TLD5191HB2W-EVAL board

User guide

LITIX™ Power TLD5191ES

About this document

Board description

- LITIX™ Power TLD5191ES: 4-switch buck-boost DC-DC controller designed for automotive applications
- Constant output current (LED driver)
- High power, high efficiency buck-boost architecture
- Slow switches configuration to switch between different load conditions
- EMC-optimized device: Spread spectrum (always ON)

Scope and purpose

The purpose of this user guide is to provide instructions for using the TLD5191ES device evaluation board TLD5191HB2W-EVAL schematic version S01, PCB version P01.

The TLD5191HB2W-EVAL is an evaluation platform for the TLD5191ES, which can work as a buck-boost LED driver, and features slow switches circuitry to change load conditions.

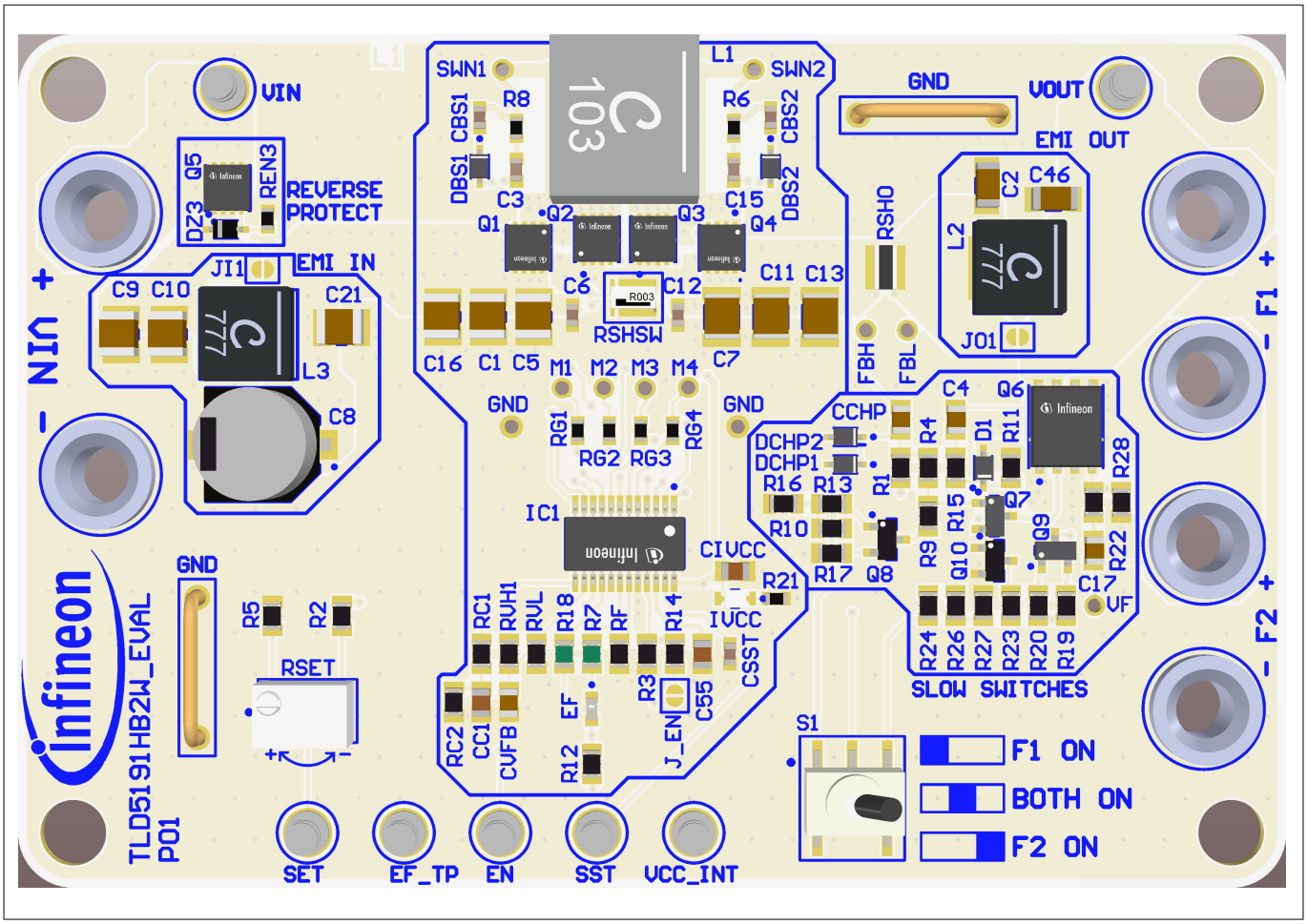

Figure 1 TLD5191HB2W-EVAL board

Intended audience

Hardware engineers

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1 Description

The 4-switch buck-boost converter architecture is among the most efficient buck-boost topologies for high-current applications. The TLD5191ES provides digital and analog dimming controls and one output flag for diagnostics.

The TLD5191HB2W-EVAL is an evaluation platform for the TLD5191ES as LED driver.

The default configuration delivers a constant current to LED load (1 A maximum). The output current can be increased to 6 A by changing resistors R_{SHO} and R_{SWCS}. If a higher current is needed, the EMI output filter has to be bypassed by closing J01.

