TLD5542-1HIPOW_EVAL board

Evaluation board manual

About this document

Scope and purpose

The scope of this user manual is to provide instructions on the use of the TLD5542-1HIPOW-EVAL evaluation board.

TLD5542-1HIPOW_EVAL board is a 4-switch synchronous buck-boost regulator that demonstrates the high-power capability of the TLD5542-1. The output is adjustable from 5 V to 24 V and the maximum output current is 25 A for up to 300 W power delivery without heatsink.

The switching frequency is 250 kHz and efficiency can go up to 98%.

The board can be configured as current regulator or voltage regulator.

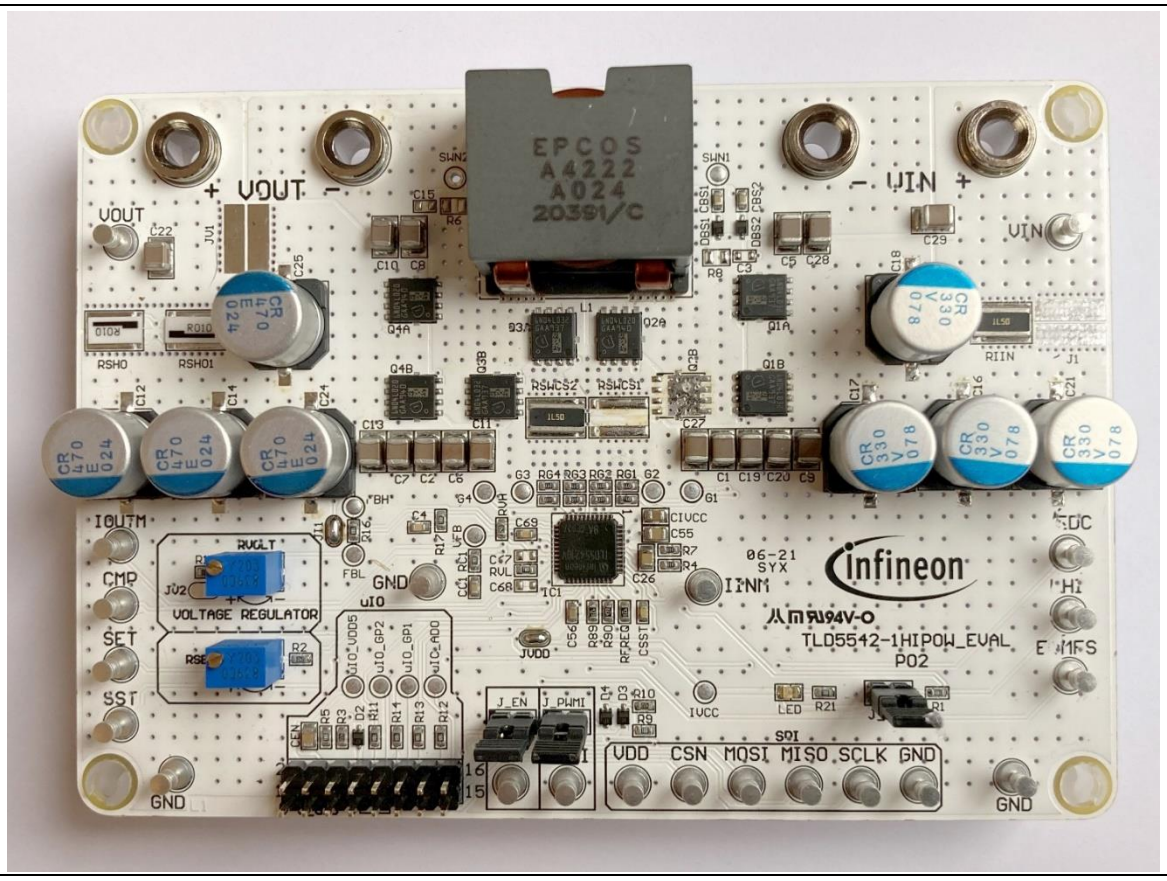

Figure 1 TLD5542-1HI_POW_EVAL device board

Intended audience

Hardware engineers, software engineers, system architects

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1 Description

The H-bridge architecture is amongst the most efficient buck-boost topologies for high current applications. The TLD5542-1 provides complete control and diagnostics through the SPI interface. The TLD5542-1 can also be used in applications without microcontroller because of the limp home mode.

