TLD5191IVREG-EVAL board

User guide

LITIX™ Power TLD5191ES

About this document

Board description

- TLD5191: Four switches buck boost DC-DC controller designed for automotive applications
- Constant current (LED) and constant voltage regulation
- High power, high efficiency buck-boost architecture
- Embedded PWM engine for digital dimming
- EMC optimized device: Spread spectrum

Scope and purpose

The scope of this user guide is to provide instructions on the use of the TLD5191ES device evaluation board TLD5191IVREG-EVAL schematic version S03 PCB version P02.

The TLD5191IVREG-EVAL is an evaluation platform for the TLD5191ES, which can work as buck-boost LED driver, or as a voltage regulator.

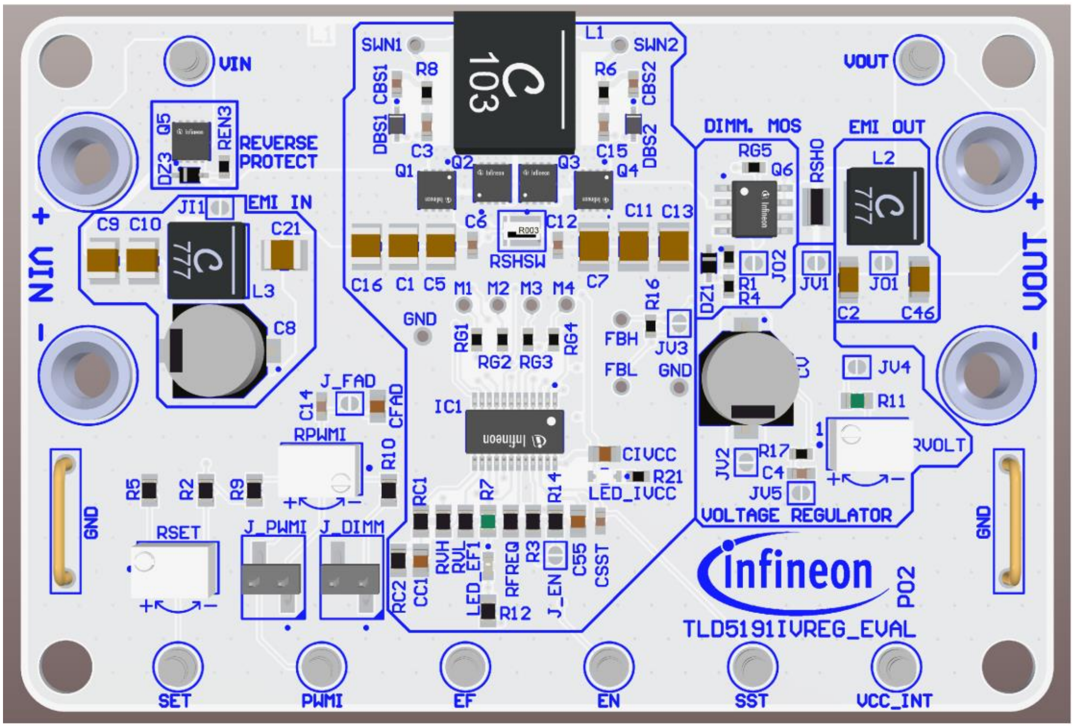

Figure 1 TLD5191IVREG-EVAL board

Intended audience

Hardware engineers

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2 Description

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

The TLD5191IVREG-EVAL is an evaluation platform for the TLD5191ES as LED driver or voltage regulator.

The default configuration delivers a constant current LED driver with 1.5 A maximum output current. The output current can be increased up to 6 A by changing resistor R_{SHO} and R_{SHSW}. (Refer to schematic, Figure 11). If higher currents are needed, the output filter is bypassed by closing J01.

The following diagram is a simplified schematic. The complete schematic is available in Chapter 7.