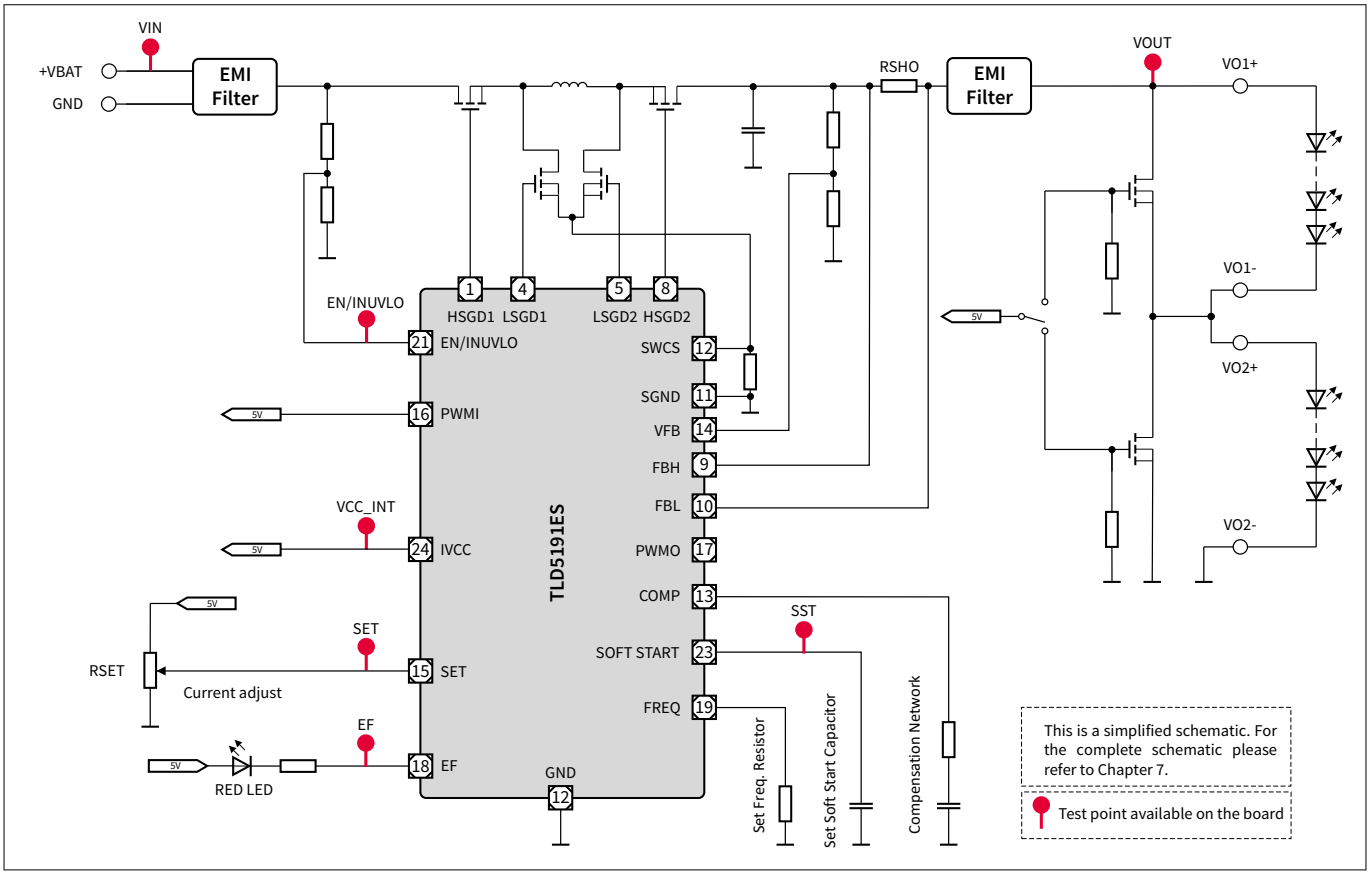

Figure 2 TLD5191HB2W-EVAL board simplified schematic

By toggling the S1 switch, the board bypasses the loads connected to its outputs, enabling the use of more functions with a single DC-DC controller such as low beam and high beam.

The board includes a trimmer and two status LEDs:

- Trimmer (R_{SET}) to adjust output current on the SET pin
- Two LEDs:
  - One blue LED showing TLD5191ES power on status on the IVCC pin
  - One red LED showing TLD5191ES faults status on the EF pin

2 Quick start procedure

The Basic setup subchapter provides step-by-step instructions for setting up and running the TLD5191HB2W-EVAL.

The board has two options for the enable signal:

- J_EN closed: EN pin is connected to input supply line, so the device is immediately enabled when valid input voltage is applied
- J_EN open: EN pin voltage can be controlled by an external signal (using EN test point)

The board is provided with J_EN closed, so that users can immediately evaluate the device.

2.1 Basic setup

The board is configured as an LED driver (current mode) with bypass output MOSFETs (slow switching MOSFETs), which enables users to quickly switch among three different load conditions:

- Only function 1 active
- Only function 2 active
- Both functions active

It is possible to switch different loads on and off simply by toggling the S1 lever switch (see below).

Since the board has been developed only to provide stable output current, no jumpers are available to regulate constant output voltage.

The available jumpers are only suitable to bypass input or output filters.

Table 1 Jumper position

Jumper name	Condition	Meaning
JI	Open	Enable the input filter
JO	Open	Enable the output filter

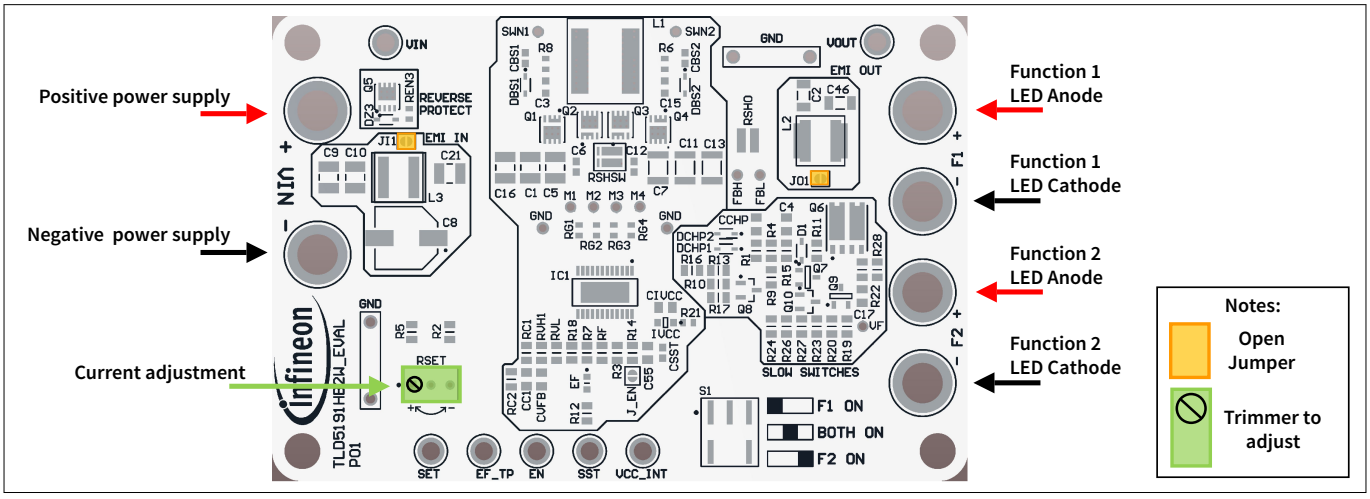

Figure 3 Constant current (LED driver) configuration

To obtain output current regulation:

1. Connect the first LED string between VO1+ and VO1- and the second LED string between VO2+ and VO1-
2. Connect a 12 V power supply to the V_{IN} connector. The blue LED turns on when V_{IVCC} is present
3. Adjust I_{OUT} via R_{SET} (>150 mA suggested for better accuracy and transient response)

2 Quick start procedure

Note: *Output overvoltage protection is set to 23 V.*

Attention**:* ***To avoid a negative spike on the F2 MOSFET gate, in the case of high overvoltage threshold (> 25 V) and load on F2 composed of fewer than 2 LEDs, it is suggested to add a Schottky diode between its gate pin and GND. This Schottky diode prevents the device from exceeding the absolute maximum ratings on the F2 MOSFET V_{GS} (Q6B in schematic).

3 Electrical characteristics

Table 2 TLD5191HB2W-EVAL version S01 P01 electrical characteristics

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Input voltage	V_{IN}	6.2	–	35	V	Minimum value set by resistor divider on the EN/INUVLO pin
Output voltage	V_{OUT}	6.2	–	23.6	V	LED driver mode: maximum value set by the resistor divider on VFB pin (overvoltage protection)
Output current	$/_{OUT}$	150	–	1000	mA	LED driver mode (up to 6 A by changing R_{SHO})
F1 Bypass time	t_{BYP_F1}	–	–	400	µs	V_{IN} 12 V, T_A = 25°C
F1 Inserting time	t_{INS_F1}	–	–	400	µs	V_{IN} 12 V, T_A = 25°C
F2 Bypass time	t_{BYP_F2}	–	–	400	µs	V_{IN} 12 V, T_A = 25°C
F2 Inserting time	t_{INS_F2}	–	–	400	µs	V_{IN} 12 V, T_A = 25°C
Switching frequency	f_{SW}	–	385	–	kHz	Spread spectrum deviation is present

4 Efficiency measurements

The following efficiency measurements have been taken with both functions active. For more information, refer to Chapter 2.1. The efficiency discontinuities on the blue curve, result from changes in the controller mode from buck to buck-boost and from buck-boost to boost. In buck-boost mode, all the four external MOSFETs are switching, increasing the total losses, while in buck or boost mode only two external MOSFETs are switching.

In particular, the change from boost to buck-boost and from buck-boost to buck mode is visible for the 5-LEDs curve, as can be seen in the graphic below.

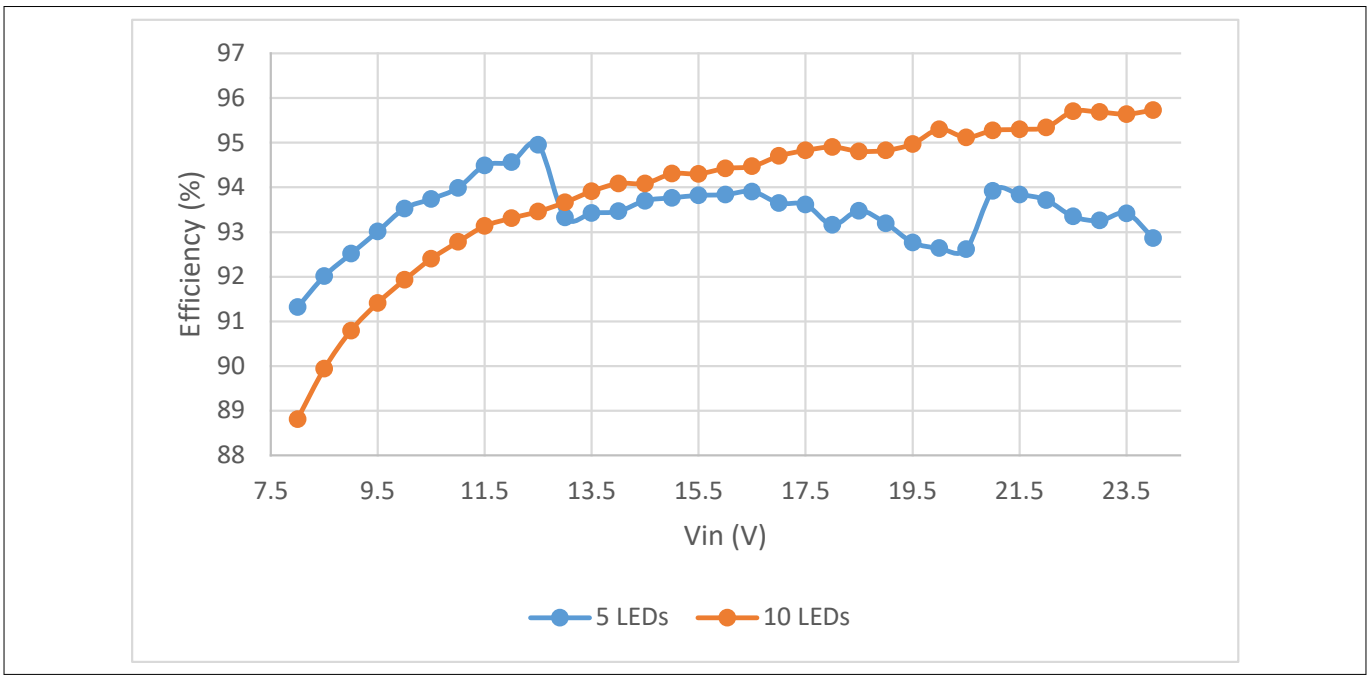

Figure 4 Efficiency versus input voltage for different loads

The efficiency performances have been obtained with the following configuration:

Table 3 Efficiency measurement configuration

EMI filters	Inserted, by keeping solder jumpers JI1 and JO1 open
Digital dimming	Fixed to 100%
Analog dimming	Output current set to 1 A using R_{SET} trimmer

Note: Efficiency with 10 LEDs was obtained by raising the overvoltage threshold.