The TLD5542-1HIPOW_EVAL demonstrates the high-power capability of the TLD5542-1 as current or voltage regulator.

The default configuration is adjustable voltage regulator with 25 A maximum output current. By reconfiguring few solder jumps, the board becomes a current regulator for battery or supercapacitors charger applications.

The board can be controlled by the PC GUI via the Infineon µIO stick (see Chapter 4).

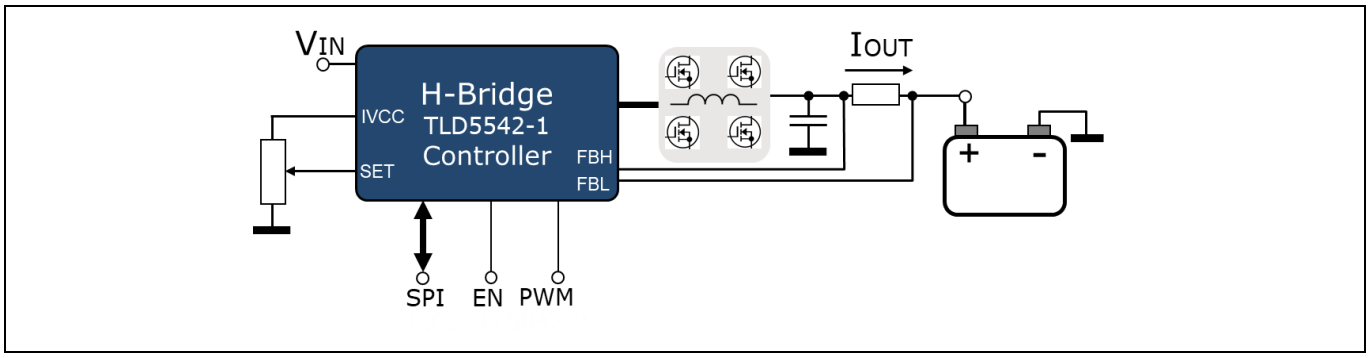


Figure 2 TLD5542-1 as battery charger

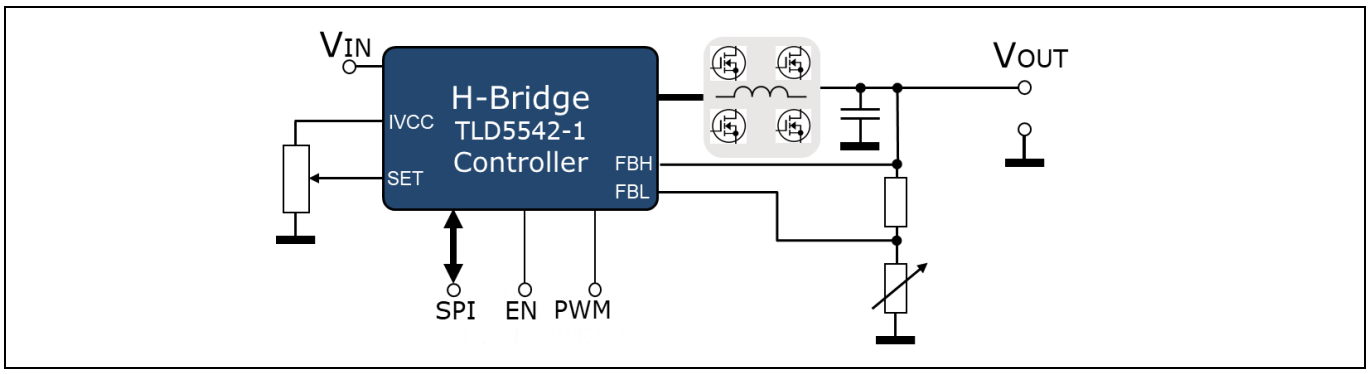


Figure 3 TLD5542-1 as voltage regulator

There are 2 trimmers, RVOLT and RSET, to easily adjust output voltage and output current in the entire range (see table 6).

2 Quick start procedure

Below, step by step procedures are laid out for setup and running the TLD5542-1HIPOW_EVAL in all available configurations.
Installation procedure for PC GUI (graphical user interface) and µIO stick interface is described in Chapter 4.

2.1 Setup as current regulator with no microcontroller

Setup of the board as simple current regulator, without a microcontroller connection and without µIO stick nor PC GUI.

