TLD5501-2QV Buck Demo

User Manual

About this document

Product description

The TLD5501-2QV is an AEC qualified dual channel buck DC-DC controller especially designed for high power automotive applications:

- Constant current (LED driver) and constant voltage regulation
- EMC optimized device: Spread spectrum
- Multiphase capability for voltage regulation
- SPI interface to configure each channel's regulation and to read the diagnostic
- Limp home function (fail-safe mode)

Scope and purpose

Scope of this user manual is to provide to the audience instructions on usage of the TLD5501-2 BUCK DEMO evaluation board (schematic version V5.0, PCB version R2).

Intended audience

This document is intended for engineers who need to perform measurements and check performances with TLD5501-2 BUCK DEMO evaluation board.

1 Table of contents

2 Description

The TLD5501-2QV BUCK DEMO is an evaluation board for high power applications with the TLD5501-2QV product. TLD5501-2QV is an AEC qualified dual channel buck DC-DC controller suitable for constant current (LED driver) and constant voltage applications.

The default configuration of the evaluation board is “Dual buck parallel voltage regulator” in which the two channels work in multiphase to provide up to 80 W to the load with an efficiency above 90%.
The board can be also configured for different scenarios:

- “Dual buck independent voltage regulators”: the two channels work as two independent constant voltage supply.
- “Dual buck independent current regulators”: the two channels work as two independent constant current supply (LED application).
- “Single buck independent current regulator plus single buck independent voltage regulator”: one channel work as constant voltage supply and the other one as constant current supply (LED application).

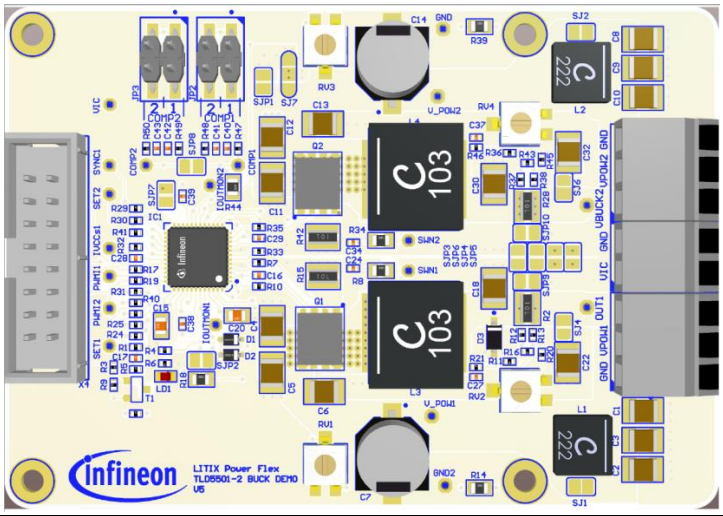


Figure 1 TLD5501-2 BUCK DEMO evaluation board

Table 1 Board configuration and connectors

Components	Description
JP2, JP3	Jumpers to set the compensation network of ch1 and ch2 respectively: Position 1 closed: 22 nF Position 2 closed: 10 nF Position 1 and 2 closed: 32 nF
RV2, RV4	Trimmers to adjust output voltage of ch1 and ch2 when set as voltage regulator
RV1, RV3	Trimmers to adjust output overvoltage (OV) and short to ground (S2G) thresholds for each channel
X4	16-pin 2.54mm pitch connector (X4) for Infineon µIO interface or external microcontroller interface
X2	Input power supply connector
X1, X3	Output voltage/current connector of each channel. Optional: with SJ7 open it can be used as input power supply for the DC-DC power stage.

3 Quick start procedure

The default configuration of the board is “Dual buck parallel voltage regulator” in which the two channels work in multiphase to provide up to 80 W to the load with an efficiency above 90%.

Table 2 Performance summary

Parameter	Conditions	Value
Input supply voltage VIC range	R1 = 39 kΩ, R5 = 20 kΩ	5.75 V to 40 V
Input supply voltage VPOW1/2 range	SJ7 closed, R1 = 39 kΩ, R5 = 20 kΩ	5.75 V to 40 V
Input supply voltage VPOW1/2 range	SJ7 open	4.5 V to 55 V
Maximum output power per channel	Vin = 12 V	40 W
Maximum output current per channel	-	7 A
Switching frequency	Set by R30 = 39 kΩ	287 kHz
Efficiency	Vin = 12 V, Rload = 1 Ω	> 92%
Output voltage range	Analog dimming = 100%, Set by RV2 potentiometer	1.5 V to 11.5 V
Overvoltage protection threshold	Set by RV1 potentiometer	1.5 V to 50 V
S2G protection threshold	Set by RV1 potentiometer, MFSSETUP_CH1,2.LEDCHAIN_CH1,2 = 2	0.091 V to 3 V
Peak switch current limit	Set by R15 and R42	10 A
Analog dimming in Limp Home	IVCC = 5 V, set by R31 and R40	49%

Below, step by step procedures are laid out for setup and running the TLD5501-2 BUCK DEMO:

1. Connect a dummy load at the OUT terminals (Output ch1 or even Output ch2 are fine) which could withstand the Max V_{OUT} (i.e. 10W 4.7 Ω resistor)
2. Check compensation network is properly connected (JP2, and JP3 are closed).
3. Connect the µIO flat cable to X4 connector, paying attention to the polarity.
4. Connect the power supply at the IN terminals (VIC and GND).
5. Launch Infineon toolbox: refer to Chapter 4 to learn how to control the eval board with the PC GUI.
6. The GUI is set by default for “Dual buck parallel voltage regulator”, thus for a constant voltage regulation set 100% of PWM duty cycle and then enable the PWM: it could be possible that an output over voltage (OV) or an output short to ground (S2G) is reported due to wrong RV1 and RV2 settings.
7. Set the OV and S2G thresholds to the desired values by rotating RV1.
8. Set the wanted output voltage by rotating RV2.

Note: It is possible to adjust output voltage from 0 to full scale (previously set by RV2) with the GUI Analog dimming knob, but the best transient response is when analog dimming is set to 100%.

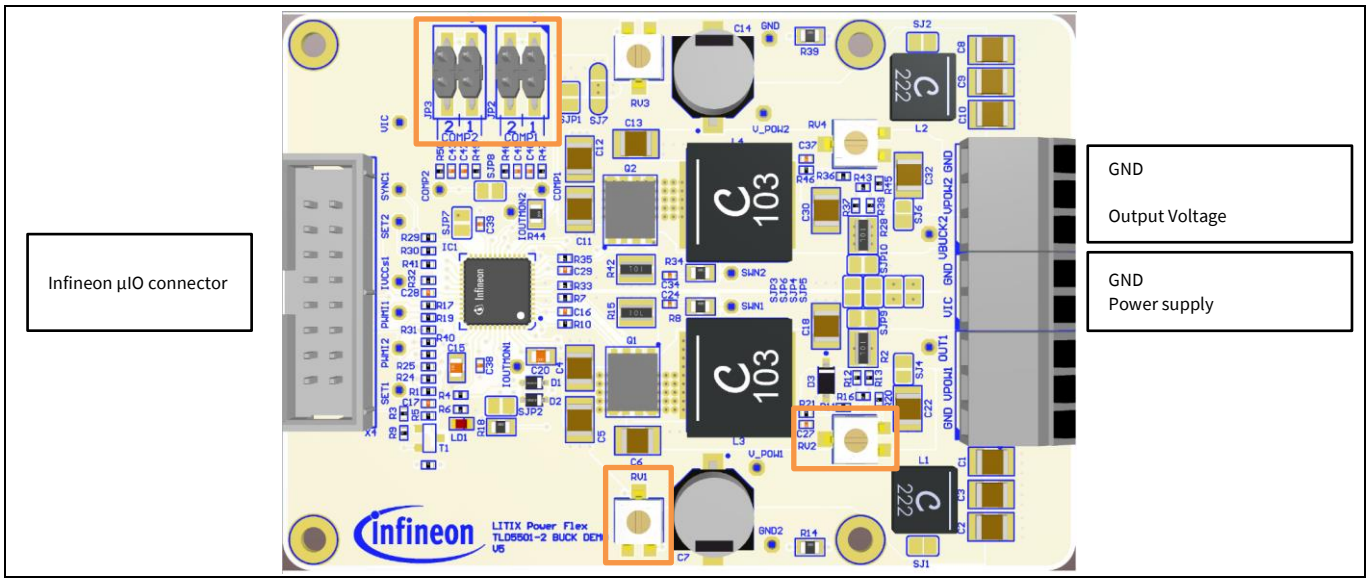


Figure 2 TLD5501-2 BUCK DEMO configuration for "Dual buck parallel voltage regulator" application