5 Additional measurements

Additional measurements to test the robustness of the design were conducted on this board.
In particular, heavy LV124 stimuli were applied to the board input.

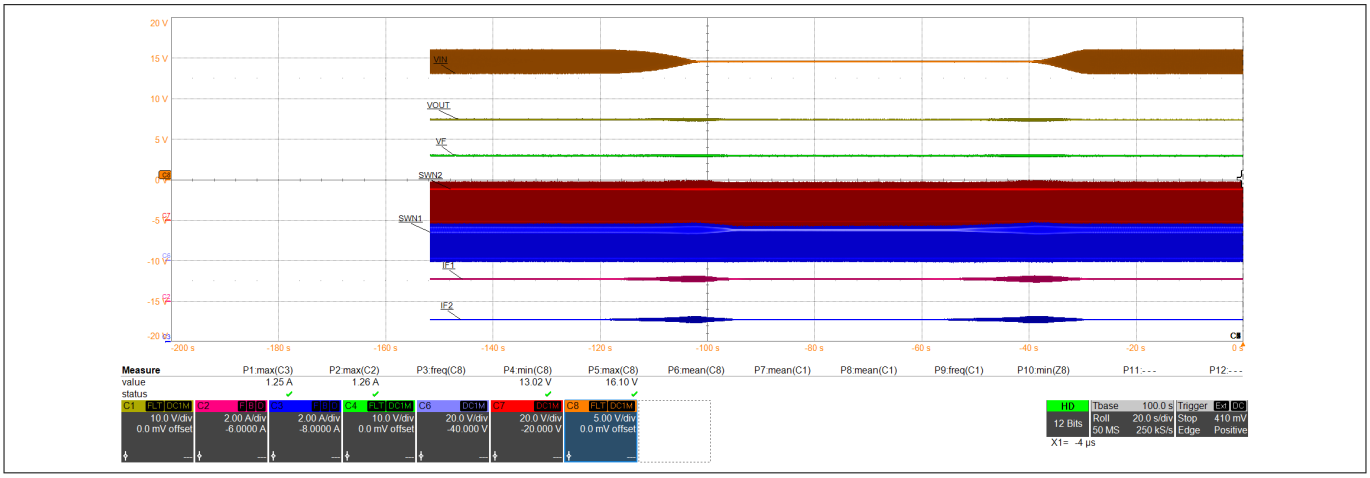

Figure 5 LV124 E-06, Test Case #2

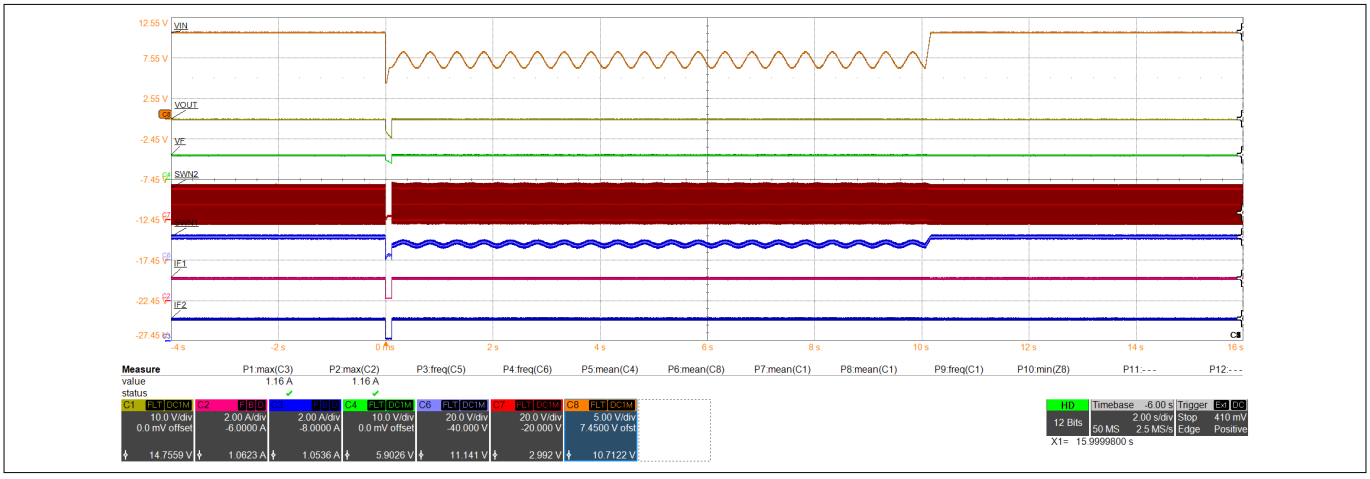

Figure 6 LV124 E-09, normal pulse

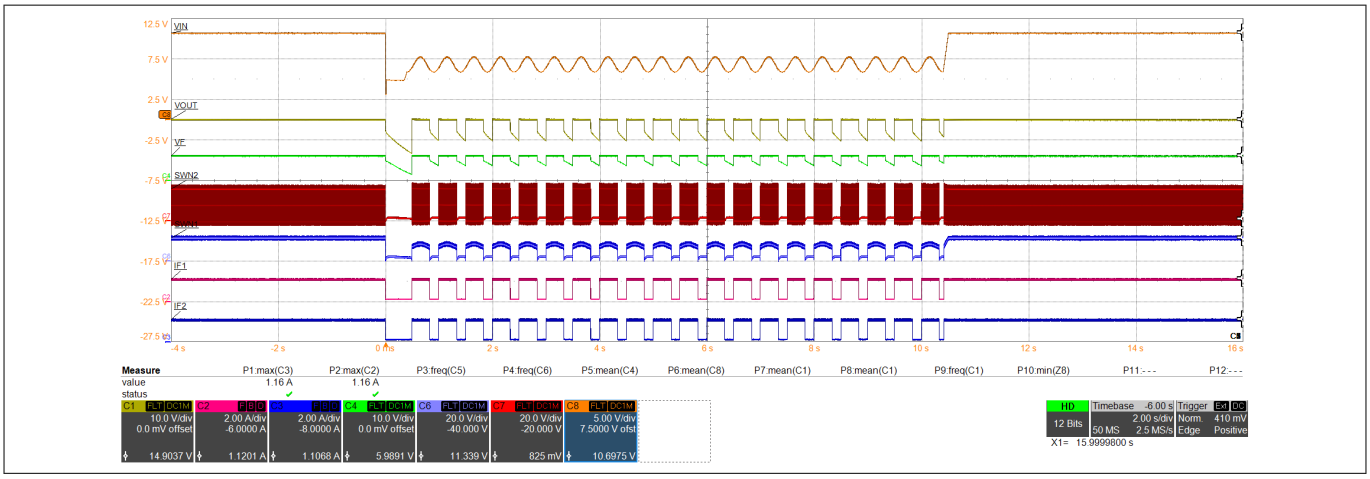

Figure 7 LV124 E-09, severe pulse

It is evident that after the pulses were applied, the board was fully operational.

6 Bill of material, layout, and schematic

Table 4 BOM

Designator	Value	Footprint	Quantity
C1, C5, C9, C10, C16, C21	10 µF	CAPC3225X270N-0	6
C2, C46	470 nF	CAPC3216X178N	2
C3, C15	470 pF	CAPC1608X90N	2
C4, C17, CCHP	47 nF	CAPC2013X140N	3
C6, C12, CBS1, CBS2	100 nF	CAPC1608X90N-4	4
C7, C11, C13	4.7 µF	CAPC3225X220N-0	3
C8	220 µF	CAPAE830X1050N-4	1
C55	1 µF	CAPC2013X145N-2	1
CC1	22 nF	CAPC2013X145N-2	1
CIVCC	10 µF	CAPC2013X145N-2	1
CSST	22 nF	CAPC1608X90N-4	1
CVFB	10 nF	CAPC2013X140N	1
D1	10 V	SOD2513X120N	1
DBS1, DBS2, DCHP1, DCHP2	BAT46WJ,115	SODFL2513X80N	4
DZ3	10 V	SOD2513X100N	1
EF	Red	LEDC1608X65N-1	1
EF_TP, EN, SET, SST, VCC_INT, VIN, VOUT	2501-2-00-80-00-00-07-0	CON-M-THT-2501-2-00-80-00-00-07-0	7