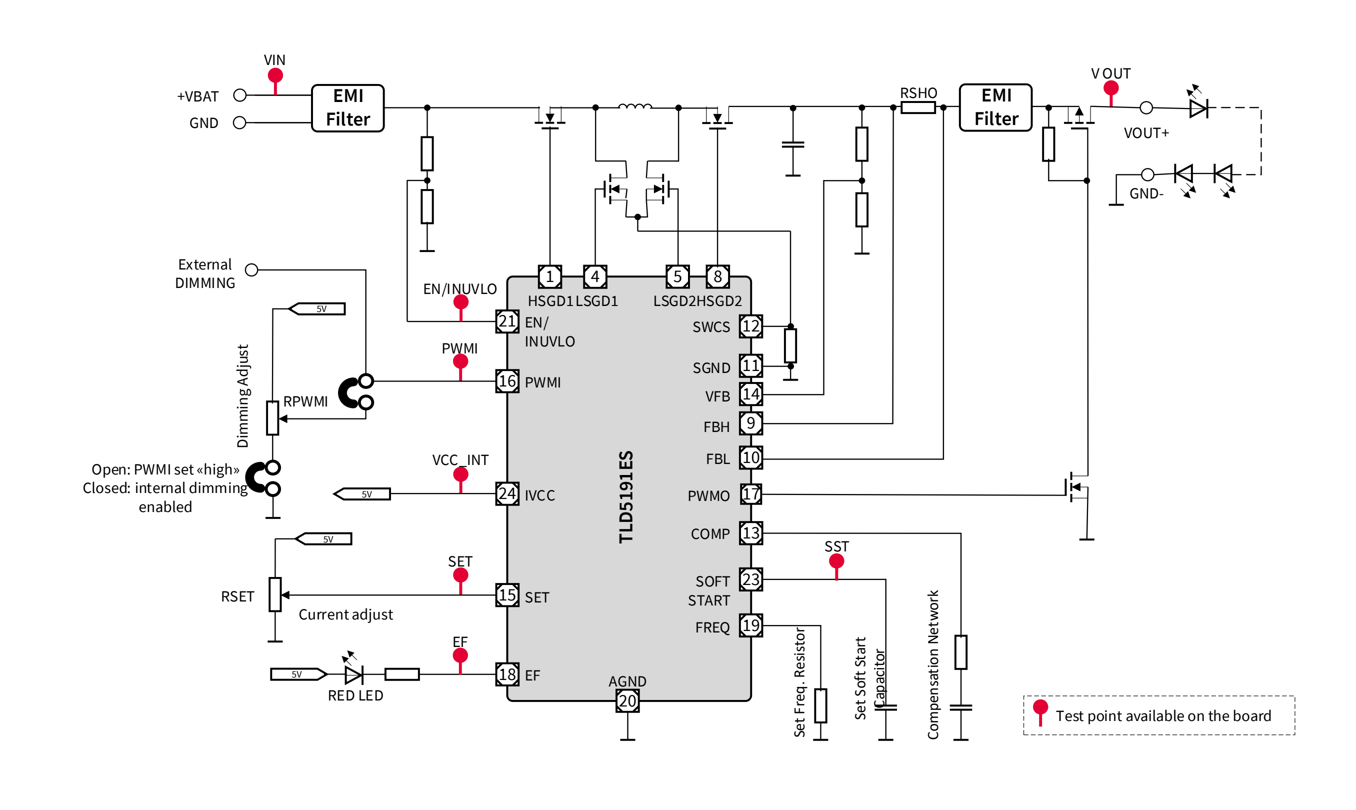

Figure 2 TLD5191IVREG_EVAL board simplified schematic in constant current mode (LED driver)

By reconfiguring a few solder jumpers, the board can be used as a powerful voltage regulator.

The board can be configured with several trimmers and also contains two status LEDs:

- Trimmer to adjust output voltage when set as voltage regulator
- Trimmer to adjust output current (via SET pin)
- Trimmer to adjust the PWM duty cycle of embedded PWM engine (via PWMI pin)
- Two LEDs:
  - One blue LED showing TLD5191ES power on status (IVCC)
  - One red LED showing TLD5191ES faults status (EF)

3 Quick start procedure

Step-by-step procedures are laid out for setup and running the TLD5191IVREG-EVAL in all available configurations.

In all configurations solder jumper J_EN has to be closed in order to enable the device via input supply lines.

Open J_EN to apply an external enable signal using EN test point.

3.1 Setup as LED driver

To configure the board as LED driver the following jumpers needs to be configured:

Table 1 Jumper position

Jumper name	Condition	Meaning
J_PWMI	Closed	Enable the embedded PWM engine
J_DIMM	Closed	Enable the embedded PWM engine duty cycle adjustment
JV1	Open	Enable the output current regulation
JV2	Open	Remove output bulk capacitance for constant voltage regulation
JV3	Closed	Disable output voltage regulation
JV4	Open	Disable output voltage regulation
JV5	Open	Disable output voltage feed forward
JO2	Open	Enable PMOS for PWM dimming