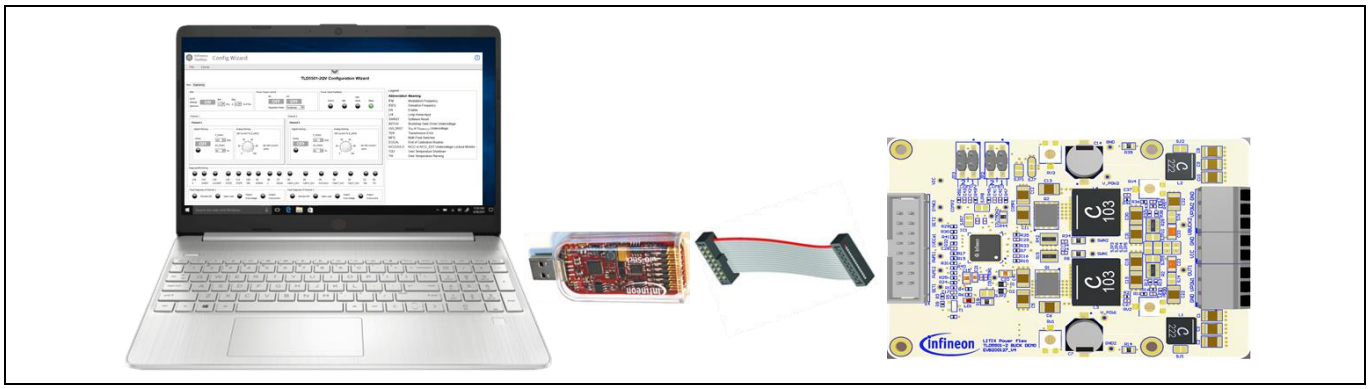


Figure 3 TLD5501-2 BUCK DEMO: Infineon µIO stick connection

4 Infineon µIO stick and Infineon Toolbox

The Infineon µIO stick is an interface device for controlling Infineon boards/kits during run time through PC:

- Enables the communication between the evaluation board and the PC GUI via SPI using the Config Wizard software, which can be downloaded via the Infineon Toolbox.
- Plugs into the evaluation board via a standard 16-pin connector and allows easy interface to the microcontroller via USB for SPI, CAN, LIN communication etc.

Figure 4 Infineon µIO stick

The Infineon Toolbox it is a single platform interface which allows:

- Quick installation of tools by name or QR code
- Help with documentation
- Viewing and starting installed tools from built-in launcher
- Receiving update notifications

Figure 5 Infineon Toolbox

4.1 Install and launch Config Wizard

1. Open the “Manage tools” tab
2. Search for “Config Wizard for LED” and click on “Install” button

Figure 6 Install Config Wizard for LED

3. Select “My Tools” tab on Infineon Toolbox
4. Press “Start” on the config wizard for LED to start

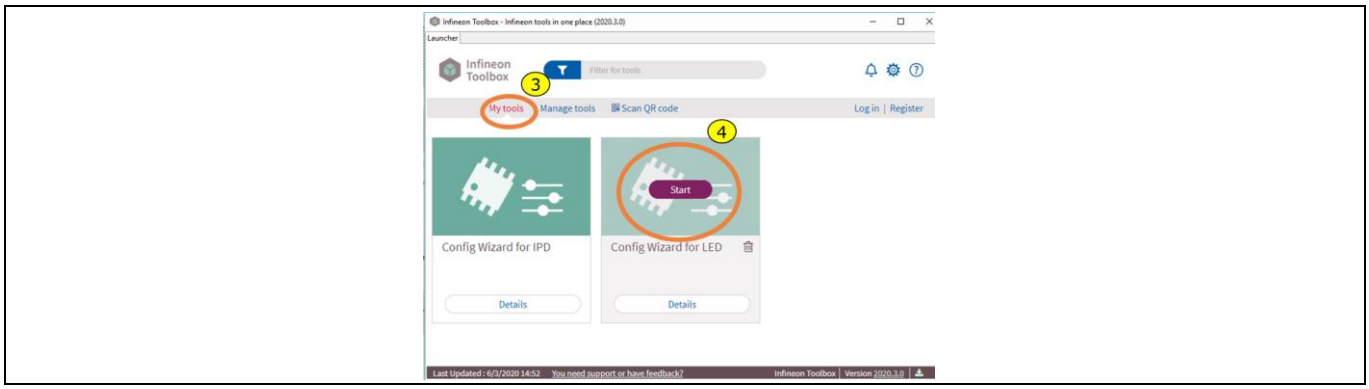


Figure 7 Start Config Wizard tool

5. Click on TLD5501-2QV icon to start the LED GUI interface

Figure 8 Launch TLD5501-2QV GUI

5 Board control with PC GUI

The TLD5501-2QV PC GUI consists of 2 interfaces:

- Basic user interface
- Engineering user interface

The GUI works only if the TLD5501-2 BUCK DEMO eval board is correctly connected to the µIO stick and properly supplied.

NOTE: The text “ON/OFF” displayed on the PC GUI buttons shows the status of the item that is being utilized.

5.1 Basic user interface

Basic user interface allows simplified access to the main registers on TLD5501-2QV (e.g. analog dimming with a knob) and provides direct feedback on TLD5501-2QV status, showing indicators for each standard diagnosis register bit.

It is possible to provide EN signal, Limp Home signal (LHI) and PWMI without the need of a function generator.

In the “Power status Control” tab a window allows to select the regulation mode between “multiphase” in case the 2ch work together to generate an output voltage, or “2-ch regulator” in case the two channels are working independently from each other. In case the “multiphase” option is selected, the “Digital Dimming” and “Analog dimming” tabs of the two channels are linked.

In order to turn on the device press the EN button: in the “Power State Feedback” tab the “Active” indicator shall turn on.
Only once the device is on, the desired analog dimming value can be set by the ”Analog Dimming” knob on the “Analog Dimming” tab.
Note: Analog dimming value is reset to 100% on each channel of the TLD5501-2QV device once the EN is turned off, or the Limp Home is enabled. If the Limp Home is enabled the SPI is not accessible anymore, with the implication that the analog dimming cannot be varied from the GUI. In Limp Home the analog dimming is defined by the voltage applied on SET pin.