The device is configured in limp home. All the registers are set to their default value and the analog dimming is provided by the voltage on the SET pin which is adjustable with RSET trimmer.

Table 1 Jumper reference and setup for current regulator

Jumper reference	Status	Description
JV1	OPEN	Bypass output current shunt resistor
JV2	OPEN	Disconnect voltage regulator feedback voltage divider
JI1	CLOSE	Connect current shunt
JVDD	CLOSE	Connect Internal 5V IVCC to VDD
J1	CLOSE	Bypass input current shunt resistor

In order to run the board in this configuration

1. Configure solder jumper for LED driver configuration as in Figure 4
2. Connect LHI (limp home) and J_PWMI jumpers

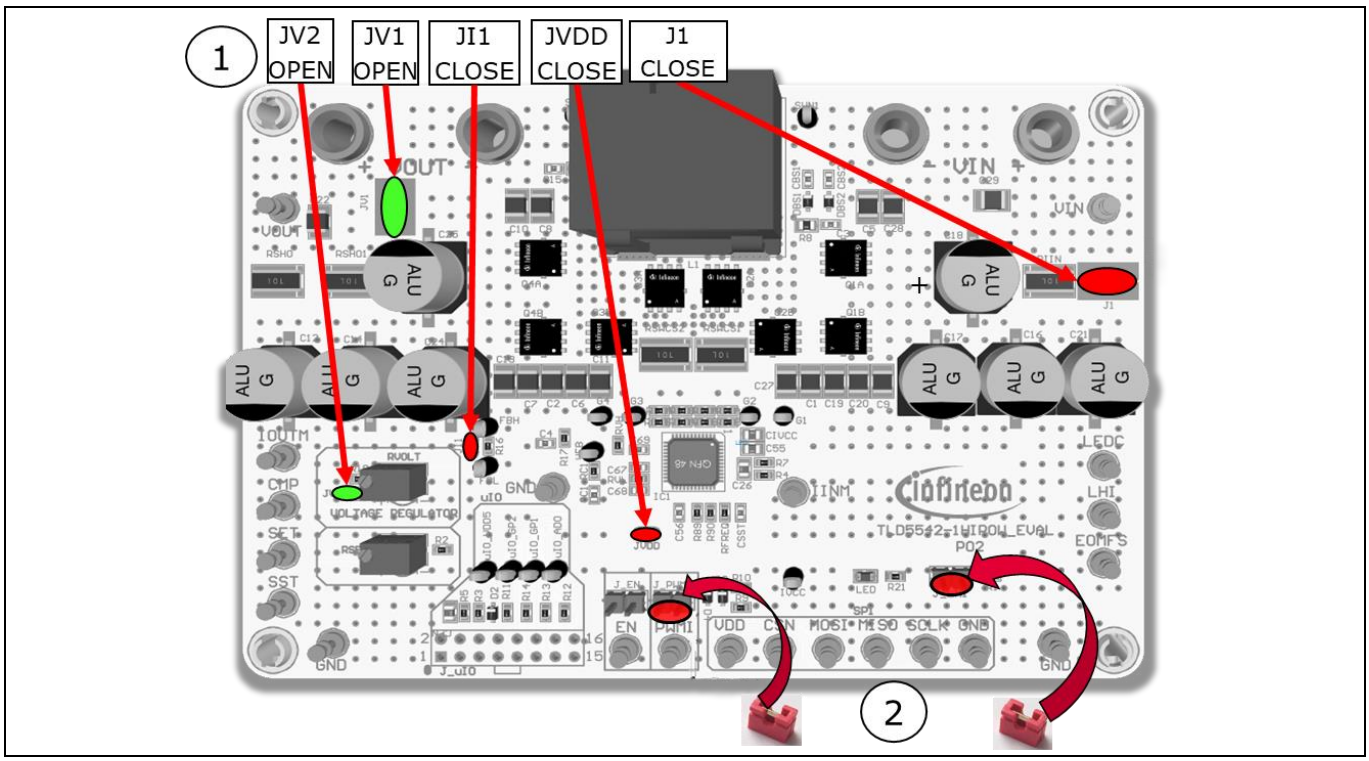


Figure 4 Jumpers to be set for current regulator mode no µC

3. Connect the load (Note that the output current can be as high as 30 A if SET is adjusted to maximum)
4. Connect a 12 V power supply to the V_{IN} connector
5. Rotate RSET trimmer completely anti-clockwise to lower the output current to the minimum
6. Connect the EN jumper to start providing output current to the load
7. Adjust I_{OUT} with RSET (output current should be higher than 2 A for better transient response)

