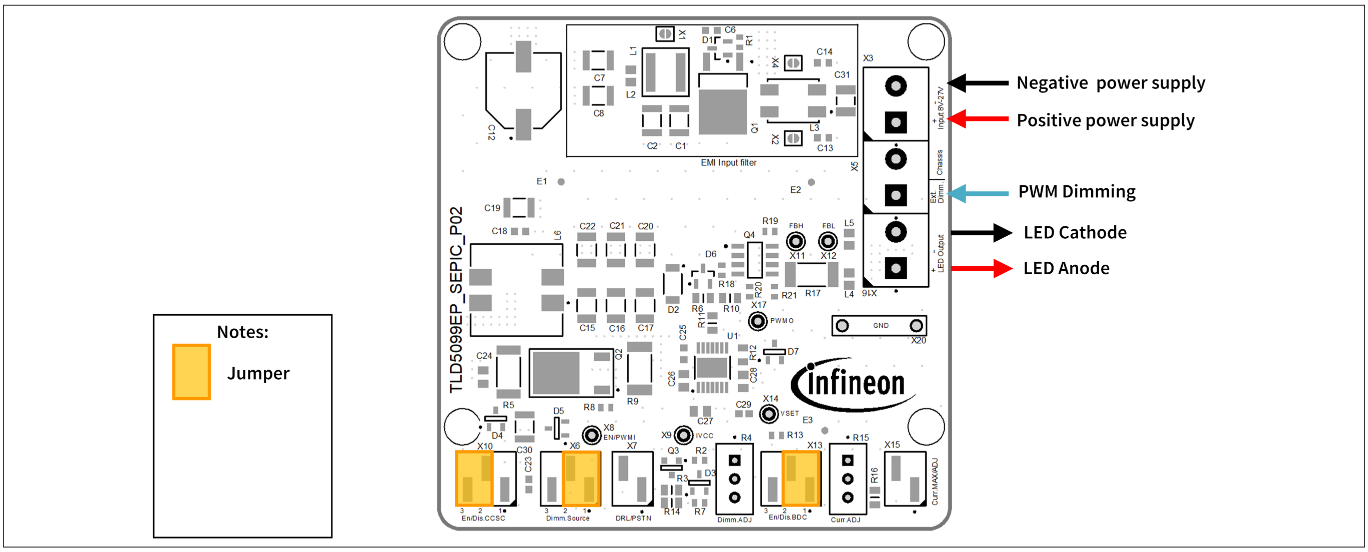

Figure 3 Default configuration of the board

3 Current adjustment

The output current adjustment can be performed by changing the value of trimmer R15 with a screwdriver, when jumper X13 is closed in position 1-2 and jumper X15 is closed. The output current can vary from 0 to 100% of the maximum output current (in this evaluation board from 0 to 1 A). By removing jumper X15, the output current will reach its maximum value. The PWM signal has to be applied as digital signal on connector X18 (max. 45 V).

Jumpers are positioned as follows:

Table 3 Jumper position

Jumper number	Condition	Meaning
X10	Close 2-3	Disable CCSC
X6	Close 2-1	External dimming enabled
X13	Close 2-1	Disable battery dependent current
X15	Closed	Adjustable output current enabled