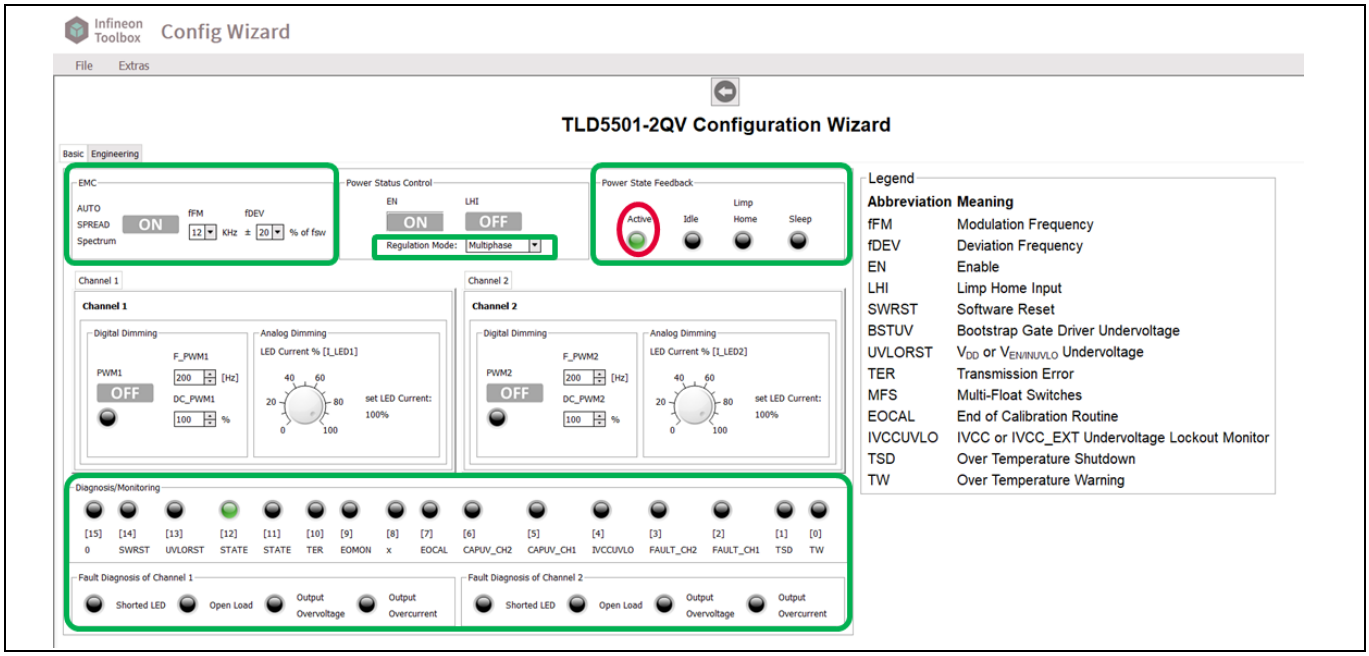


Figure 9 TLD5501-2QV GUI – Basic user interface

In the “Digital Dimming” tab it is possible to configure the PWMI frequency and duty cycle. In Order to enable the DC-DC switching activity the PWM button need to be activated in ON state.

On the “Diagnosis/Monitoring” tab the standard diagnosis register is provided, showing information on the working status of the device.

On the “EMC” tab the spread spectrum function can be enabled/disabled and configured.

Note: Spread Spectrum function is enabled by default.

5.2 Engineering user interface

The Engineering user interface allows the user to send a sequence of SPI commands to the TLD5501-2. PWMI and EN pin control is also possible in this interface.

The suggested sequence of operations in order to send the SPI commands is:

6. Write the list of SPI commands that has to be sent
7. Turn on the device by pressing the EN button
8. Enable the switching activity by pressing PWMI button
9. Press the SEND button to send commands on the list, starting from the one highlighted in the list

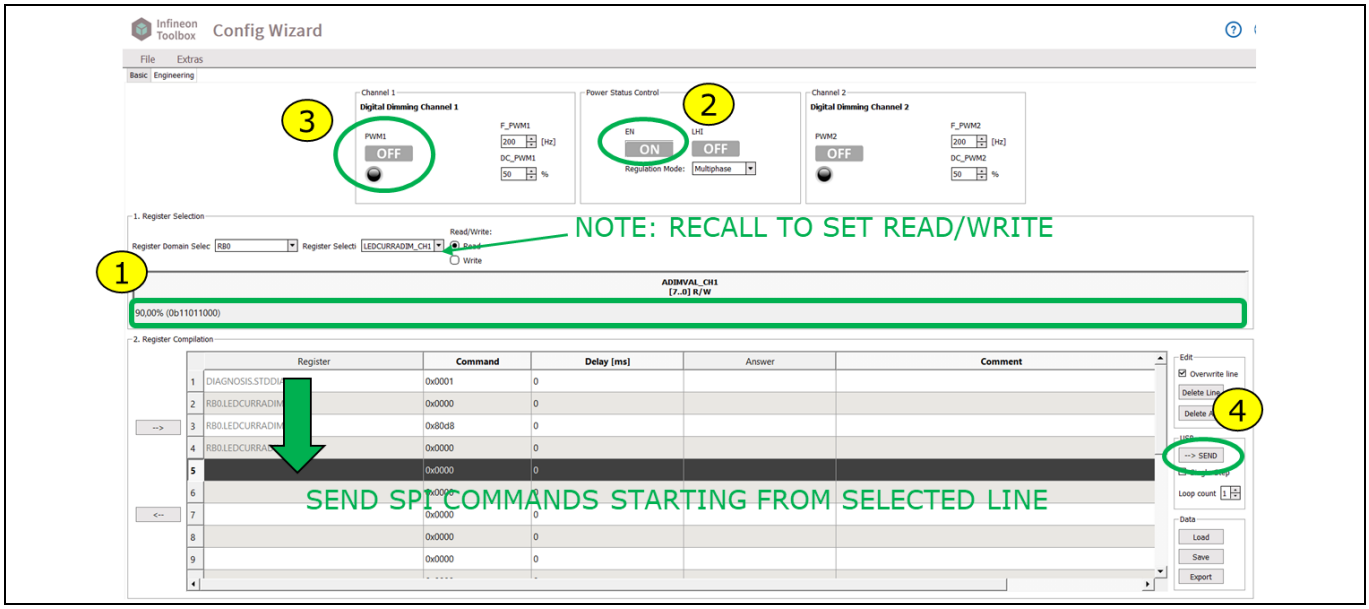
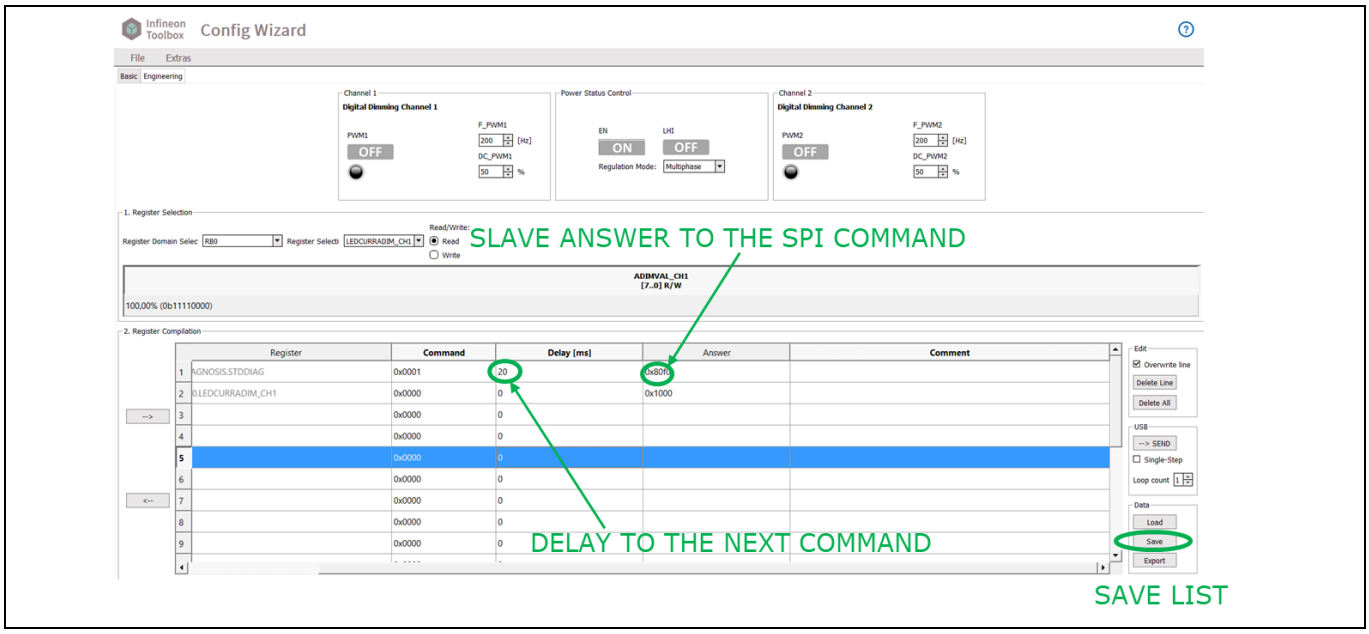


Figure 10 TLD5501-2 GUI – Engineering user interface

It is possible to describe each command with a comment and to save the list of commands by clicking on the “Save” button.

It is possible to set the delay applied before executing the next command in the “Delay” column, the accuracy of the timer is approximately 10 ms.

Board control with PC GUI



6 Operating range and power derating

The TLD5501-2 BUCK DEMO has very high efficiency, so it can deliver up to 40 W at the output on each channel without a heat sink at T_A = 25°C, V_{IN} = 12 V I_{OUT} < *7 A* (see Figure 11 for power-derating curve).