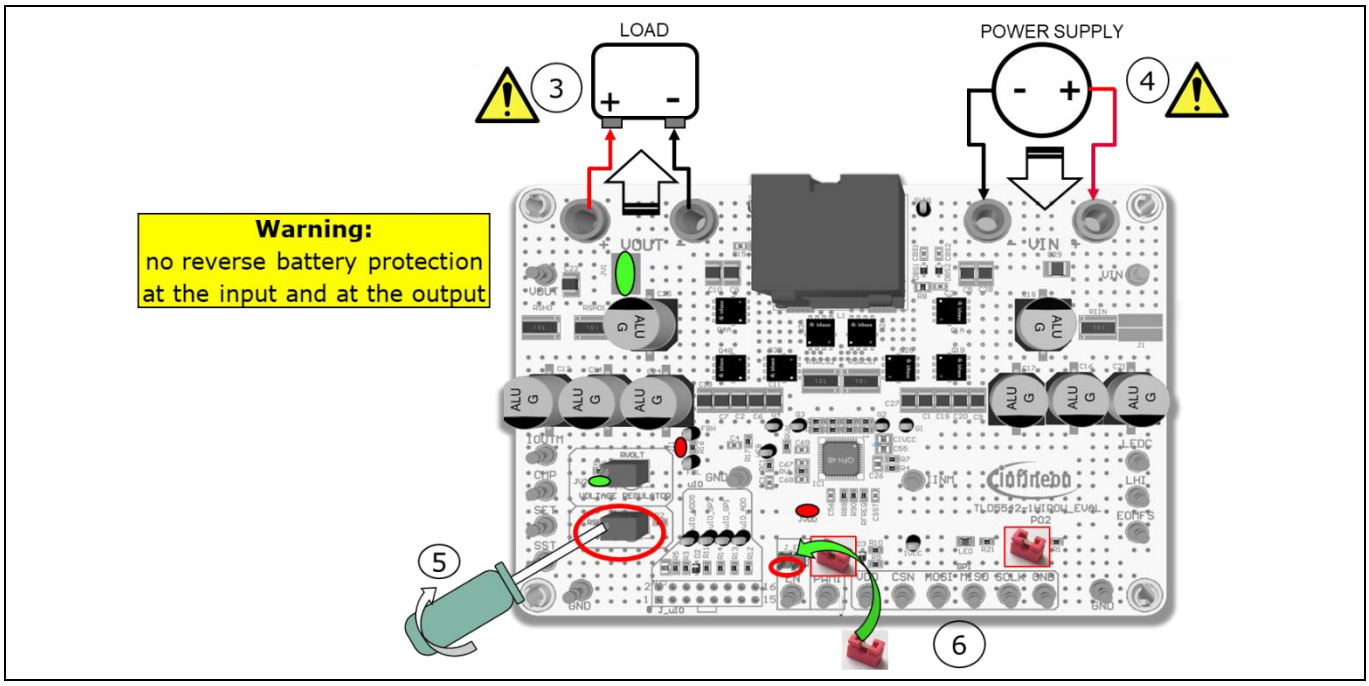


Figure 5 Connect power supply and load, adjust output current

Warning:

1. **If the load is a battery or a supercapacitor, do not use PWMI to stop output current, use EN instead. Otherwise, the device will affect a startup without soft-start assistance sinking high current from the charging battery at the V_{OUT} connector.**
2. **The board is not reverse protected at the input nor at the output, if a battery is connected with reverse polarity the board or the battery may catch fire.**

Correct start-up sequence, to provide current at the load is:

- Set EN to ON with PWMI kept to OFF (blue LED on the PCB turns ON)
- Set desired analog dimming level by using SET pin if limp home mode, otherwise operate via SPI
- Set PWMI to ON

2.2 Board set up as voltage regulator with no microcontroller nor PC GUI

The following describes how to setup the board as a simple voltage regulator without PC GUI. No microcontroller connection and no µIO stick is present.