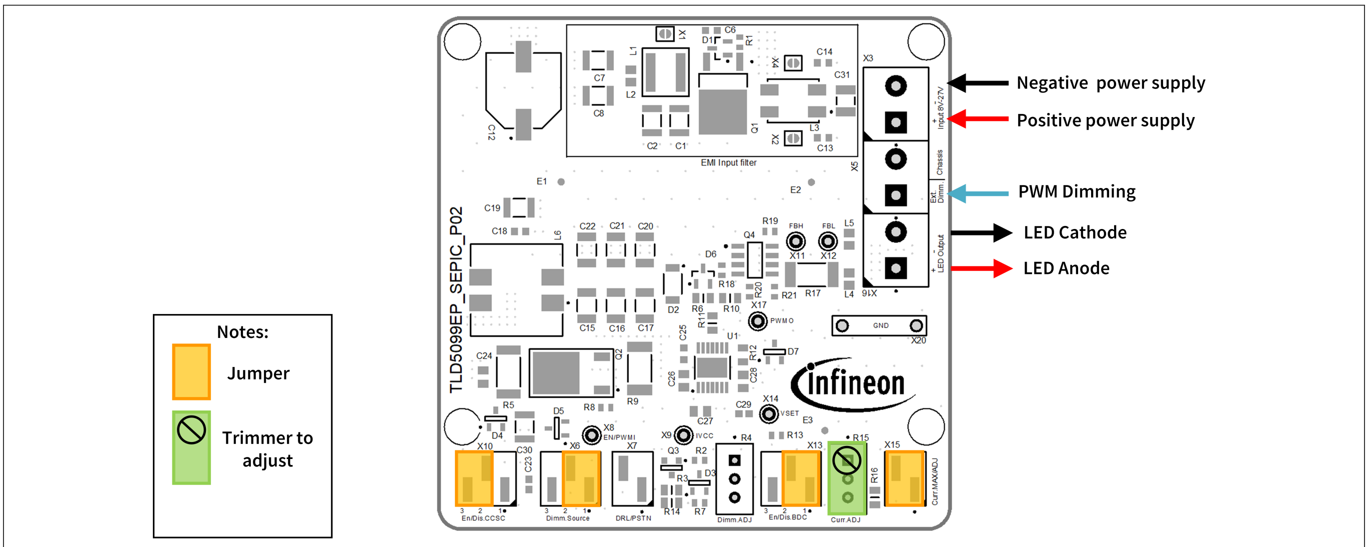

Figure 4 Current adjustment

4 Power derating (Battery dependent current)

The 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. The aim is to have 1.6 V on pin SET when the battery voltage reaches the desired threshold, below which the output current must decrease proportionally.

R14 can be calculated using:

$$R14 = \left(R15 + R16\right) \cdot \left(\frac{V_{\mathrm{BATT}}}{1.6} - 1\right) \quad (1)$$

where

- R15 = 10 kΩ
- R16 = 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 TLD5099EP datasheets for more information).

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

Table 4 Jumper position

Jumper number	Condition	Meaning
X10	Close 2-3	Disable CCSC
X6	Close 2-1	External dimming enabled
X13	Close 2-3	Enable battery dependent current
X15	Closed	Adjustable output current enabled

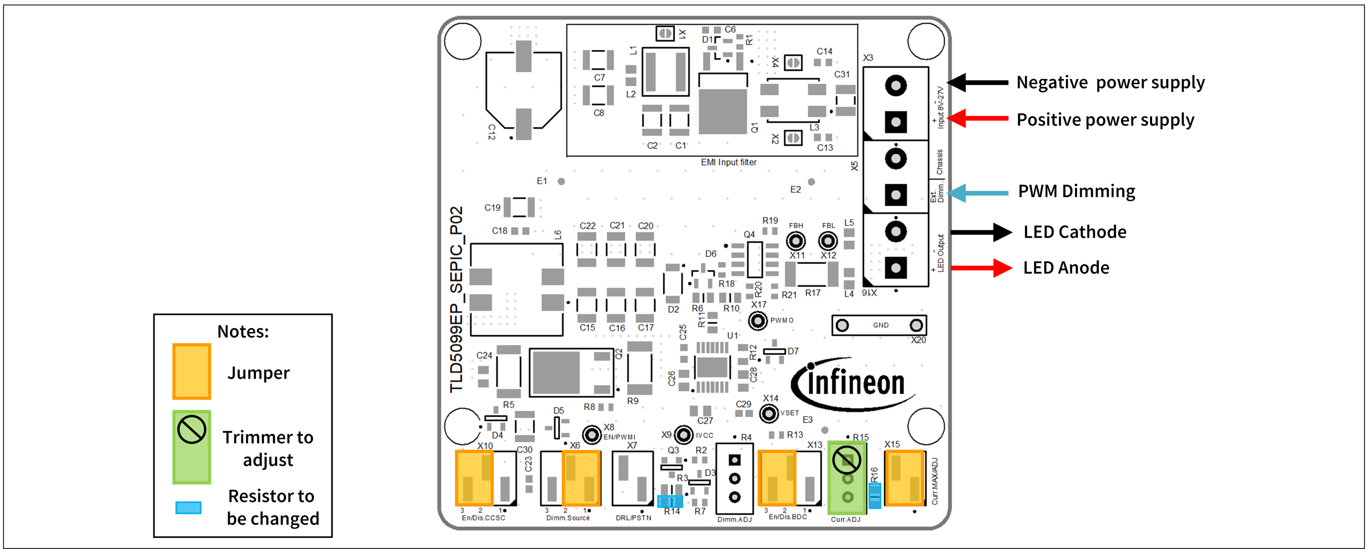

Figure 5 Power derating

5 Embedded PWM engine

The embedded PWM engine provides an internal PWM signal without any external dimming signal required. It is enabled when jumper X6 is closed in position 2-3. If jumper X7 is open, EN/PWMI pin is biased at 5 V and then the duty cycle is 100%. Closing jumper X7, the duty cycle is adjustable by means of trimmer R4. The PWM frequency is set to 350 Hz. If another PWM frequency is needed, C27 must be changed to a proper value (please refer to the TLD5099EP datasheets for more information).