Note: *The module does not implement thermal protection, so ensure proper cooling when output power exceeds the power-derating curve. The heat sink has to be positioned below the switching MOSFETs.*

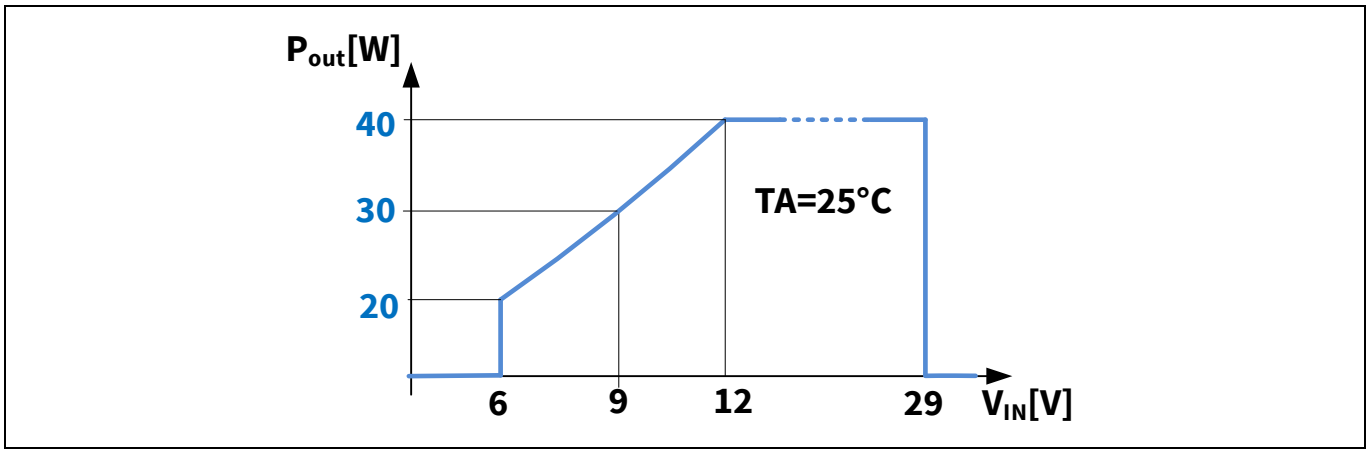


Figure 11 Output power derating curve (T_A = 25°C, I_{OUT} < *7 A*)

7 Efficiency Measurements

Efficiency of one channel in constant voltage regulation with a 1Ω load.

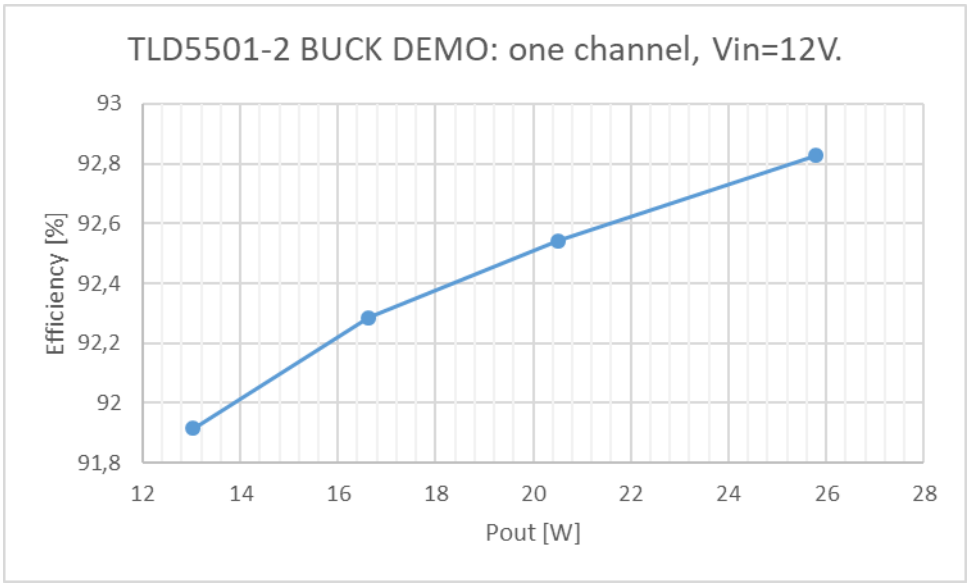


Figure 12 TLD5501-2 BUCK DEMO: one channel efficiency measurements

8 TLD5501-2 BUCK DEMO board configuration

The default configuration of the evaluation board is “Dual buck parallel voltage regulator” in which the two channels work in multiphase to provide up to 80 W to the load with an efficiency above 90%. The board can be also configured for different scenarios:

- “Dual buck independent voltage regulators”: the two channels work as two independent constant voltage supply.
- “Dual buck independent current regulators”: the two channels work as two independent constant current supply (LED application).
- “Single buck independent current regulator plus single buck independent voltage regulator”: one channel work as constant voltage supply and the other one as constant current supply (LED application).

8.1 Dual buck independent voltage regulators

In this configuration the two channels work as two independent constant voltage supply. The following board configuration shall be applied:

Open (green): SJP2-SJP3-SJP4-SJP5-SJP6-SJP7-SJP8

Populate (orange): R11-R14-R16-R18-R20-R21-R36-R39-R43-R44-R45-R46-C27-C37

Not-populate (red): R12-R13-R37-R38

Close (blue): SJP9-SJP10

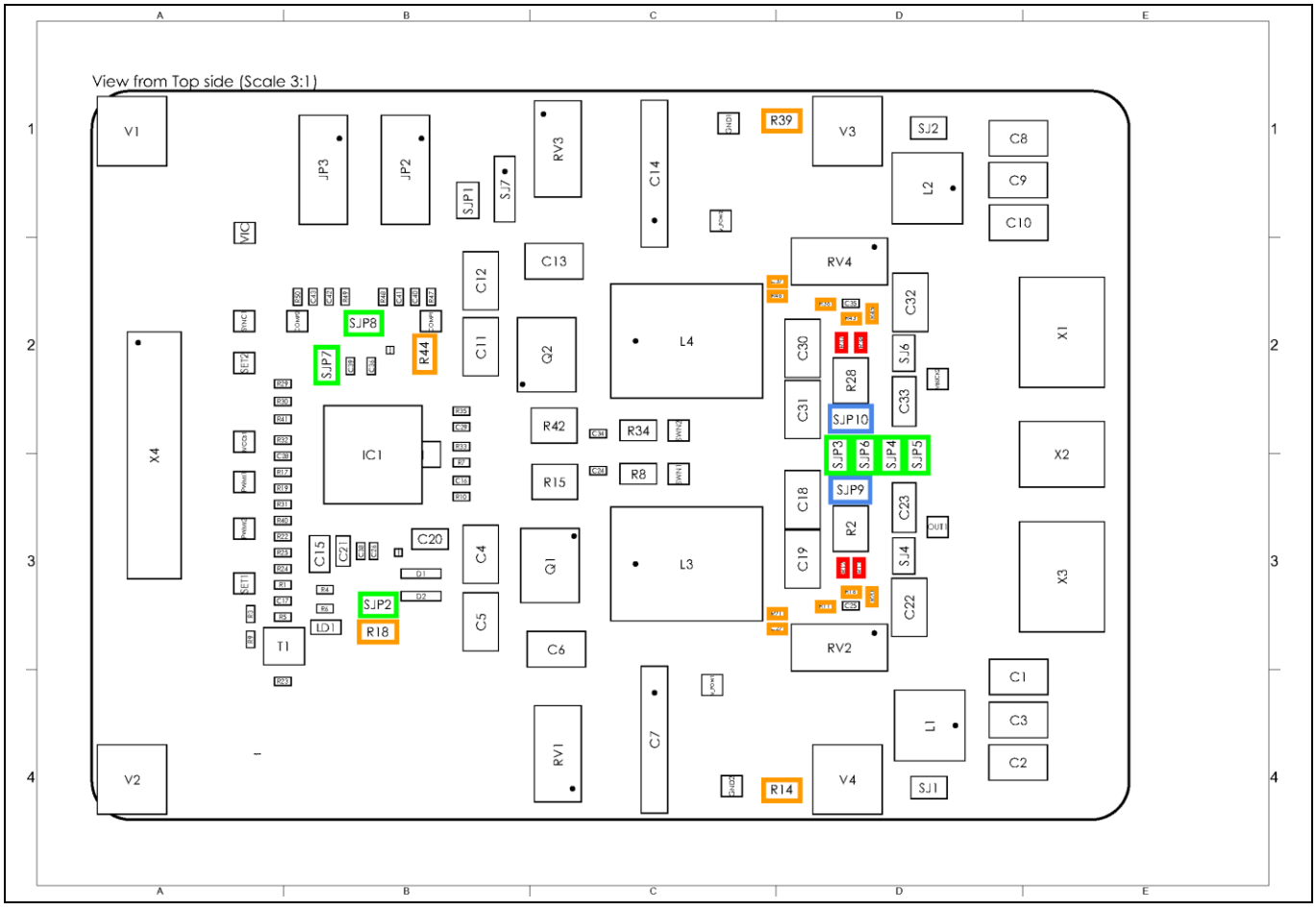


Figure 13 TLD5501-2 BUCK DEMO configuration for “Dual buck parallel voltage regulator” application