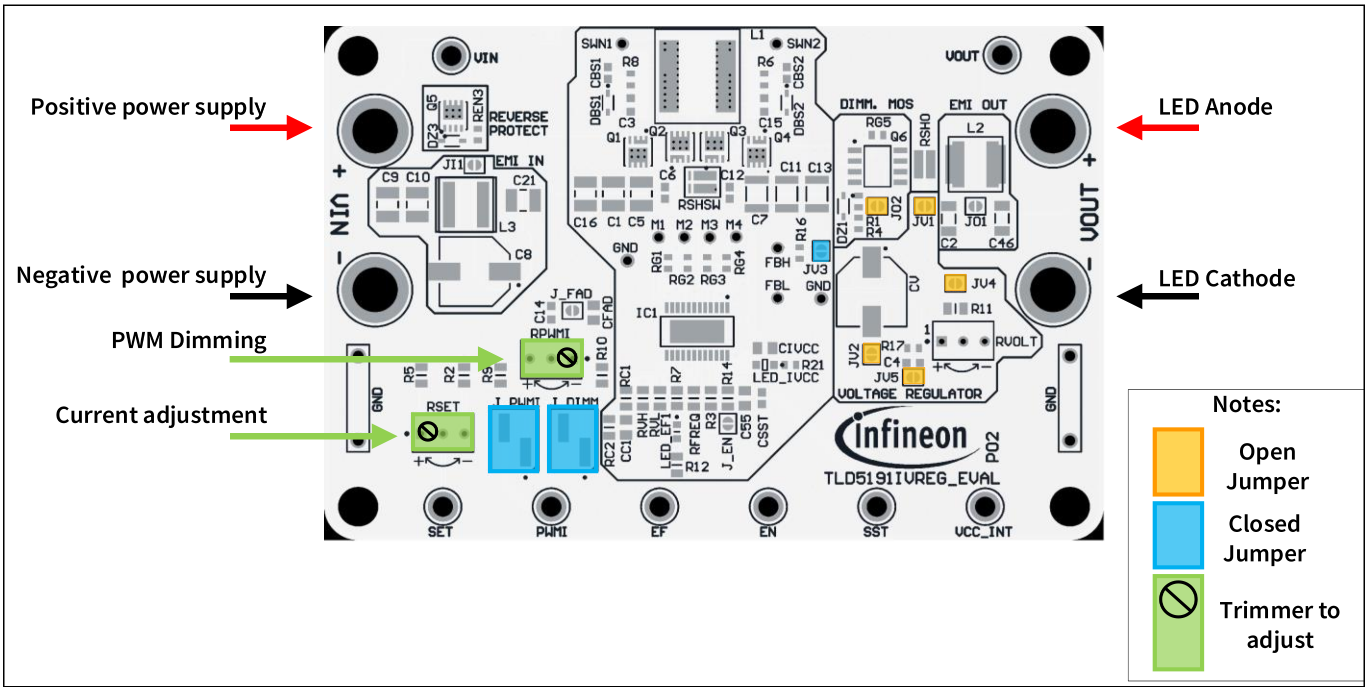

Figure 3 Constant current (LED driver) configuration

1. If an external PWM signal is intended to be used, open J_PWMI jumper
2. Connect the LED load
3. Connect a 12 V power supply to the V_{IN} connector → the blue LED should turn on indicating V_{IVCC} present
4. Adjust I_{OUT} via R_{SET} (>150 mA suggested for better accuracy and transient response)
5. Adjust PWM duty cycle via R_{PWMI} if enabled (see Chapter 3.1.1).

Note: *If the output voltage is below 6 V (i.e. load of just one LED) it is recommended to close JO2 to bypass the PMOS for PWM dimming in order to avoid excessive power dissipation on the PMOS*

3.1.1 Embedded PWM engine

The embedded PWM engine provides an internal PWM signal without any external dimming signal required. It is enabled when jumper J_PWMI is closed. If jumper J_DIMM is open, the PWMI pin is biased at 5 V and then the duty cycle is 100%. Closing jumper J_DIMM, the duty cycle is adjustable by means of trimmer R_{PWMI}. The PWM frequency is fixed at nominal value of 270 Hz.

3.2 Set up as voltage regulator

To configure the board as voltage regulator the following jumpers needs to be configured:

Table 2 Jumper position

Jumper name	Condition	Meaning
J_PWMI	Closed	Enable on board PWMI setting
J_DIMM	Open	Set PWMI at 5 V
JV1	Closed	Disable the output current regulation
JV2	Closed	Add output bulk capacitance for constant voltage regulation
JV3	Open	Enable output voltage regulation
JV4	Closed	Enable output voltage regulation
JV5	Closed	Enable output voltage feed forward
JO2	Closed	Bypass PMOS for PWM dimming

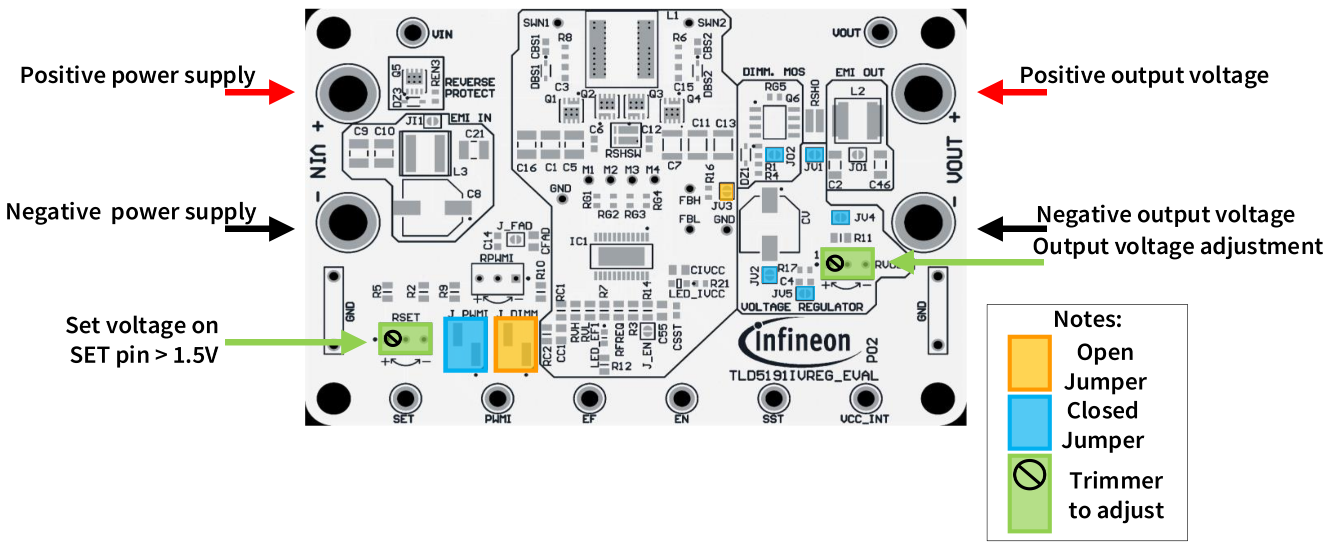

Figure 4 Voltage regulator configuration

1. Connect a 12 V power supply to the V_{IN} connector
2. Rotate R_{SET} trimmer fully clockwise (100% analog dimming, improves transient response and accuracy)
3. Rotate R_{VOLT} trimmer to obtain the desired V_{OUT}
4. Connect the load

Note: *It is possible to adjust output voltage from 0 to full scale (previously set by R_{VOLT}) by rotating R_{SET}, but the best transient response is obtained when analog dimming is set to 100%*

4 Operating range

The TLD5191IVREG-EVAL has very high efficiency, so it can deliver up to 60 W at the output without a heat sink at T_A = 25°C, V_{IN} = 12 V.

Please note that the module does not implement thermal protection, so ensure proper cooling when output power exceeds 60 W or input voltage drops below 9 V. Position the heat sink below the switching MOSFETs as shown in Figure 5.