Jumpers are positioned as follows:

Table 5 Jumper position

Jumper number	Condition	Meaning
X10	Close 2-3	Disable CCSC
X6	Close 2-3	Internal dimming enabled
X13	Close 2-1	Disable battery dependent current
X7	Closed	Adjustable PWM dimming for position light

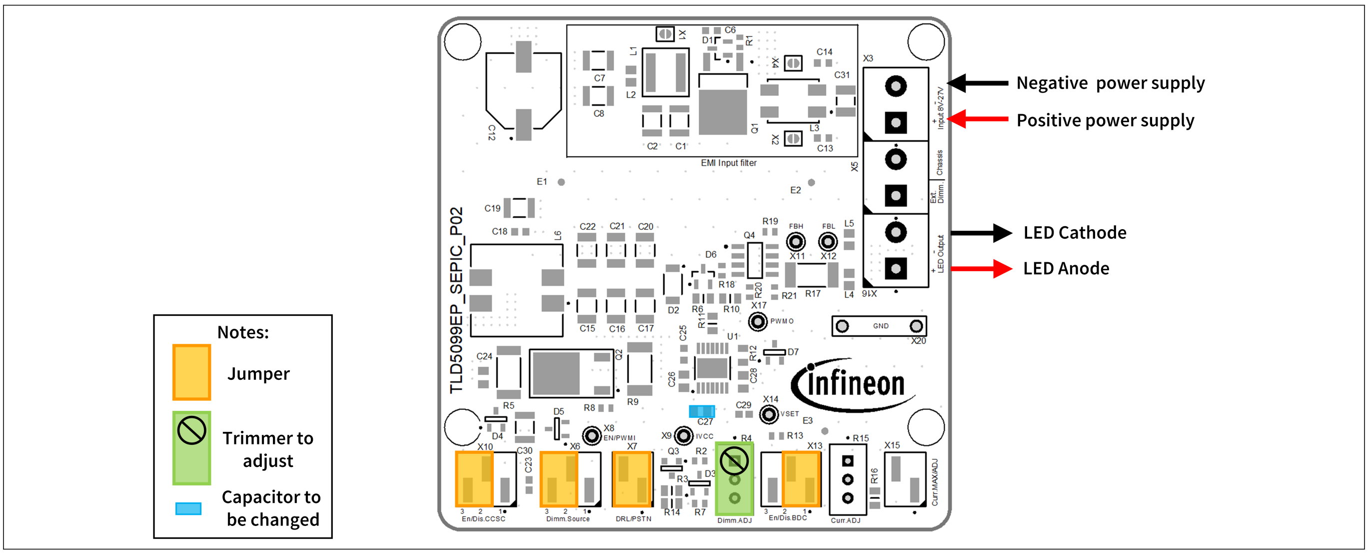

Figure 6 Embedded PWM engine

6 Cold crank survival circuit

This feature helps the system to survive LV124 test E11 “severe test pulse”, when the input voltage drops below 4.5 V, which is the minimum input voltage for the TLD5099EP. This circuit feeds back the device with the output voltage when the input voltage drops. To activate this feature, close jumper X10 in position 1-2. Other settings can be left as preferred.