TLD5501-2 BUCK DEMO board configuration

Optional: open SJ7 if separate VPOW1 and VPOW2 and VIC are needed, close SJ4 or SJ6 to increase the output capacitor of the two channels.

Below, step by step procedures are laid out for setup and running the TLD5501-2 BUCK DEMO in this configuration:

1. Connect a dummy load at the both OUT terminals (Output ch1 and Output ch2) which could withstand the Max V_{OUT} (i.e. 10W 4.7 Ω resistor)
2. Check compensation network is properly connected (JP2, and JP3 are closed).
3. Connect the µIO flat cable to X4 connector, paying attention to the polarity.
4. Connect the power supply at the IN terminals (VIC and GND).
5. Launch Infineon toolbox: refer to Chapter 4 to learn how to control the eval board with the PC GUI.
6. In the “Power Status Control” tab select the “2-ch regulator” to control each channel independently.
7. For a constant voltage regulation set 100% of PWM duty cycle and then enable the PWM: it could be possible that an output over voltage (OV) or an output short to ground (S2G) is reported to one or both the channels due to wrong RV1, RV2, RV3 and RV4 settings.
8. For each channel set the OV and S2G thresholds to the desired values by rotating RV1 and RV3 respectively.
9. For each channel set the wanted output voltage by rotating RV2 and RV4 respectively.

Note: It is possible to adjust output voltage from 0 to full scale (previously set by RV2 and RV4) with the GUI Analog dimming knob, but the best transient response is when analog dimming is set to 100%.

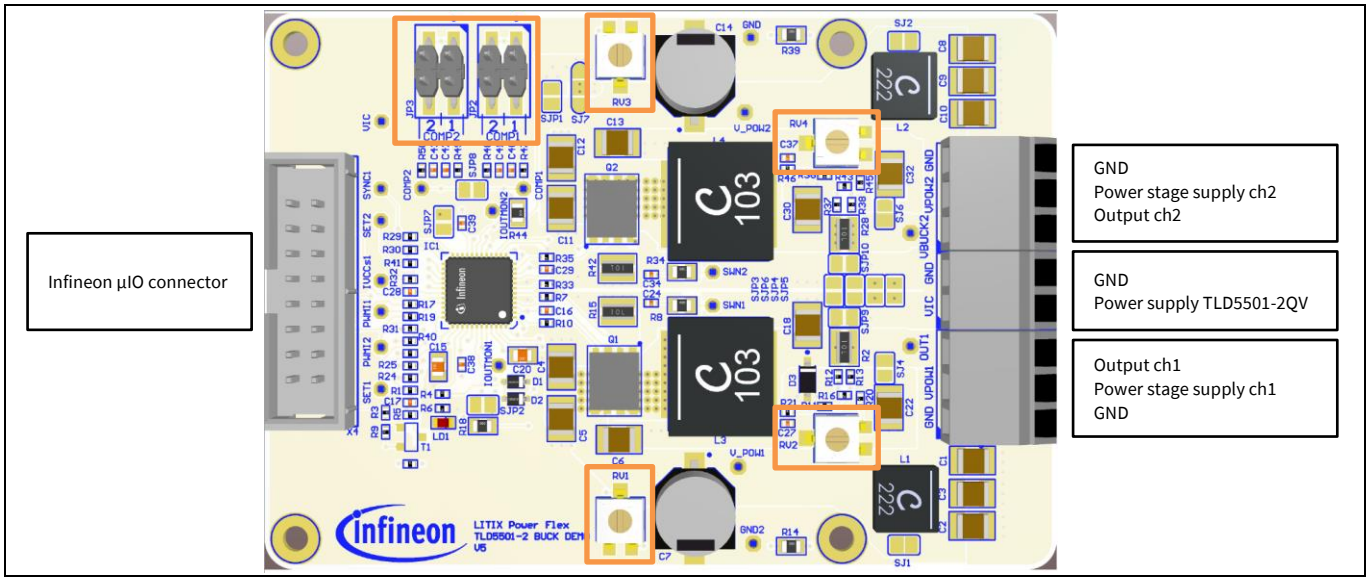


Figure 14 TLD5501-2 BUCK DEMO configuration for “Dual buck independent voltage regulator” application

8.2 Dual buck independent current regulators

In this configuration the two channels work as two independent constant current supply for LED applications. The following board configuration shall be applied:

Open (green): SJP2-SJP3-SJP4-SJP5-SJP6-SJP7-SJP8-SJP9-SJP10

Populate (orange): R12-R13-R14-R18-R37-R38-R39-R44

Not-populate (red): R11-R16-R20-R21-R36-R43-R45-R46-C27-C37

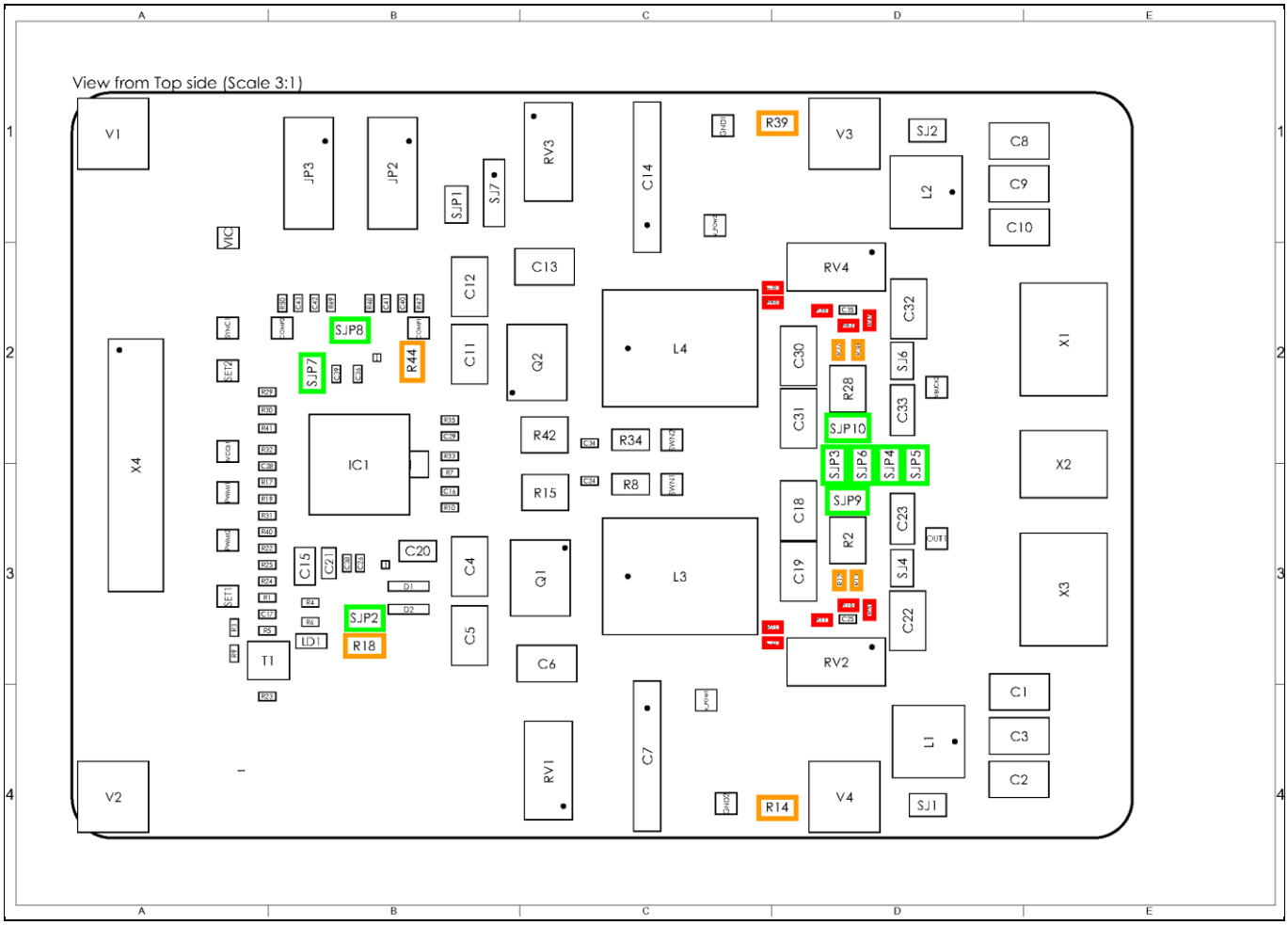


Figure 15 TLD5501-2 BUCK DEMO configuration for "Dual buck parallel current regulators" application

Optional: open SJ7 if separate VPOW1 and VPOW2 and VIC are needed, close SJ4 to increase the output capacitor of channel1.

Below, step by step procedures are laid out for setup and running the TLD5501-2 BUCK DEMO in this configuration:

1. Connect a LED load at the both OUT terminals (Output ch1 and Output ch2) which could withstand the output current.
2. Check compensation network is properly connected (JP2, and JP3 are closed).
3. Connect the µIO flat cable to X4 connector, paying attention to the polarity.
4. Connect the power supply at the IN terminals (VIC and GND).

5. Launch Infineon toolbox: refer to Chapter 4 to learn how to control the eval board with the PC GUI.
6. In the “Power Status Control” tab select the “2-ch regulator” to control each channel independently.
7. For a constant current application set the target analog dimming, PWM frequency and duty cycle and then enable the PWM: it could be possible that an output over voltage (OV) or an output short to ground (S2G) is reported to one or both the channels due to wrong RV1, and RV3 settings.
8. For each channel set the OV and S2G thresholds to the desired values by rotating RV1 and RV3 respectively.

Note: It is possible to adjust output current from 0 to full scale (1A set by R2 and R28) with the GUI Analog dimming knob, but the best transient response is when analog dimming is set to 100%.

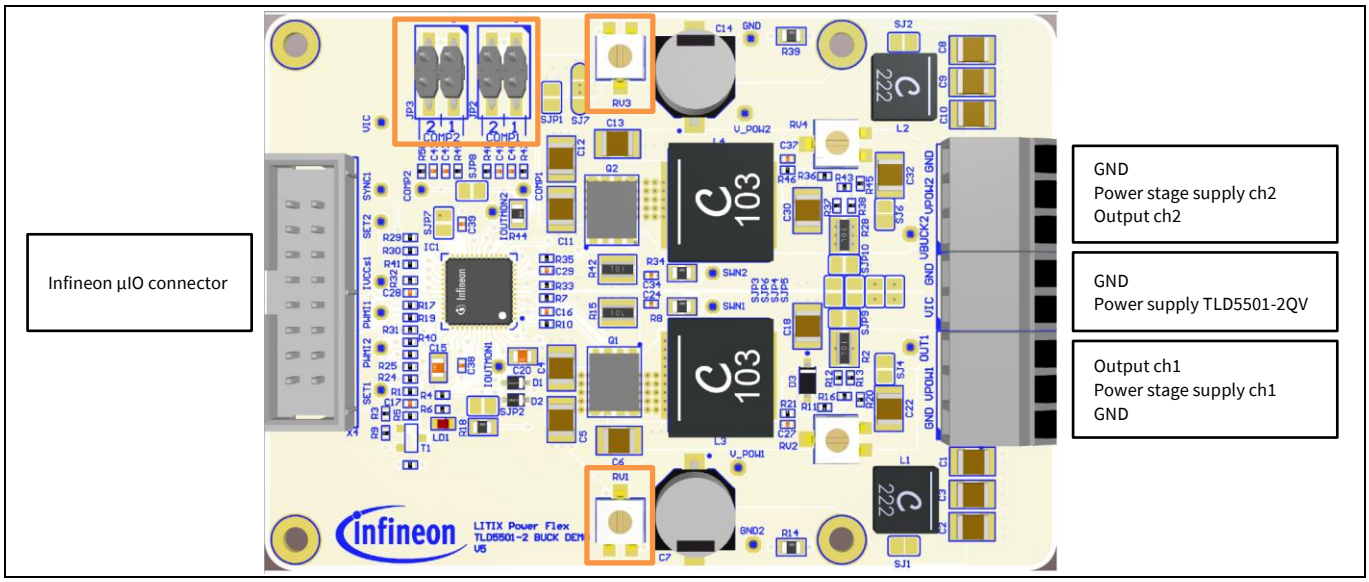


Figure 16 TLD5501-2 BUCK DEMO configuration for “Dual buck independent current regulators” application

8.3 Single buck independent current regulator plus single buck independent voltage regulator

In this configuration one channel work as constant voltage supply and the other one as constant current supply (LED application). The following board configuration shall be applied:

Open (green): SJP2-SJP3-SJP4-SJP5-SJP6-SJP7-SJP8-SJP10

Populate (orange): R11-R14-R16-R18-R20-R21-R37-R38-R39-R44-C27

Not-populate (red): R12-R13-R36-R43-R45-R46-C37

Close (blue): SJP9

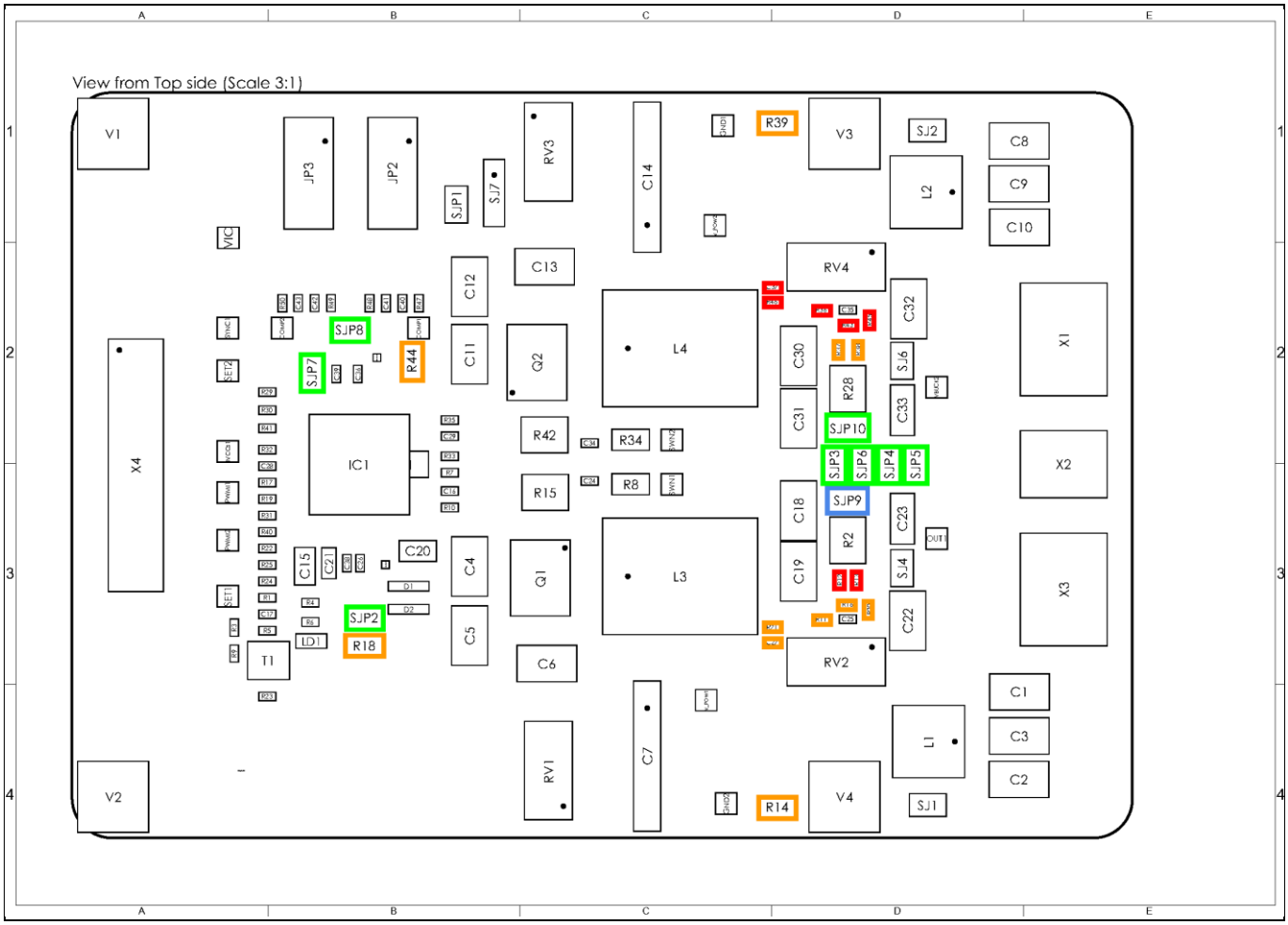


Figure 17 TLD5501-2 BUCK DEMO configuration for "Dual buck parallel current regulators" application

Optional: open SJ7 if separate VPOW1 and VPOW2 and VIC are needed.

Below, step by step procedures are laid out for setup and running the TLD5501-2 BUCK DEMO in this configuration:

1. Connect a LED load at the ch2 out terminals which could withstand the output current, connect a dummy load at the ch1 out terminals which could withstand the Max V_{OUT} (i.e. 10W 4.7 Ω resistor)
2. Check compensation network is properly connected (JP2, and JP3 are closed).
3. Connect the µIO flat cable to X4 connector, paying attention to the polarity.

4. Connect the power supply at the IN terminals (VIC and GND).
5. Launch Infineon toolbox: refer to Chapter 4 to learn how to control the eval board with the PC GUI.
6. In the “Power Status Control” tab select the “2-ch regulator” to control each channel independently.
7. For a constant current application set the target analog dimming, PWM frequency and duty cycle and then enable the PWM: it could be possible that an output over voltage (OV) or an output short to ground (S2G) is reported to channel 2 due to wrong RV3 setting.
8. For a constant voltage regulation set 100% of PWM duty cycle and then enable the PWM: it could be possible that an output over voltage (OV) or an output short to ground (S2G) is reported to channel 1 due to wrong RV1 and RV2 setting.
9. For each channel set the OV and S2G thresholds to the desired values by rotating RV1 and RV3 respectively.
10. For channel 1 set the wanted output voltage by rotating RV2.

Note: It is possible to adjust output current of “channel 2” from 0 to full scale (1A set by R28) and the output voltage of “channel 1” from 0 to full scale (previously set by RV2) with the GUI Analog dimming knob, but the best transient response is when analog dimming is set to 100%.

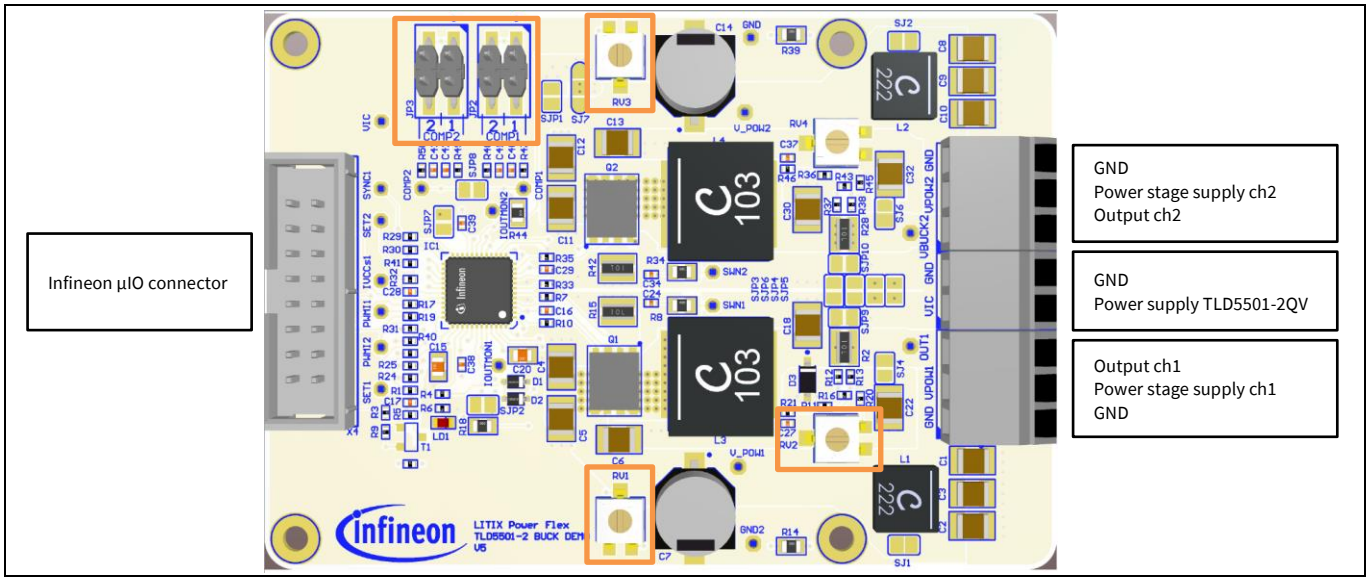


Figure 18 TLD5501-2 BUCK DEMO configuration for “Dual buck independent current regulators” application