GND2, VIN+, VO1-, VO1+, VO2-, VO2+	575-8	CON-F-TH-575-6	6
GND, GND1	D3082-05	D3082-05	2
IC1	TLD5191ES	SOP65P600X115-25N-V	1
IVCC (LED)	Blue	LEDSC200X125X70R-2N	1
J_EN, JI1, JO1	Solder Jumper 2 Pins	SOLDER_BRIDGE_0.7X1.299PAD	3
L1	10 µH	DFN1000X1130X1000-2N	1
L2, L3	1.8 µH	DFN636X656X310	2
Q1, Q2	IPZ40N04S5L-7R4	INF-PG-TSDSON-8-32-1-V	2
Q3, Q4	IAUZ30N06S5L140	INF-PG-TSDSON-8-32-1-V	2
Q5	BSZ086P03NS3 G	INF-PG-TSDSON-8-31	1
Q6	IPG20N06S2L-50	INF-PG-TDSON-8-10	1
Q7, Q9	BC856B,215	SOT95P230X110-3N	2
Q8, Q10	BC846ALT1G	SOT95P237X111-3N	2
R1, R3, R19, RVL	2.2 kΩ	RESC2113X50N	4

(table continues...)

Table 4 (continued) BOM

Designator	Value	Footprint	Quantity
R2	44.2 kΩ	RESC2113X50N	1
R4, R10, R11, R13, R16, R17, R20, R24, R26, R27, R28	10 kΩ	RESC2113X50N	11
R5	910 Ω	RESC2113X50N	1
R6, R8	4.7 Ω	RESC1609X50N	2
R7, R18	10 kΩ	RESC2013X55N	2
R9, R23	22 kΩ	RESC2113X50N	2
R12	47 kΩ	RESC2113X50N	1
R14	5.6 kΩ	RESC2113X50N	1
R15, R22	10 Ω	RESC2113X50N	2
R21	2.2 kΩ	RESC1609X50N	1
RC1	1 kΩ	RESC2113X50N	1
RC2	not mounted	RESC2113X50N	1
REN3	10 kΩ	RESC1609X50N	1
RF	27 kΩ	RESC2113X50N	1
RG1, RG2, RG3, RG4	10 Ω	RESC1609X50N	4
RSET	20 kΩ	POTV3266Y	1
RSHO	150 mΩ	RESC1632X68N	1
RSHSW	7 mΩ	RES-SMD-KRL3216T4	1
RVH1	33 kΩ	RESC2113X50N	1
S1	GT13MSCBE	SW-SMD-GT11MSCBETR	1