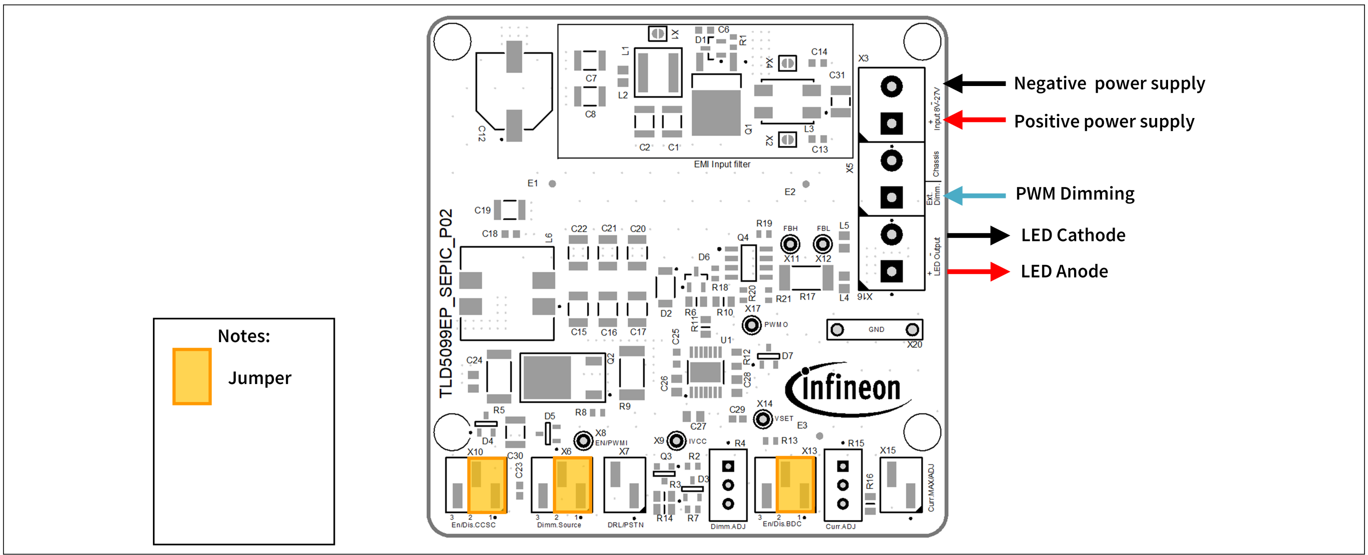

Figure 7 Cold crank survival circuit

7 Schematics

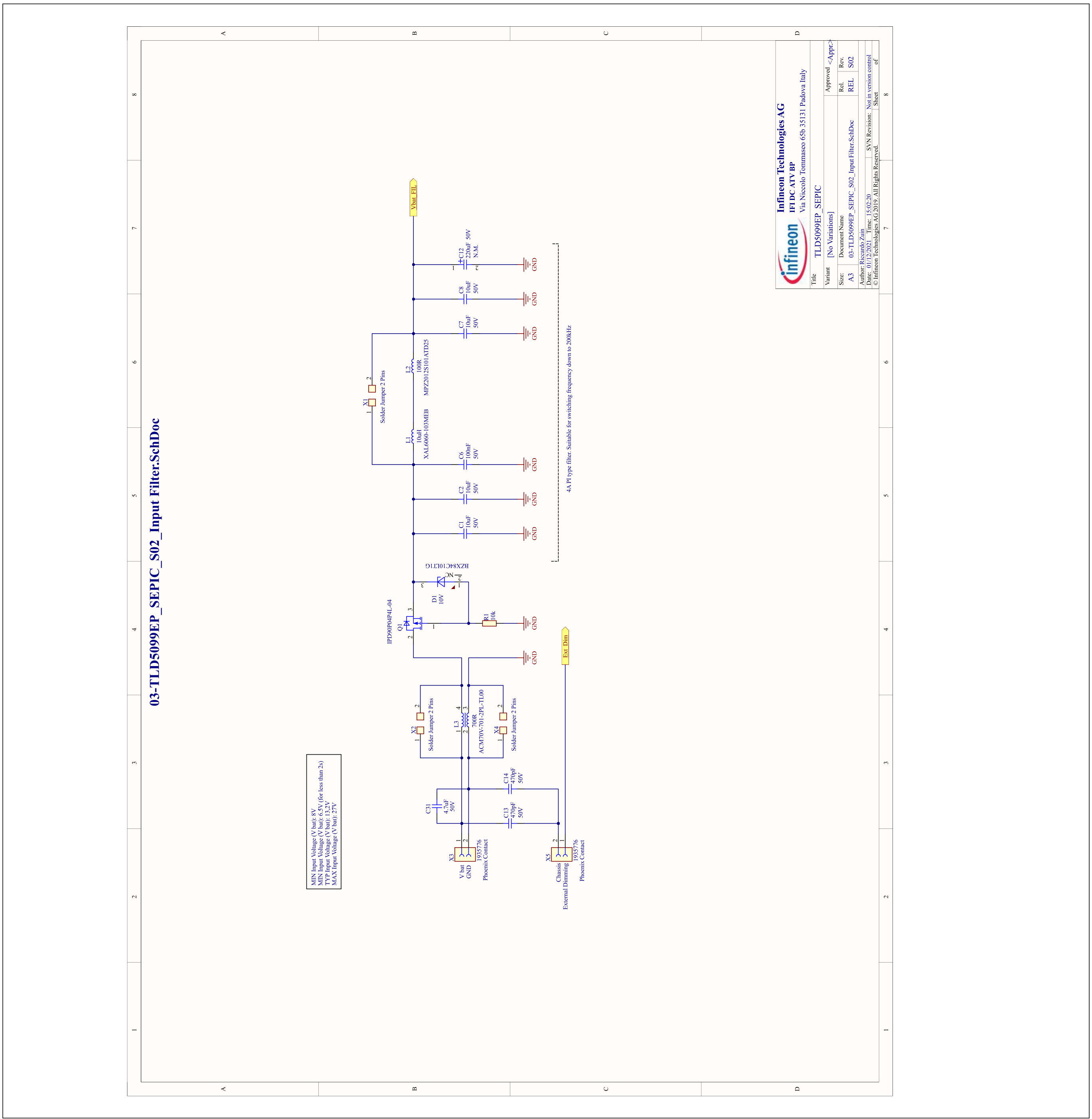

Figure 8 **Input filter**

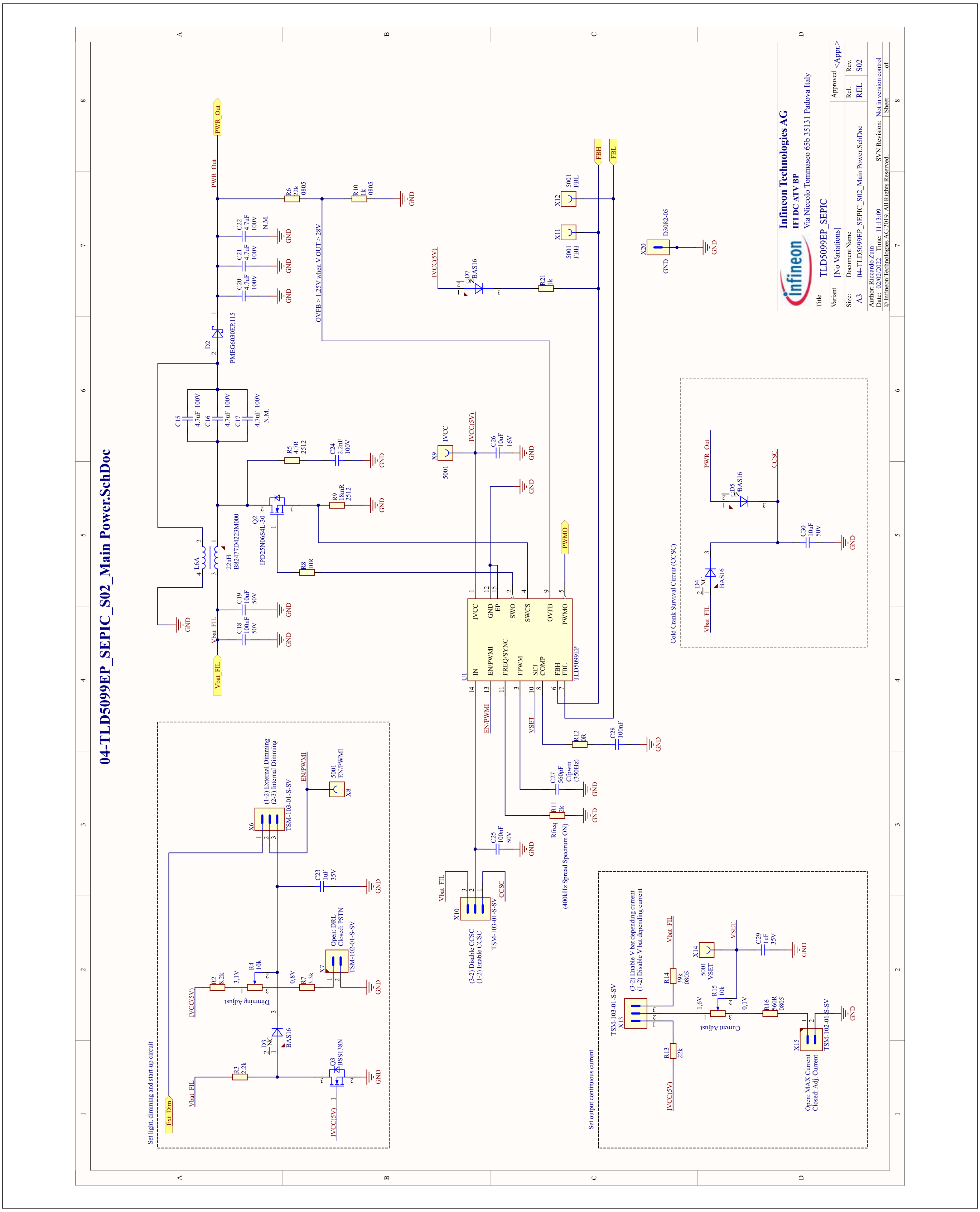

Figure 9 Main power

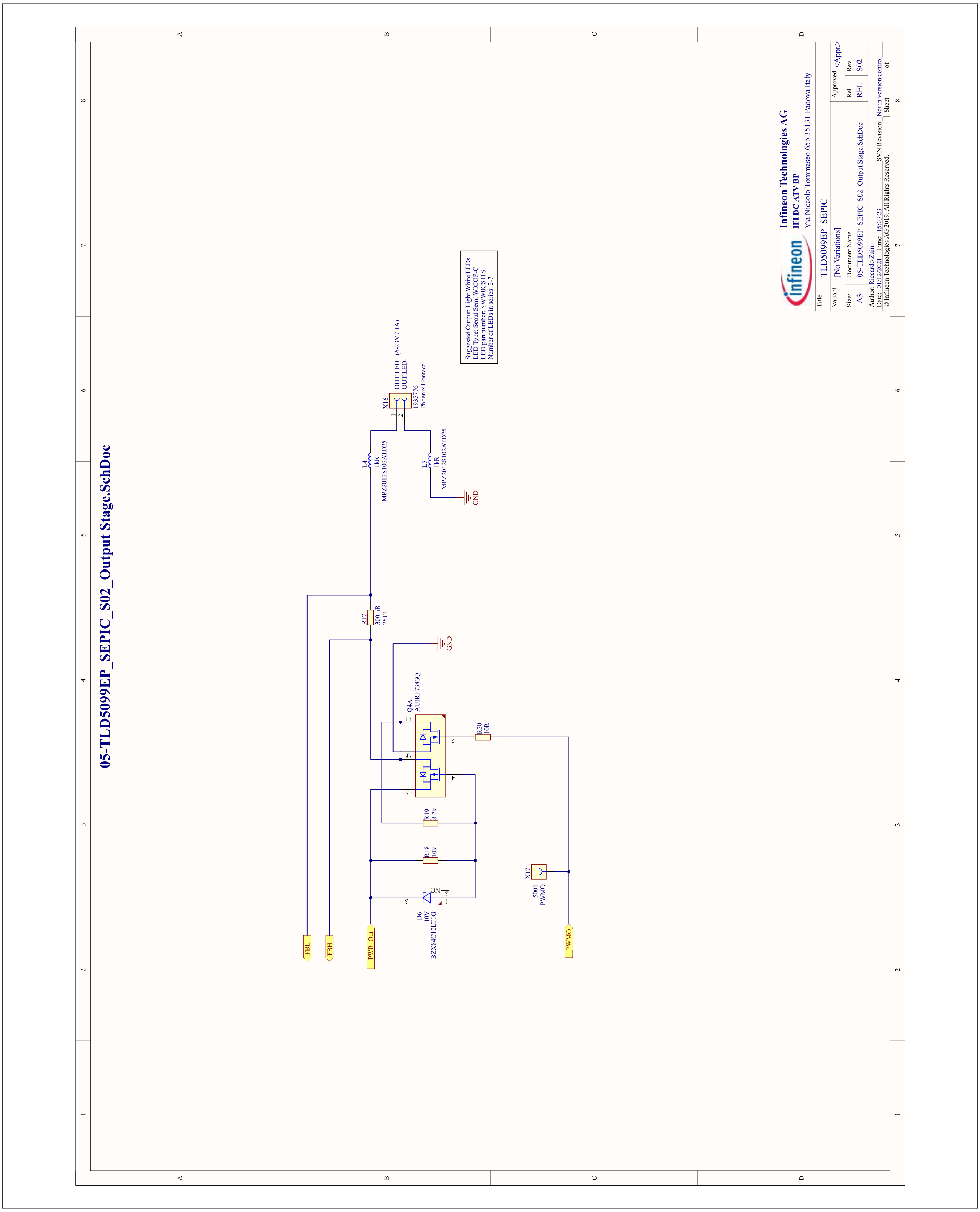

Figure 10 **Output stage**

8 PCB layout

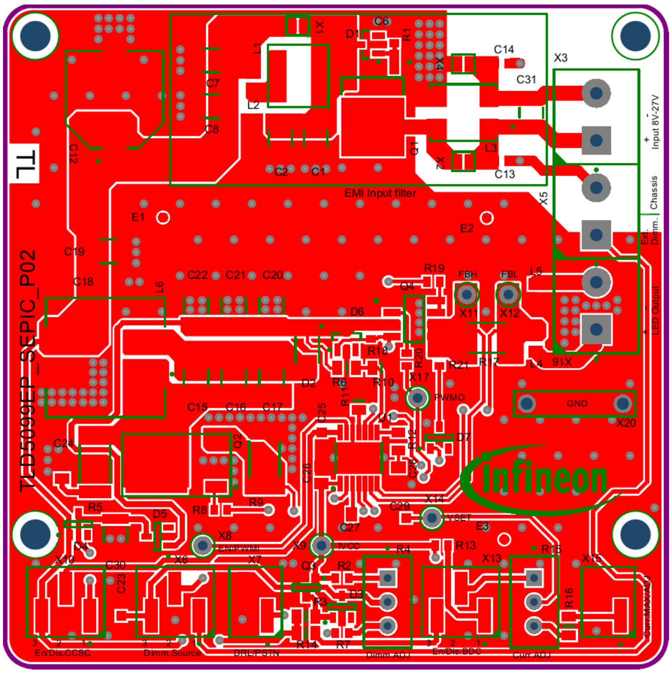

Figure 11 PCB layout top view

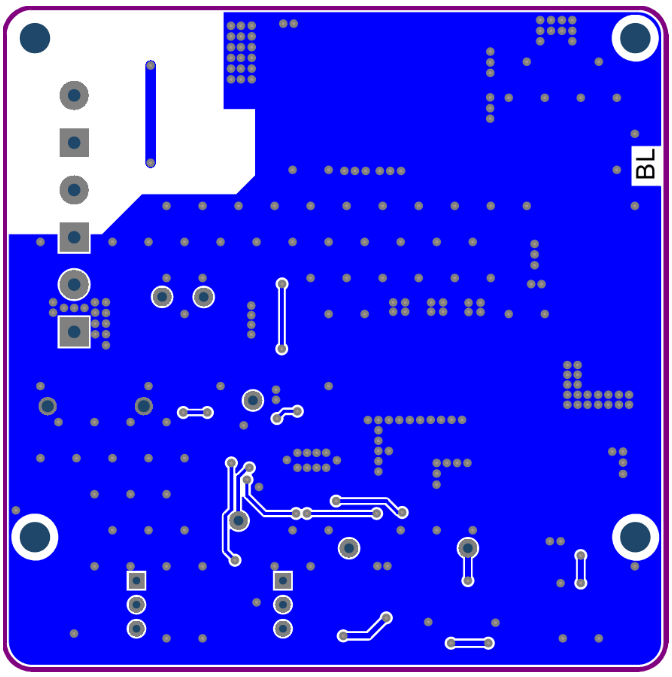

Figure 12 PCB layout bottom view

9 Bill of material