9 PCB - component placement

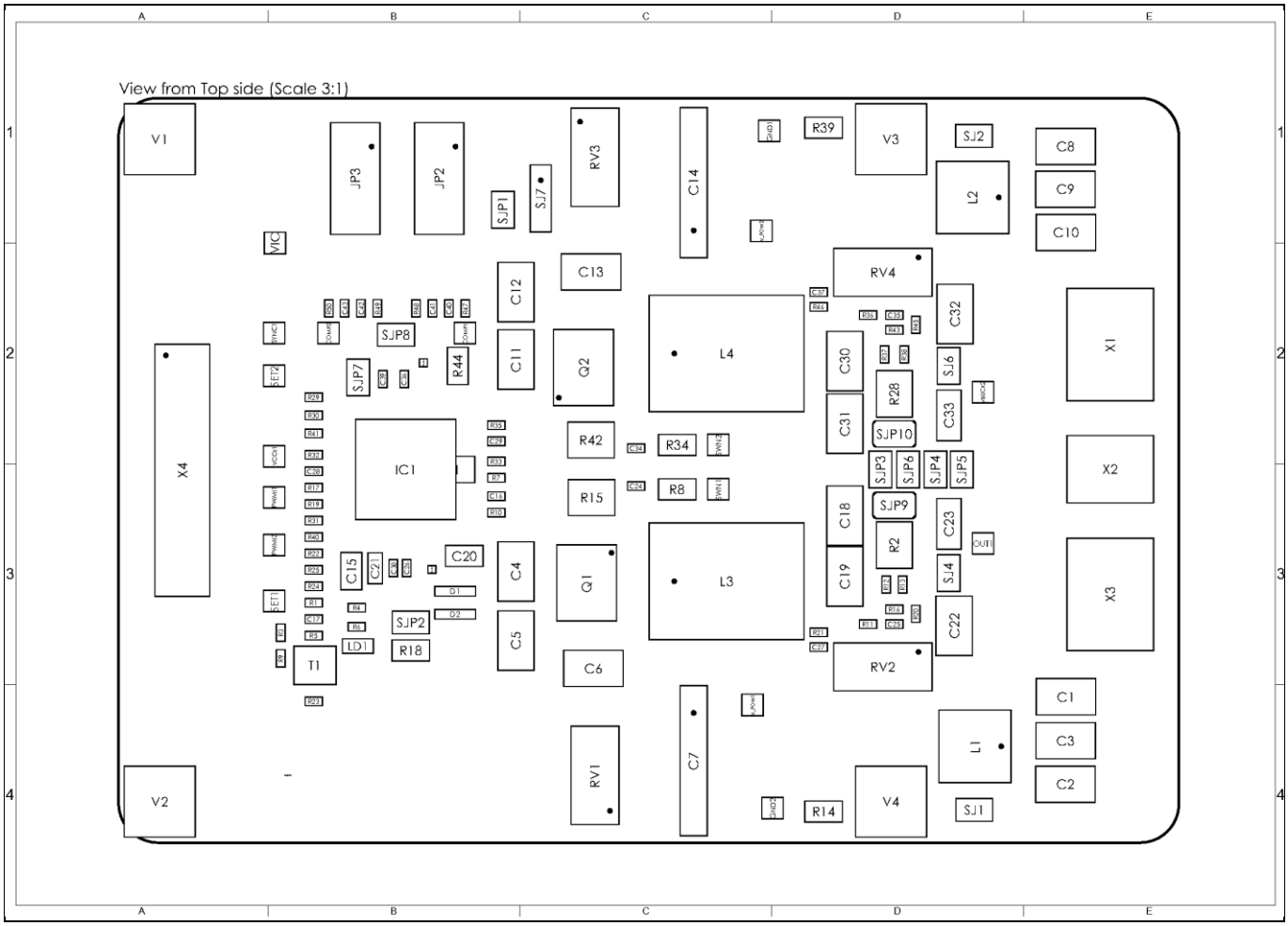


Figure 19 PCB component placement - top view

10 Schematic

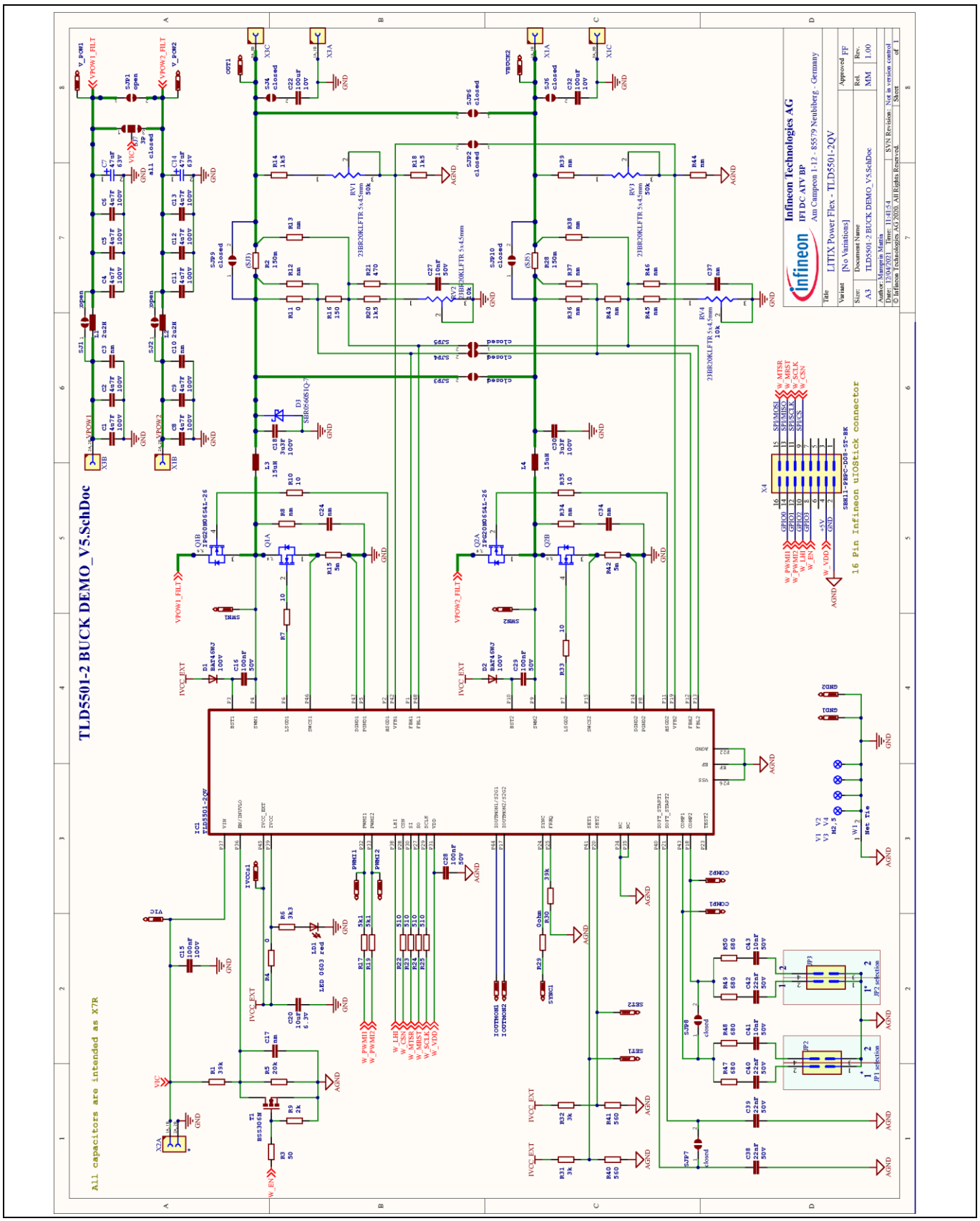


Figure 20 Schematic

11 Bill of Material

Table 3 Bill of Material

Designator	Value	Manufacturer	Part number
C1, C2, C4, C5, C6, C8, C9, C11, C12, C13	4.7 µF	TDK EPCOS	
C15, C16, C28, C29	100 nF	TDK EPCOS	
C7, C14	100 µF, 80 V	TDK EPCOS	
C18, C30	3.3 µF	TDK EPCOS	
C20	10 µF, 6.3 V	TDK EPCOS	
C22, C32	100 µF	TDK EPCOS	
C27	10 nF, 50 V	TDK EPCOS	
C38, C39, C40, C42	22 nF	TDK EPCOS	
C41, C43	10 nF	TDK EPCOS	
D1, D2		NXP	BAT46WJ
D3		DIODES	SBR0560S1Q-7
IC1		Infineon	TLD5501-2QV
L1, L2	2.2 µH	Coilcraft	XAL6030-222ME
L3, L4	15 µH	Coilcraft or TDK	XAL1010-153ME or SPM10065VT-150M-D
LD1	LED 0603 red		
Q1, Q2	Dual MOSFET: 60 V / 26 mΩ N-ch	Infineon	IPG20N06S4L-26
R1, R30	39 kΩ	Panasonic	
R2, R28	150 mΩ	Panasonic	
R4, R11, R29	0 Ω	Panasonic	
R47, R48, R49, R50	680 Ω	Panasonic	
R3	50 Ω	Panasonic	
R5	20 kΩ	Panasonic	
R6	3.3 kΩ	Panasonic	
R7, R10, R33, R35	10 Ω	Panasonic	
R9	2 kΩ	Panasonic	
R14, R18, R20	1.5 kΩ	Panasonic	
R15, R42	5 mΩ	Panasonic	
R16	150 Ω	Panasonic	
R17, R19	5.1 kΩ	Panasonic	
R21	470 Ω	Panasonic	
R22, R23, R24, R25	510 Ω	Panasonic	
R31, R32	3 kΩ	Panasonic	
R40, R41	560 Ω	Panasonic	
RV1, RV3	50 kΩ TRIM	Panasonic	

Designator	Value	Manufacturer	Part number
RV2, RV4	10 kΩ TRIM	Panasonic	
T1	30 V, 57 mΩ N-ch	Infineon	BSS306N

Revision history

Document version	Date of release	Description of changes
Rev. 1.00	2018-02-27	Initial User Manual
Rev. 2.00	2021-04-12	Updated board to be connected to PC via Infineon µIO Stick

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TLD5501-2 BUCK DEMO

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