Table 2 Jumper reference and setup for voltage regulator

Jumper reference	Status	Description
JV1	CLOSE	Bypass output current shunt resistor
JV2	CLOSE	Connect voltage regulator feedback voltage divider
JI1	OPEN	Disconnect current shunt from FBL
JVDD	CLOSE	Connect Internal 5V IVCC to VDD
J1	CLOSE	Bypass input current shunt resistor

1. Configure all solder jumpers as shown in Figure 6
2. Connect J_EN, LHI and PWMI jumpers

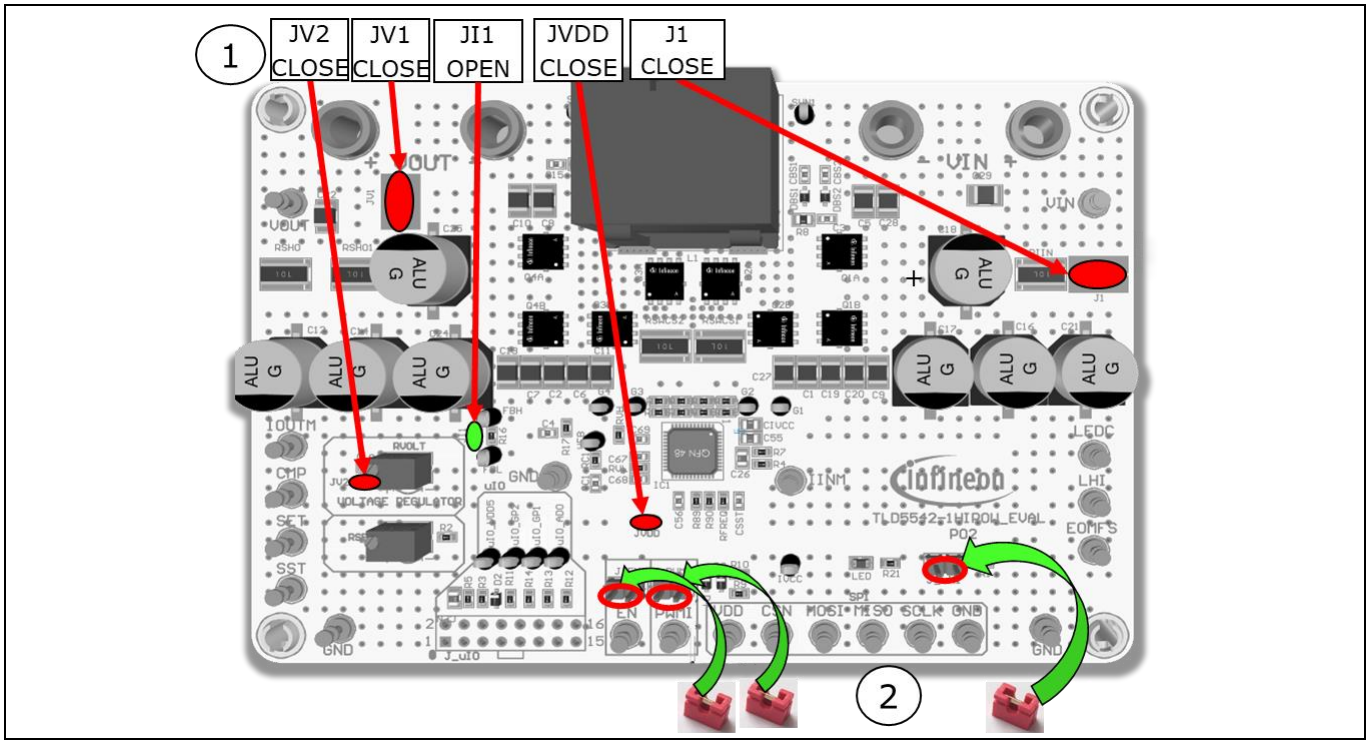


Figure 6 Jumpers to be set for voltage regulator mode no µC

3. Connect a 12 V power supply to the V_{IN} connector
4. Rotate RSET trimmer completely clockwise (100% analog dim, improves transient response and accuracy)