Table 6 Bill of material

Designator	Value	Manufacturer	Manufacturer order number
C1, C2, C7, C8, C19, C30	10 uF	muRata	GCM32EC71H106KA03
C6, C18, C25	100 nF	AVX	06035C104K4Z2A
C12	220 uF	Panasonic	EEEFK1H221P
C13, C14	470 pF	muRata	GCM1885C1H471JA16
C15, C16, C20, C21	4.7 uF	TDK	CGA6M3X7S2A475K200AE
C17, C22	4.7 uF	TDK	CGA6M3X7S2A475K200AE
C23, C29	1 uF	TDK	CGA3E1X7R1V105K080AC
C24	2.2 nF	MuRata	GCM2165C2A222FA16
C26	10 uF	TDK	CGA4J1X7S1C106K125AC
C27	560 pF	muRata	GCM2165C2A561JA16
C28	100 nF	TDK	CGA4J2X7R2A104M125AE
C31	4.7 uF	Kemet	C1210C475K5RACAUTO
D1, D6	10 V	ON Semiconductor	BZX84C10LT1G
D2	PMEG6030EP,115	Nexperia	PMEG6030EP,115
D3, D4, D5, D7	BAS16	Infineon Technologies	BAS16
L1	10 uH	Coilcraft	XAL6060-103MEB
L2	100 Ω	TDK Corporation	MPZ2012S101ATD25
L3	–	TDK	ACM70V-701-2PL-TL00
L4, L5	1 kΩ	TDK	MPZ2012S102ATD25
L6	22 uH	TDK Corporation	B82477D4223M000
Q1	IPD90P04P4L-04	Infineon Technologies	IPD90P04P4L-04
Q2	IPD25N06S4L-30	Infineon Technologies	IPD25N06S4L-30
Q3	BSS138N	Infineon Technologies	BSS138N
Q4	AUIRF7343Q	Infineon Technologies	AUIRF7343Q
R1, R18	10 kΩ	Vishay	CRCW060310K0FK
R2, R19	8.2 kΩ	Vishay	CRCW06038K20FK
R3	2.2 kΩ	Vishay	CRCW08052K20FK
R4, R15	10 kΩ	Vishay	T93YA103KT20
R5	4.7 Ω	Vishay	CRCW25124R70FK
R6	22 kΩ	Vishay	CRCW080522K0FK
R7	3.3 kΩ	Vishay	CRCW06033K30FK
R8, R20	10 Ω	Vishay	CRCW060310R0FK
R9	18 mΩ	Vishay	WSL2512R0180FEA18
R10	1 kΩ	Vishay	CRCW08051K00FK
R11	2 kΩ	Vishay	CRCW08052K00FK

(table continues...)