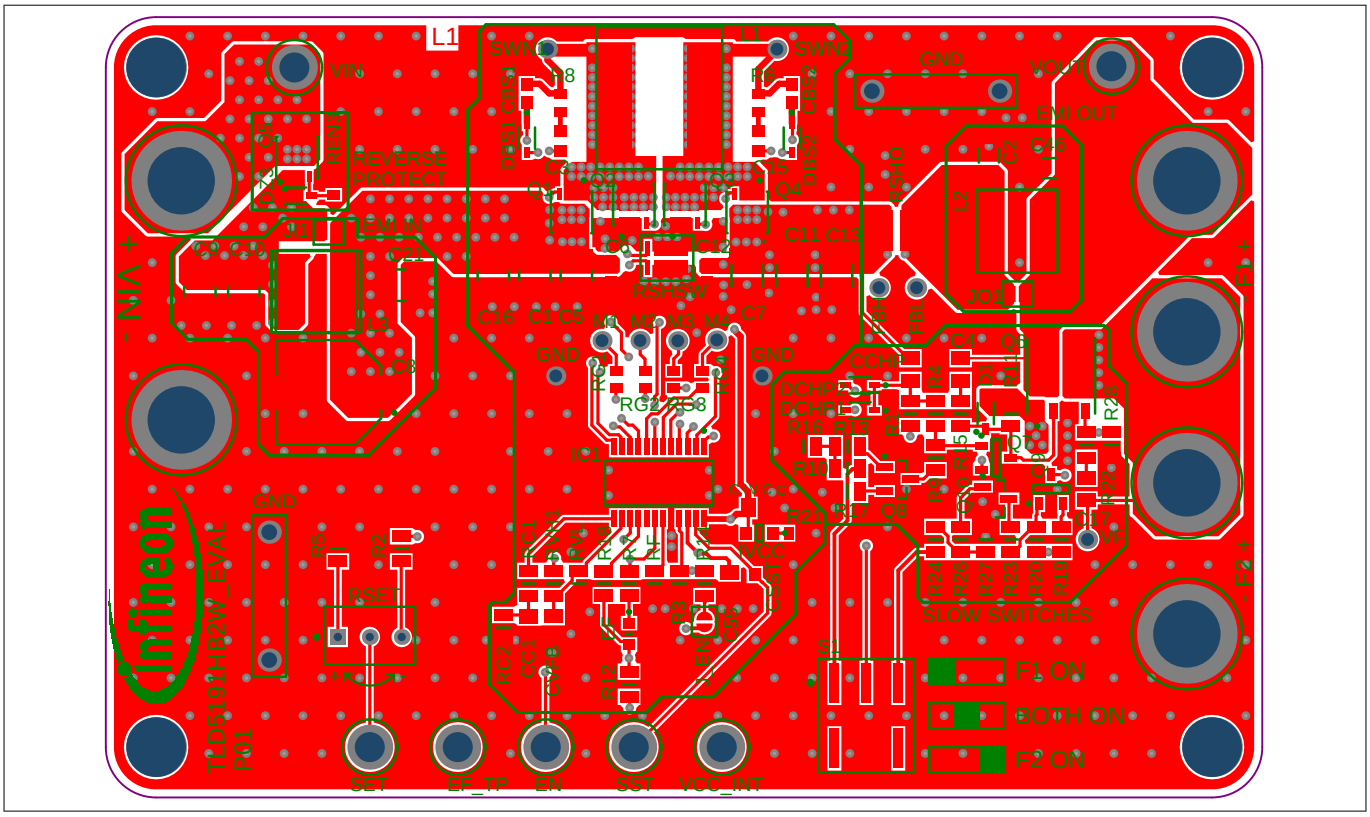

Figure 8 PCB layout top view

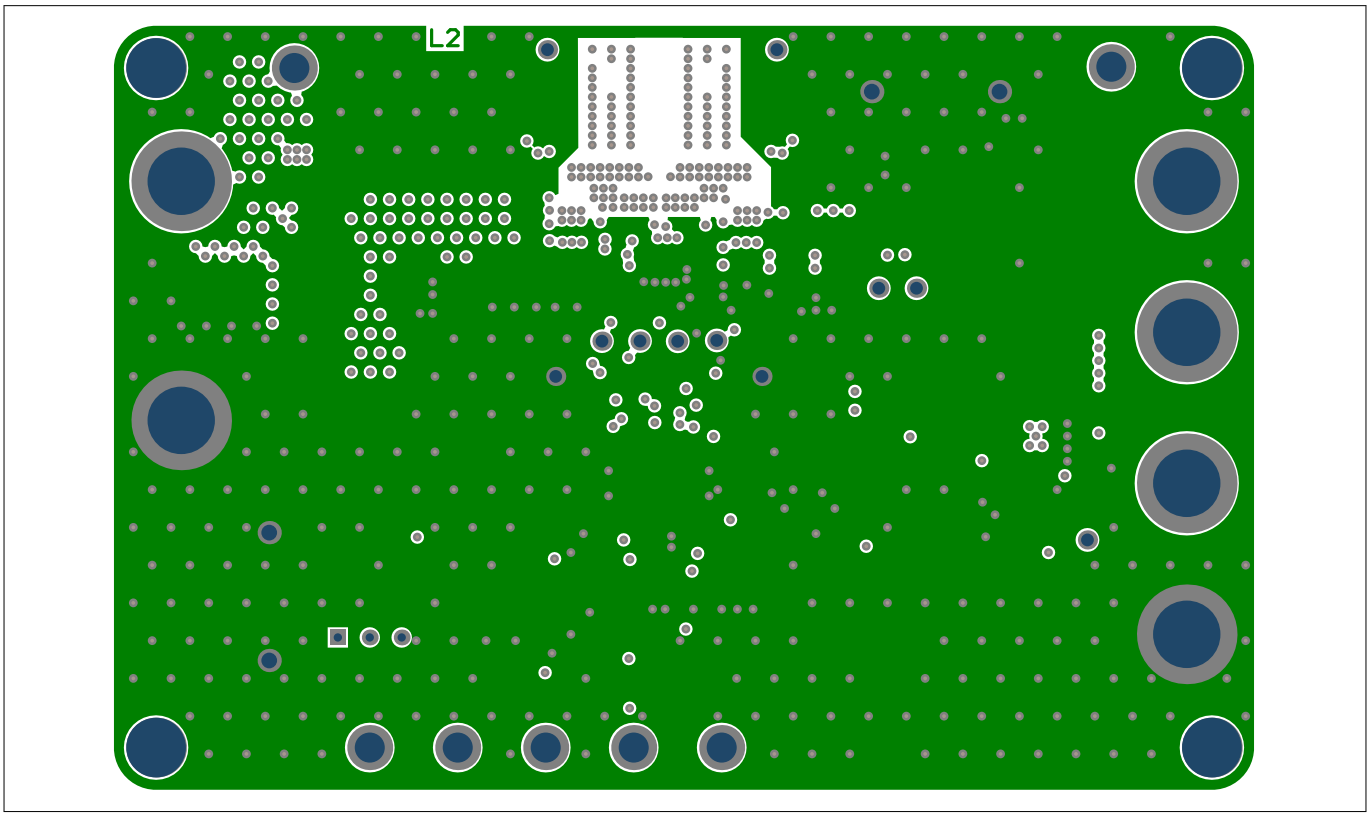

Figure 9 PCB layer 2

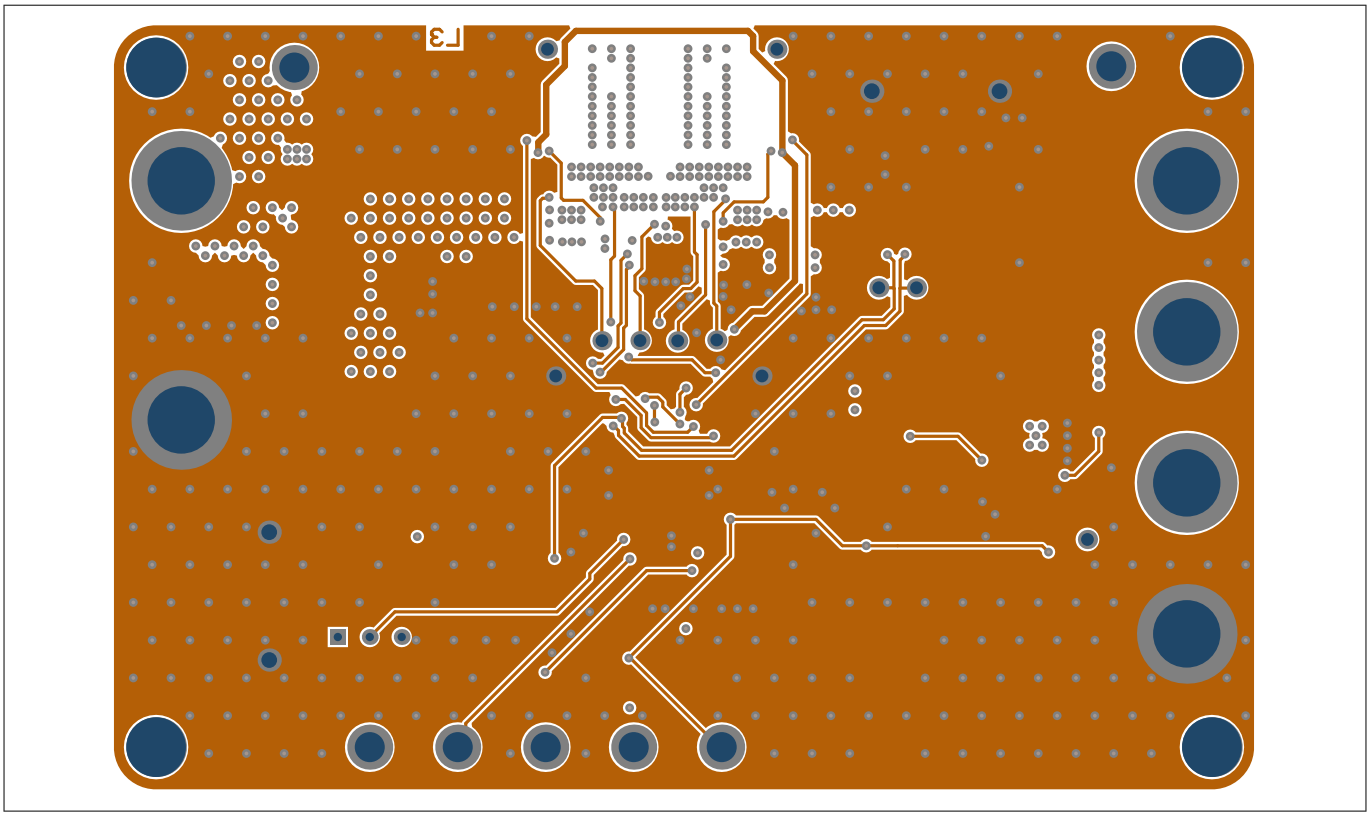