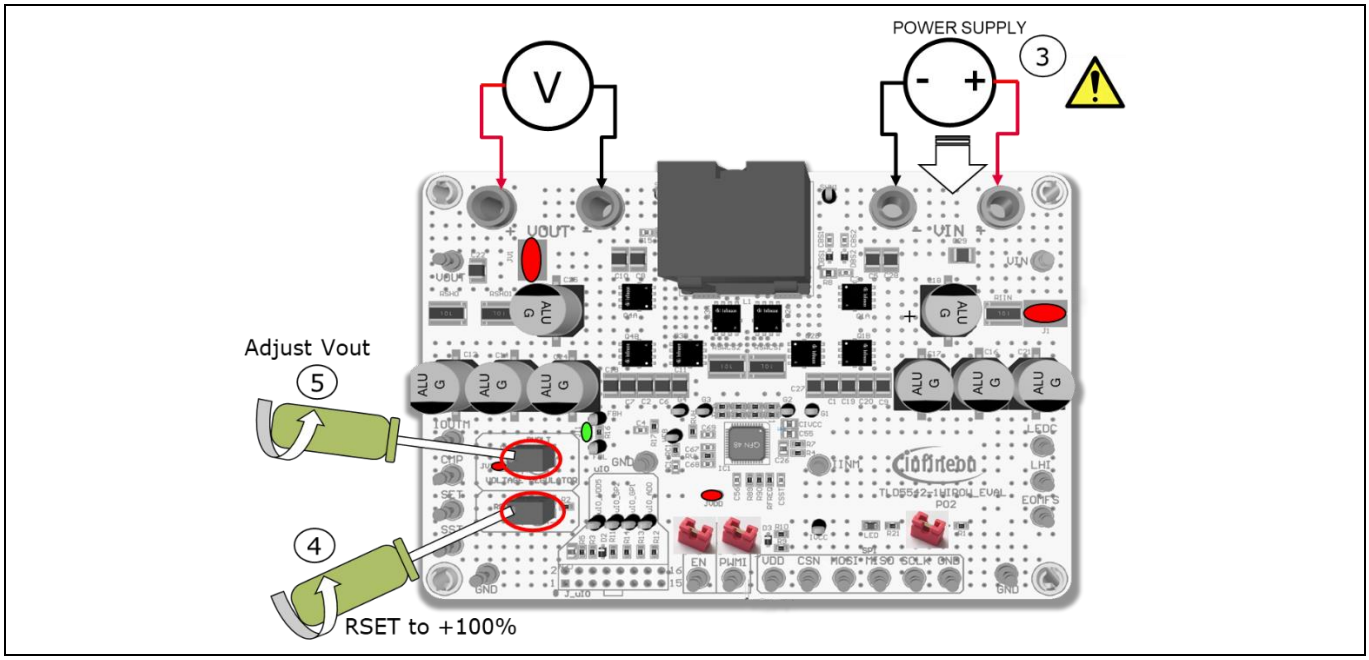


Figure 7 Connect power supply, turn RSET to maximum and adjust V_{OUT} with RVOLT

5. Rotate RVOLT trimmer to obtain the desired V_{OUT}
6. Connect the load to V_{OUT}

2.3 Board set up as voltage/current regulator with PC GUI

The TLD5542-1 HIPOW_EVAL can be controlled by the PC GUI via a µIO stick. All the plug jumpers have to be removed, or the µIO will not be able to control the TLD5542-1 properly.

1. Set solder jumpers for voltage (Chapter 2.1) or current (Chapter 2.2) regualtor
2. Remove jumper plugs J_LHI, J_PWMI, J_EN