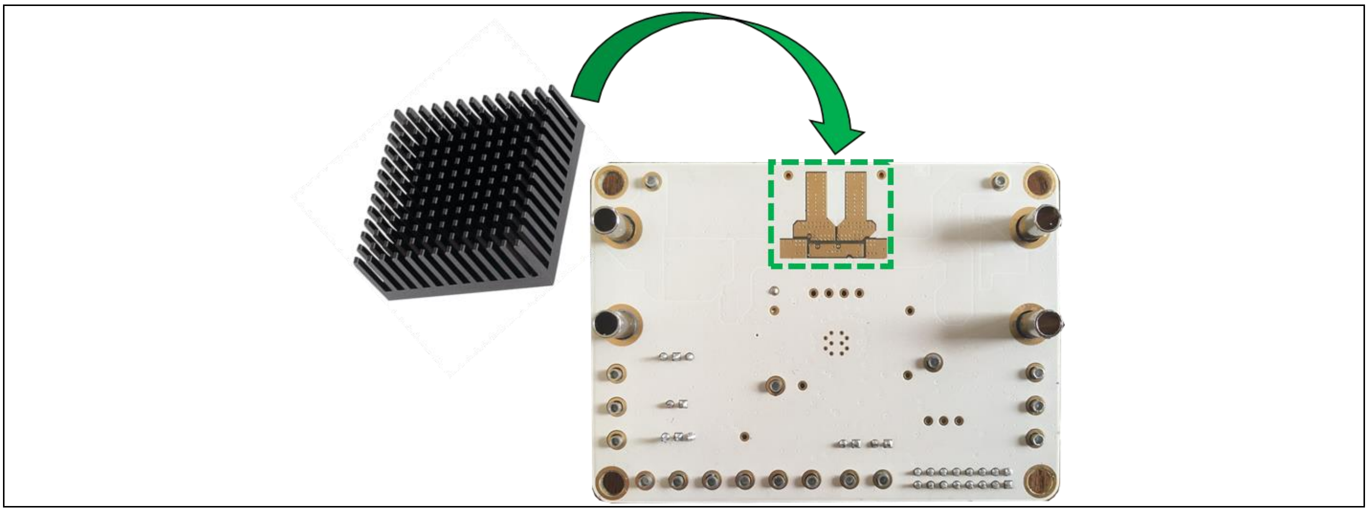

Figure 5 Heat sink placement (optional)

The heat sink shall be electrically insulated from the PCB by means of a thermal pad.

5 Electrical characteristics

Table 3 TLD5191IVREG-EVAL version S03 P02 – electrical characteristics

Parameter	Symbol	Value			Unit	Note/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}	2.15 6.2	–	41.8 22.5	V	LED driver mode: max. value set by the resistor divider on VFB pin (overvoltage protection) Voltage mode: max value set by R_{VOLT} trimmer
Output current	I_{OUT}	150 0	–	1500 6	mA A	LED driver mode (up to 6 A by changing R_{SHO}) Voltage mode
Output power	P_{OUT}	–	–	60	W	V_{IN} 12 V to 35 V, T_A = 25°C See Chapter 4 for power derating curve
Switching frequency	f_{SW}	–	385	–	kHz	Spread spectrum deviation is present
PWM frequency	PWM_{freq}	75 220	– 275	– 330	Hz	External PWM signal applied Embedded PWM engine enabled

6 Efficiency measurements

The following efficiency measurements have been taken under constant current configuration (LED driver). The efficiency discontinuities are given by the controller mode changes 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 mode is visible for 5 and 6 LEDs. The change from buck-boost to buck mode is visible for 2 and 3 LEDs. Both the changes from boost to buck-boost mode and from buck-boost to buck mode are visible for the 4 LED curves.