Table 6 (continued) Bill of material

Designator	Value	Manufacturer	Manufacturer order number
R12	0 Ω	Yageo	AC0805JR-070RL
R13	22 kΩ	Vishay	CRCW060322K0FK
R14	39 kΩ	Vishay	CRCW080539K0FK
R16	560 Ω	Vishay	CRCW0805560RFK
R17	300 mΩ	Vishay	WSL2512R3000FEA
R21	1 kΩ	Vishay	CRCW06031K00FK
U1	TLD5099EP	Infineon Technologies	TLD5099EP
X1, X2, X4	Solder Jumper 2 Pins	Infineon Technologies	Solder Jumper 2 Pins
X3, X5, X16	1935776	Phoenix Contact	1935776
X6, X10, X13	TSM-103-01-S-SV	Samtec	TSM-103-01-S-SV
X7, X15	TSM-102-01-S-SV	Samtec	TSM-102-01-S-SV
X8, X9, X11, X12, X14, X17	5001	Keystone	5001
X20	D3082-05	Harwin	D3082-05

10 Efficiency measurements

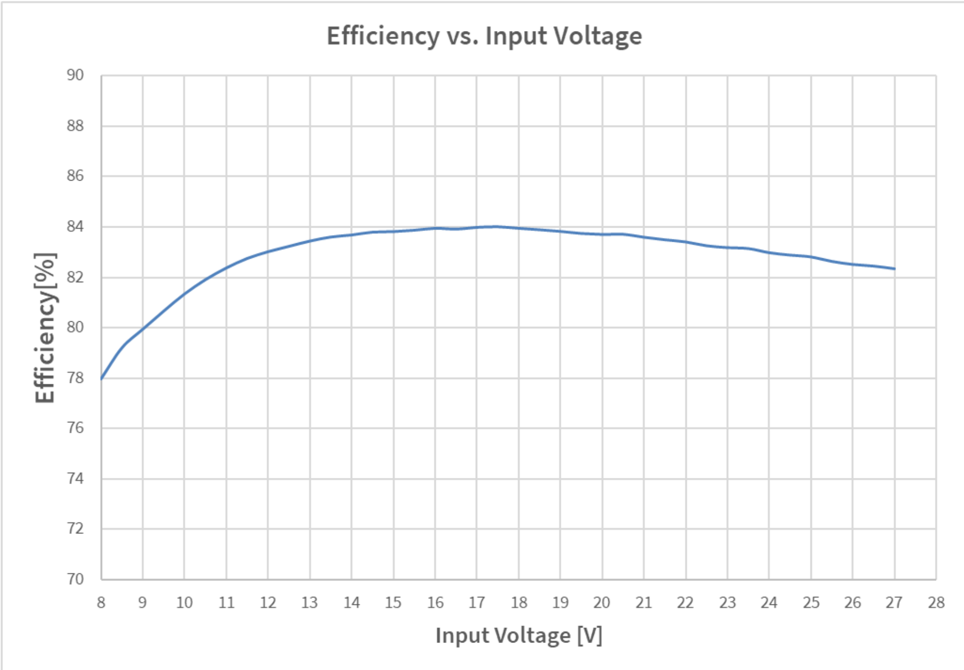

Figure 13 Efficiency vs. input voltage

This efficiency performance has been obtained with:

Table 7 Parameters influencing efficiency

Output load	Series of 7 white standard LED with V_J = 3 V kept cooled with forced air
EMI filter	Totally bypassed by closing the jumpers X1, X2 and X4
CCSC	Off (jumper X10 closed on 2-3)
Current adjustment	Off (jumper X15 left open)
Dimming output	Off (jumper X7 left open)

Efficiency performances can be increased: refer to Maximizing efficiency.

11 Maximizing efficiency

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

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

1. Remove the snubber circuit R5, C24 or choose a lower value for the capacitor C24 (for example 1 nF)
2. Bypass the whole EMI filter by bridging the jumpers X1, X2 and X4
3. Bypass the output ferrite beads L4 and L5
4. Replace the main inductor L6 with one that boasts a lower parasitic DC resistance, for example
   - TDK model B82477C6223M603
   - TDK model B82477D6223M603
5. Turn off the CCSC by placing the jumper X10 on position 2-3
6. Bypass the gate resistor R8

12 Minimizing EM emissions

This evaluation board has been designed to reach a fair compromise between efficiency performance and EM emissions compliance. Furthermore, this evaluation board can fulfill the class V of the CISPR25 in conducted emissions from 150 kHz to 108 MHz.

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

1. Choose a higher value for the capacitor C24 (for example 2.7 nF or 3.3 nF)
2. Include the whole EMI filter by removing bridges from the jumpers X1, X2 and X4
3. Increase the gate resistor value R8 with a small value such as 22 Ω
4. With a short piece of wire connect the CHASSIS TERMINAL to the test ground plane as close as possible to where the board is placed

Revision history

Document version	Date of release	Description of changes
Rev.2.00	2022-02-04	Second release related to evalboard S02_P02 • Editorial changes and rephrasing for clarity • Updated all figures • Rearranged connectors on evalboard • Added ground bar on evalboard
Rev.1.00	2020-01-29	First release related to evalboard S01_P01

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