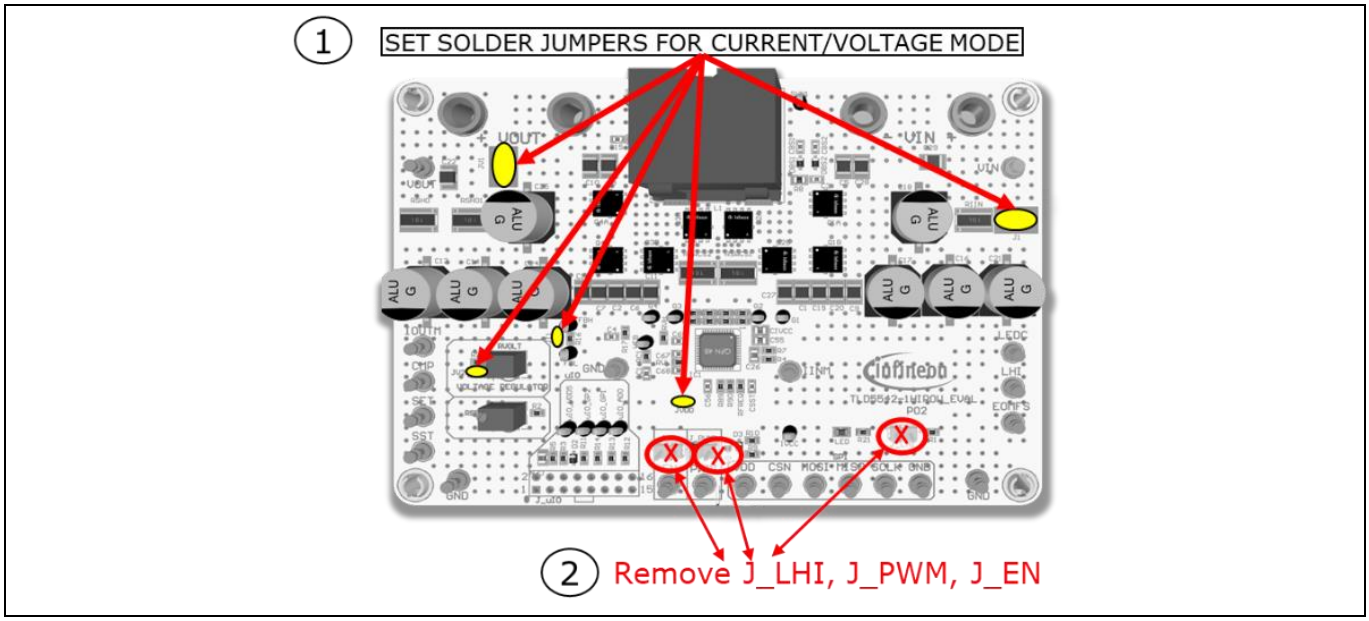


Figure 8 Control with µIO stick board preparation

3. Connect the µIO to J_uIO connector (pin 1 mark on PCB on RED cable strip) and uIO stick to the PC

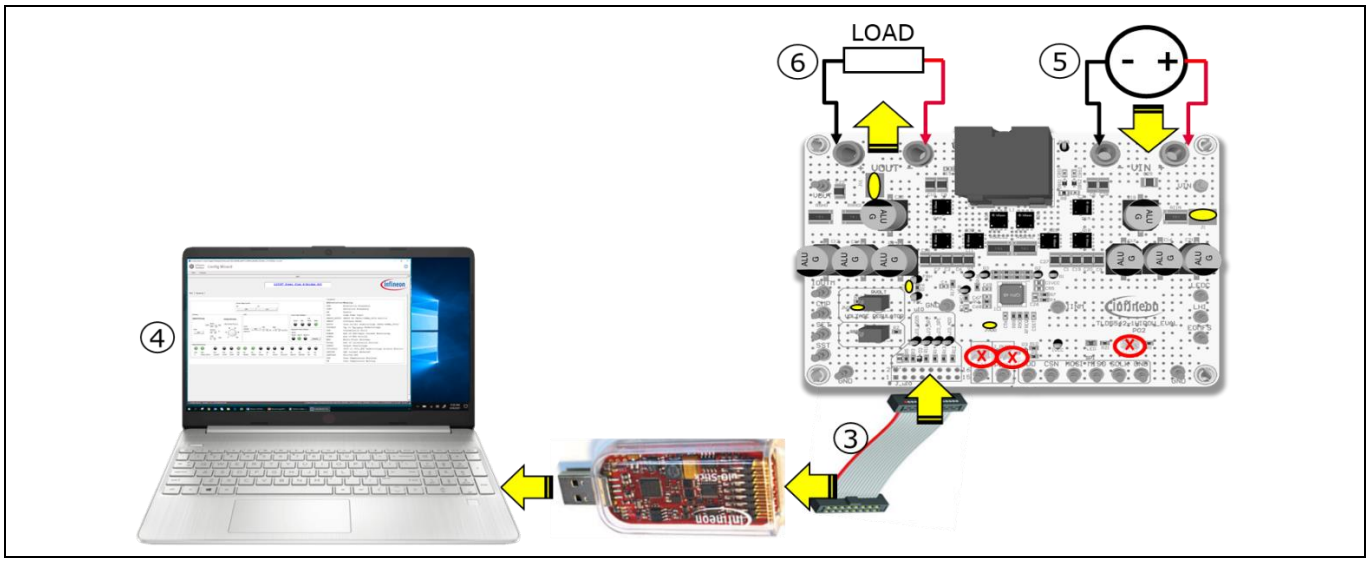


Figure 9 Connect µIO stick, power supply, load

4. Launch Infineon Toolbox and the Config Wizard for LED, see chapter 3.1
5. Connect power supply to the V_{IN} connector
6. Adjust for the desired output current/voltage with the GUI (see Chapter 4) and connect the load