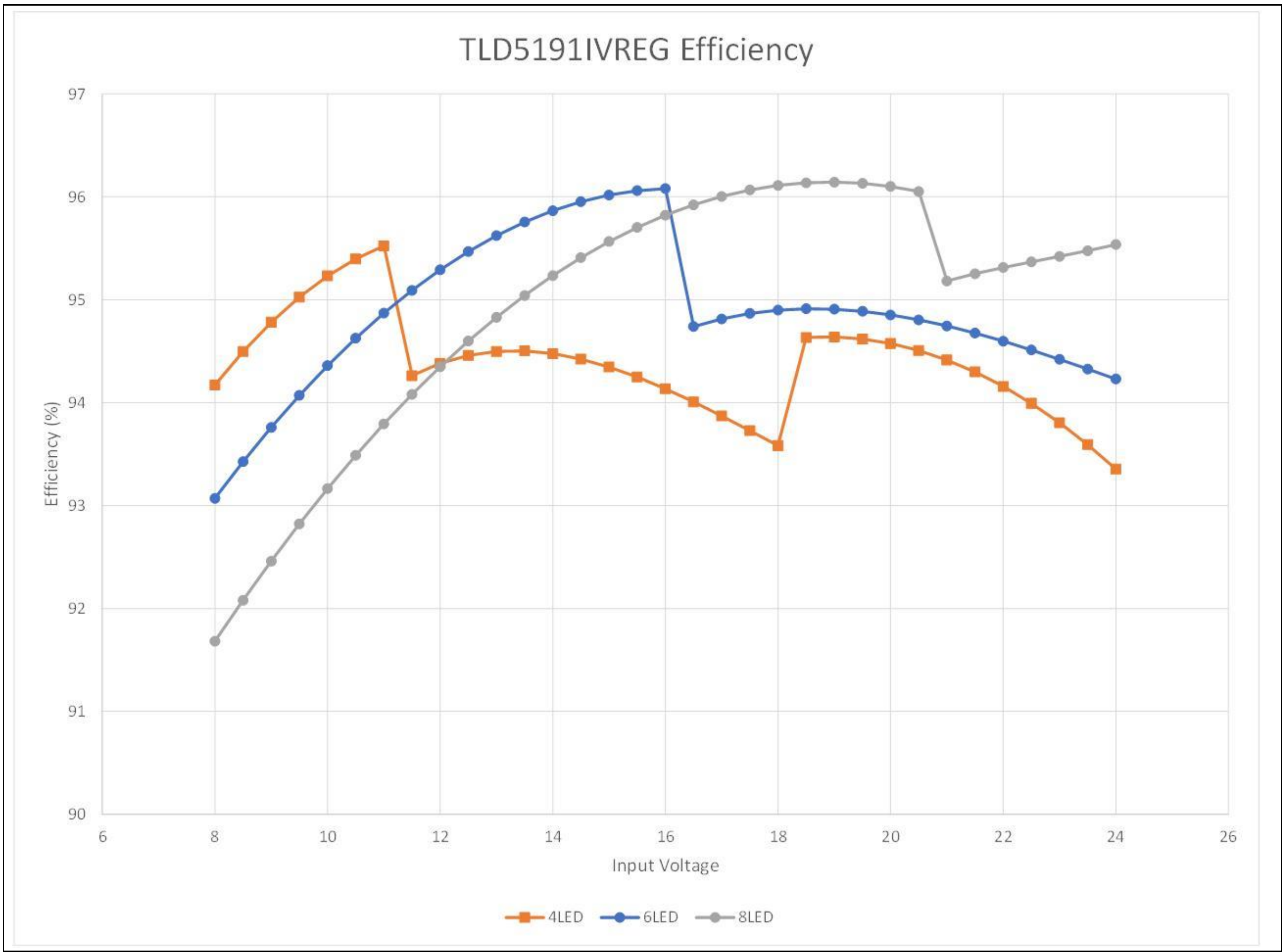

Figure 6 Efficiency versus input voltage for different loads

The efficiency performances have been obtained with the following configuration:

Table 4 Efficiency measurement configuration

EMI filters	Bypassed by closing solder jumpers JI1 and JO1
PMOS dimming	Bypassed by closing solder jumper JO2
Digital dimming	Duty cycle set to 100% by closing J_PWMI jumper and by opening J_DIMM jumper
Analog dimming	Output current set to 1.5 A via R_{SET} trimmer

7 Bill of material, layout and schematic

Table 5 BOM

Designator	Value	Footprint	Quantity
C1, C5, C9, C10, C16, C21	10uF	C1210	6
C2, C46	470nF	C1206	2
C3, C15	470pF	C0603	2
C4, C14	10nF	C0603	2
C6, C12, CBS1, CBS2	100nF	C0603	4
C7, C11, C13	4.7uF	C1210	3
C8, CV	220uF	CAPAE830X1050N	2
C55	1uF	C0805	1
CC1	22nF	C0805	1
CIVCC	10uF	C0805	1
CSST	22nF	C0603	1
DBS1, DBS2	BAT46WJ,115	SOD323F	2
DZ1, DZ3	10V	SOD323	2
IC1	TLD5191ES	TSDSO24	1
J_DIMM, J_PWMI	TSM-102-01-S-SV	CON-M-SMD-TSM-102-01-S-SV	2
L1	10uH	Coilcraft XAL1010	1
L2, L3	1.8uH	Coilcraft XAL6030	2
LED_EF1	Red	LED 0805	1
LED_IVCC	Blue	LED 0805	1
Q1, Q2	IPZ40N04S5L-7R4	PG-TSDSON-8-32	2
Q3, Q4	IAUZ30N06S5L140	PG-TSDSON-8-32	2
Q5	BSZ086P03NS3 G	PG-TSDSON-8	1
Q6	BSO615CGXUMA1	PG-DSO-8	1
REN3	10kΩ	R0603	1
R2	44.2kΩ	R0805	1
R3	2.2kΩ	R0805	1
R5	910Ω	R0805	1
R6, R8	4.7Ω	R0603	2
R7, R11	10kΩ	R0805	2
R9	22kΩ	R0805	1
R10	470Ω	R0805	1
R12, RVH	47kΩ	R0805	2
R14	5.6kΩ	R0805	1
R1, R4,	5.6kΩ	R0603	2
R16	150Ω	R0603	1
R17	1.5kΩ	R0603	1

Designator	Value	Footprint	Quantity
R21	2.2kΩ	R0603	1
RC1	1kΩ	R0805	1
RC2	3.3MΩ	R0805	1
RFREQ	27kΩ	R0805	1
RG1, RG2, RG3, RG4	10Ω	R0603	4
RG5	0Ω	R0603	1
RPWMI, RSET, RVOLT	Bourns 3266Y-1-203LF	-	3
RSHO	100mΩ	R0612	1
RSHSW	7mΩ	R1206	1
RVL	1.5kΩ	R0805	1