Figure 10 PCB layer 3

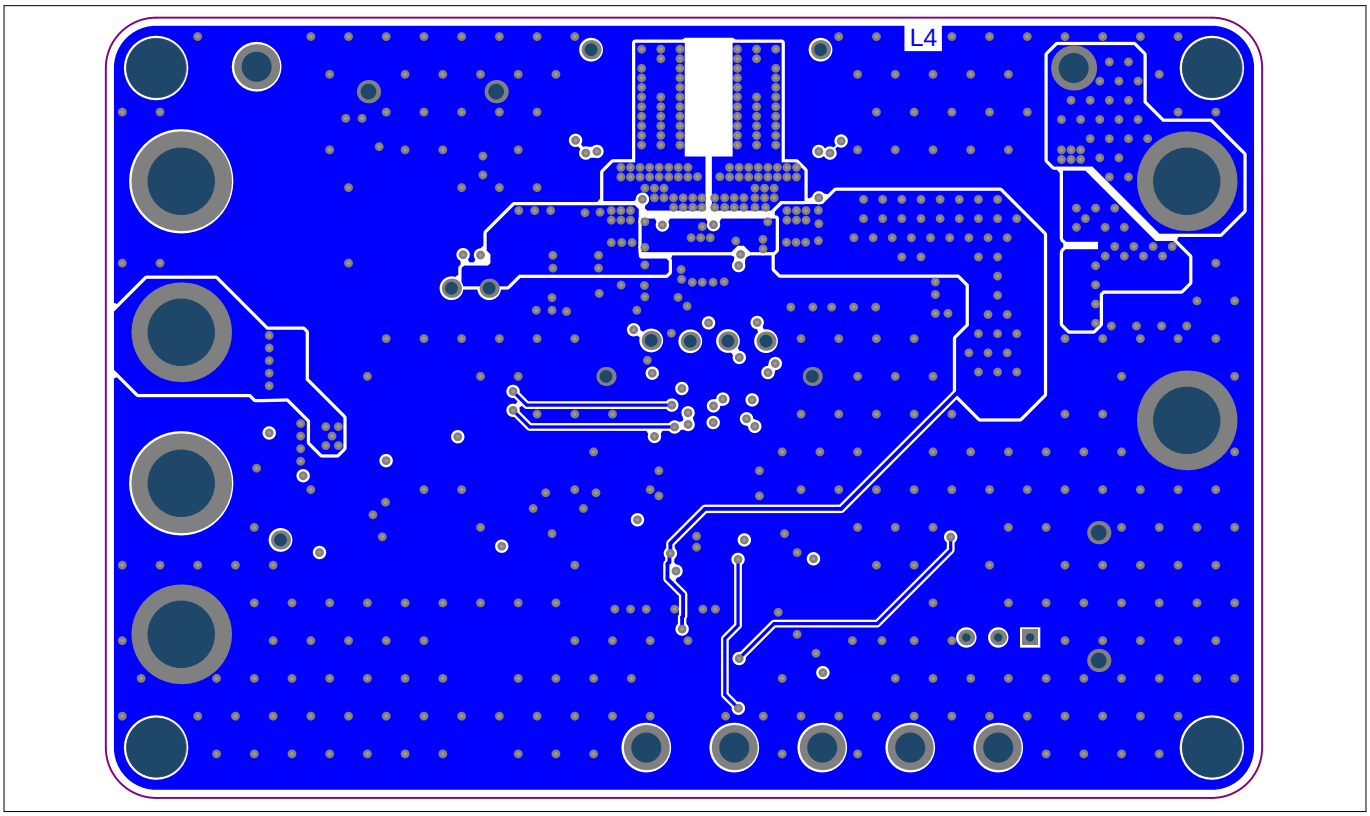

Figure 11 PCB layout bottom view

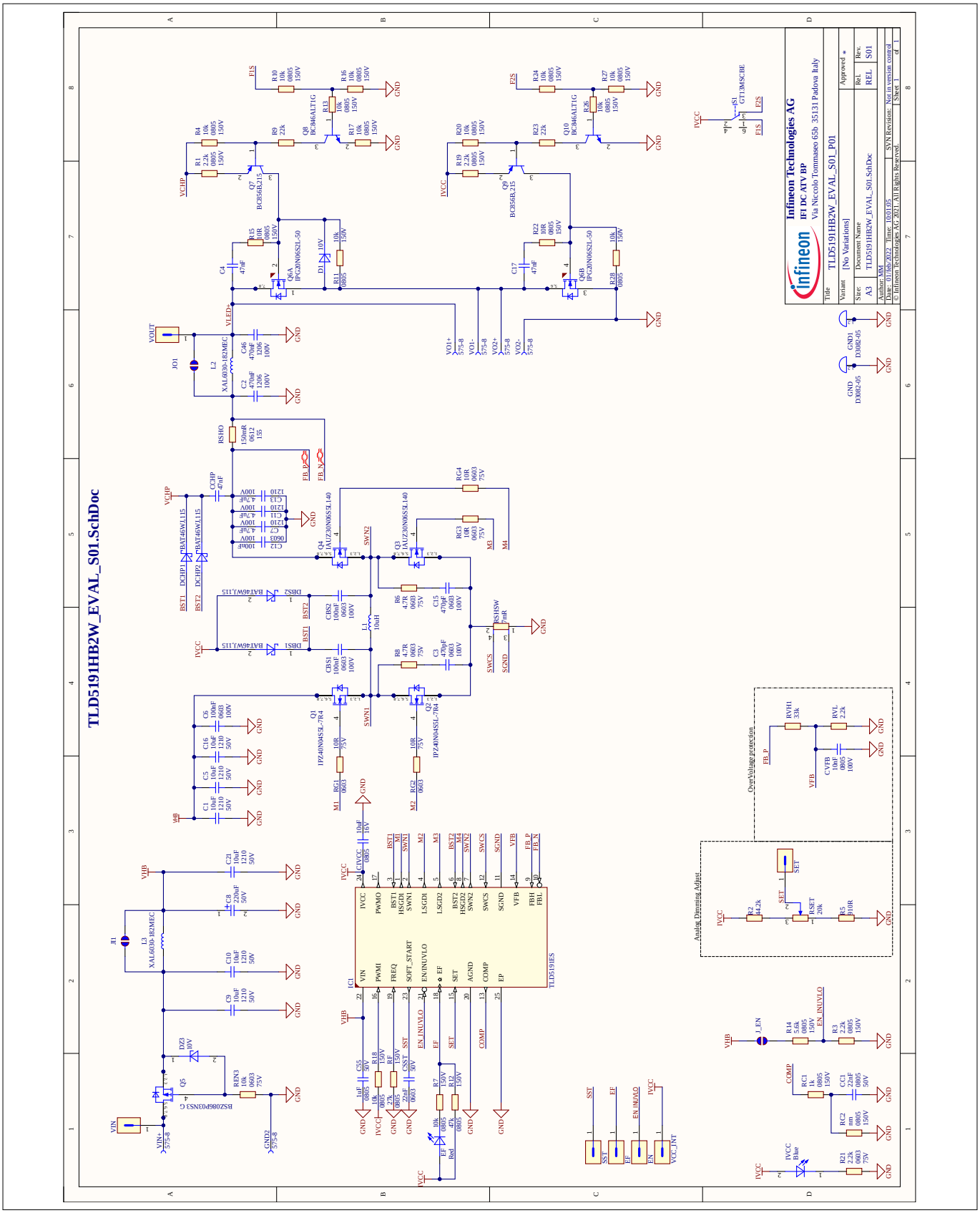

Figure 12 Schematic view

Revision history

Document version	Date of release	Description of changes
Rev. 1.00	2022-04-05	• Initial release

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