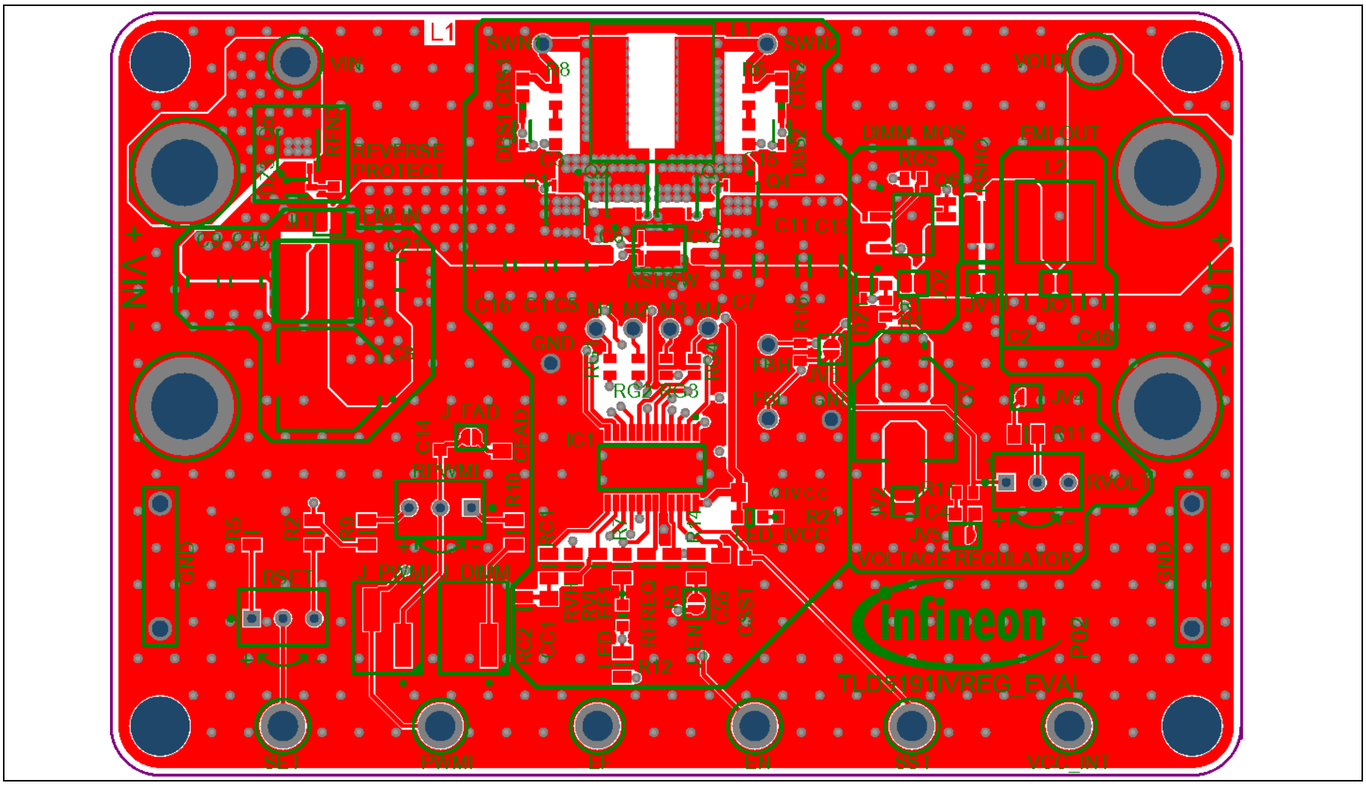

Figure 7 PCB layout top view

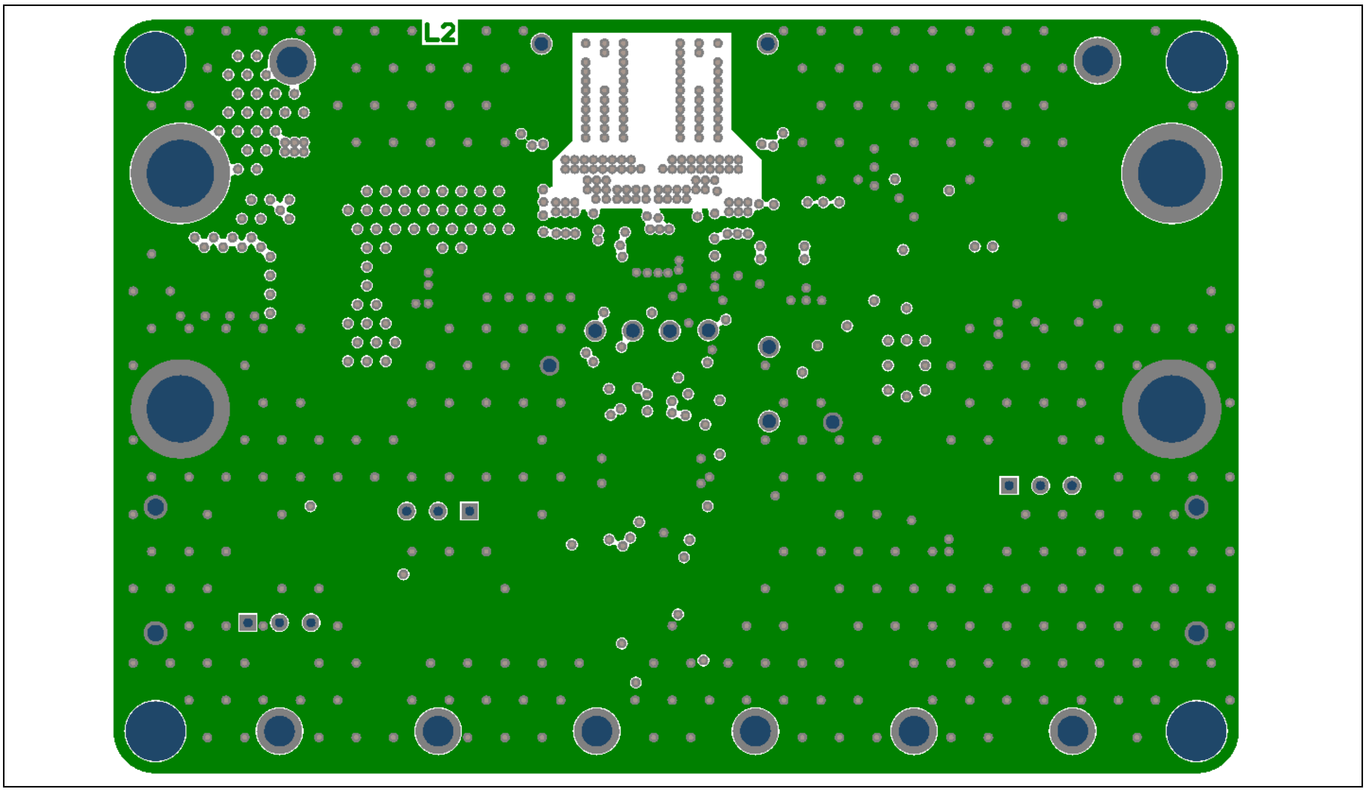

Figure 8 PCB layer 2

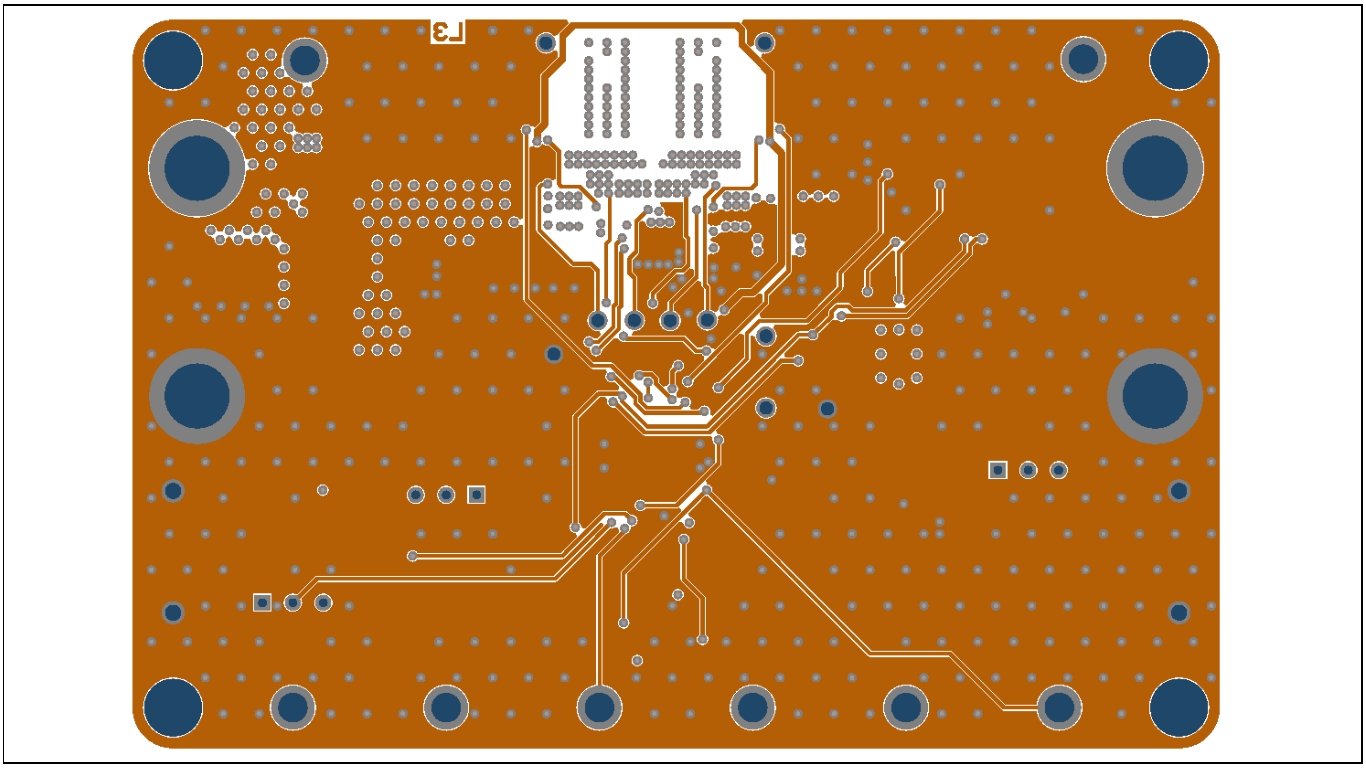

Figure 9 PCB layer 3

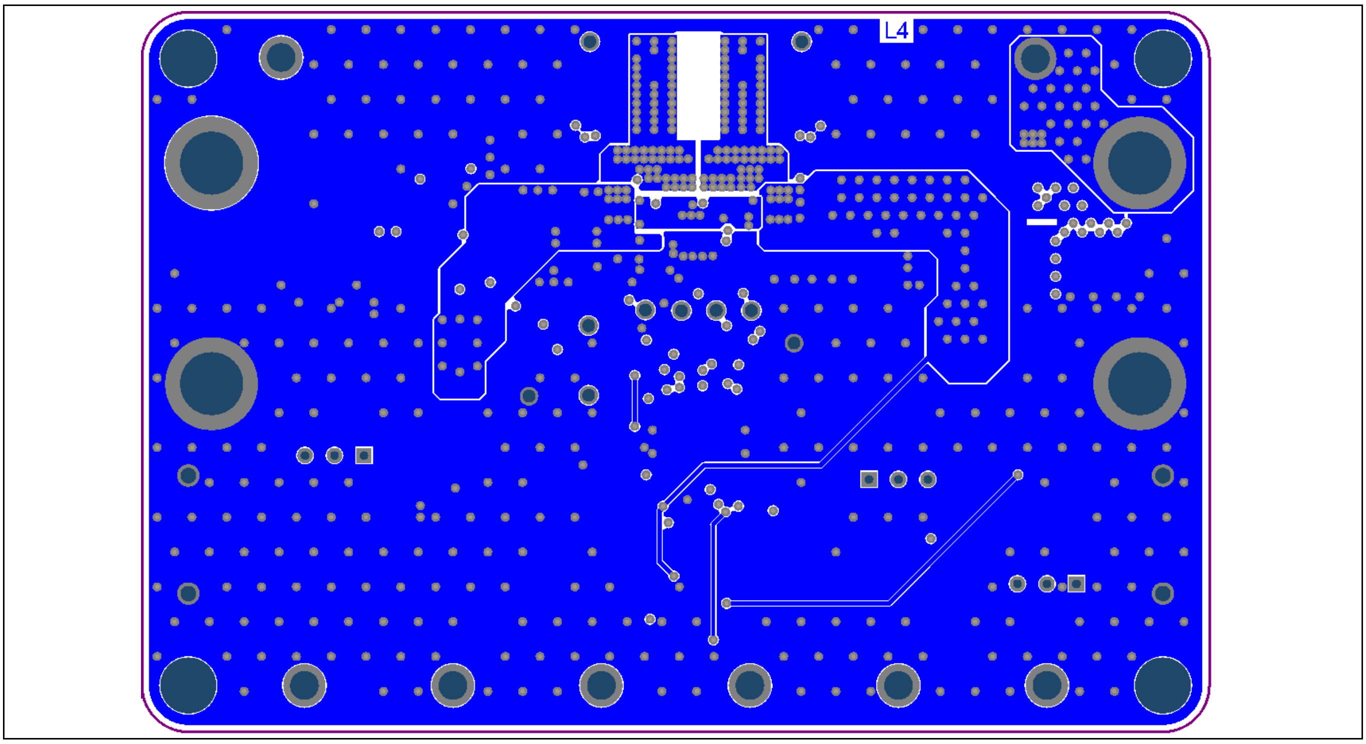

Figure 10 PCB layout bottom view

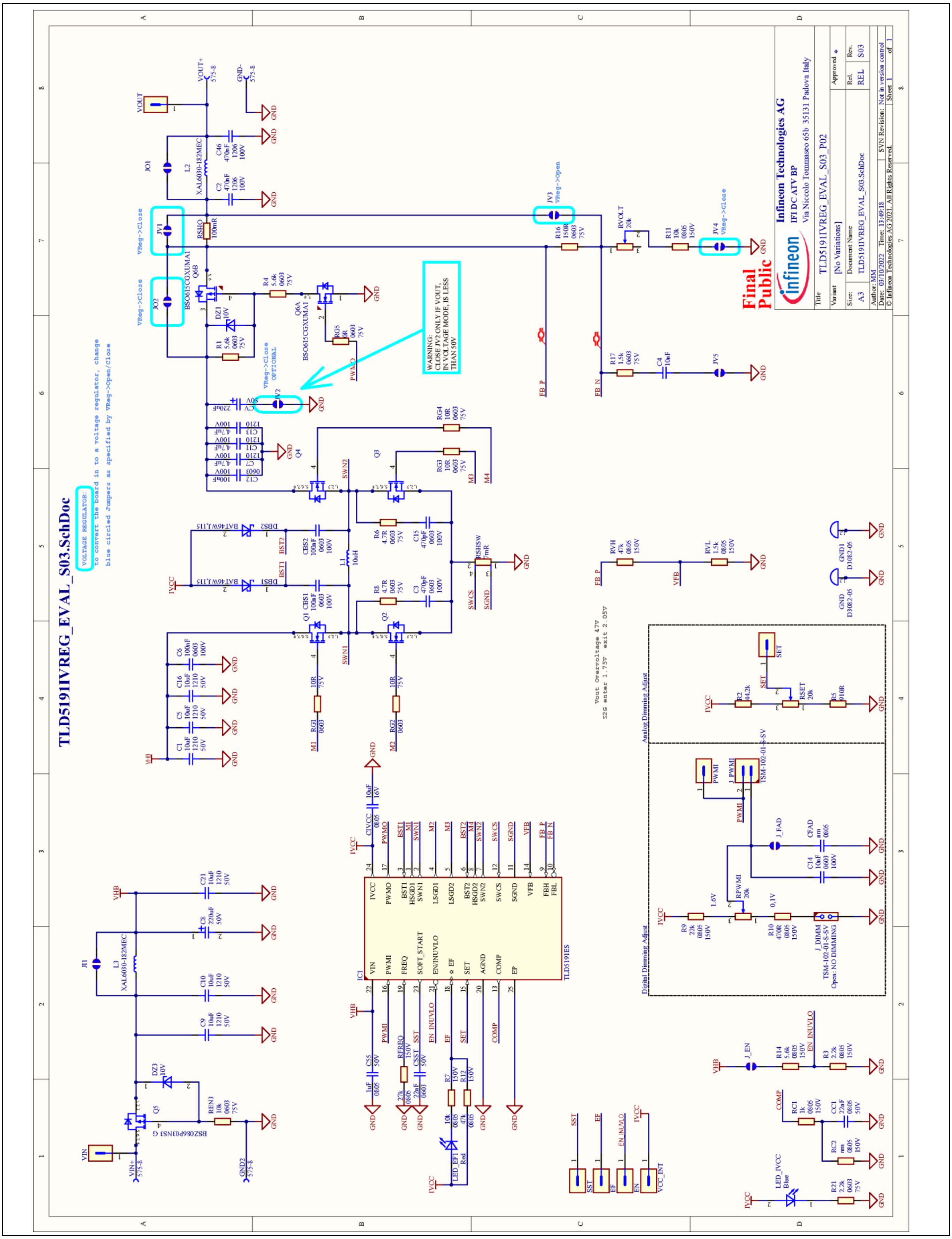

Figure 11 Schematic view

8 Revision history

Document version	Date of release	Description of changes
Rev. 2.00	2022-11-03	• Updated description text • Repaired typo in Figure 2 • Updated Figure 1, Figure 3 and Figure 4, Figure 6 • Updated Table 4 • Added PCB layout Figure 7, Figure 8, Figure 9, Figure 10 • Editorial improvements
Rev. 1.00	2021-04-13	Initial User guide

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