3 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 connection between the evaluation board and USB for SPI programming and monitoring by using the **Config Wizard** software, which can be downloaded via the **Infineon Toolbox [1]**
- Plugs into the evaluation board via a standard 16-pin connector and allows easy interface to the microcontroller via USB for SPI, CAN and LIN communication

Figure 10 Infineon µIO stick

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

- 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 11 Infineon Toolbox

For details about Infineon toolbox and µIO stick check the Infineon website: **Infineon Toolbox**.

3.1 Install and launch Config Wizard

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

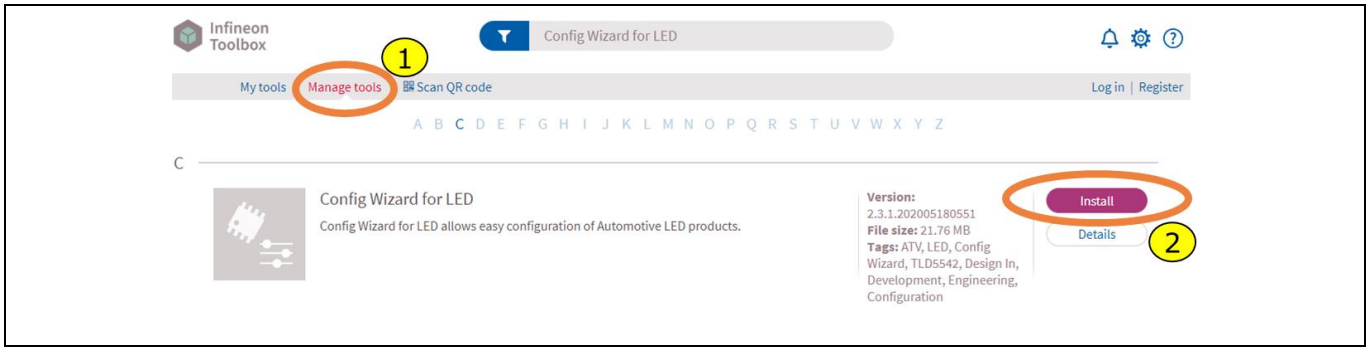


Figure 12 Install Config Wizard for LED

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

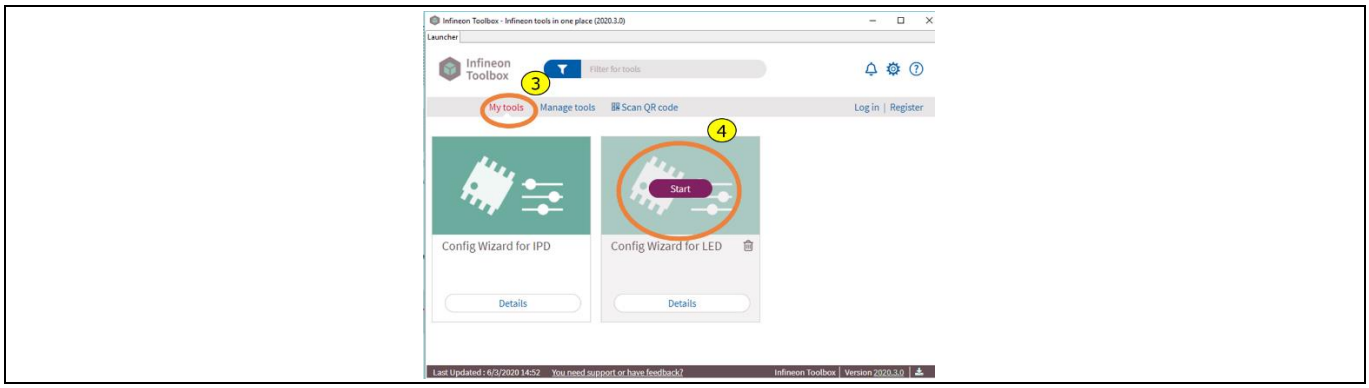


Figure 13 Start Config Wizard tool

5. Click on TLD5542-1 icon to start the LED GUI interface

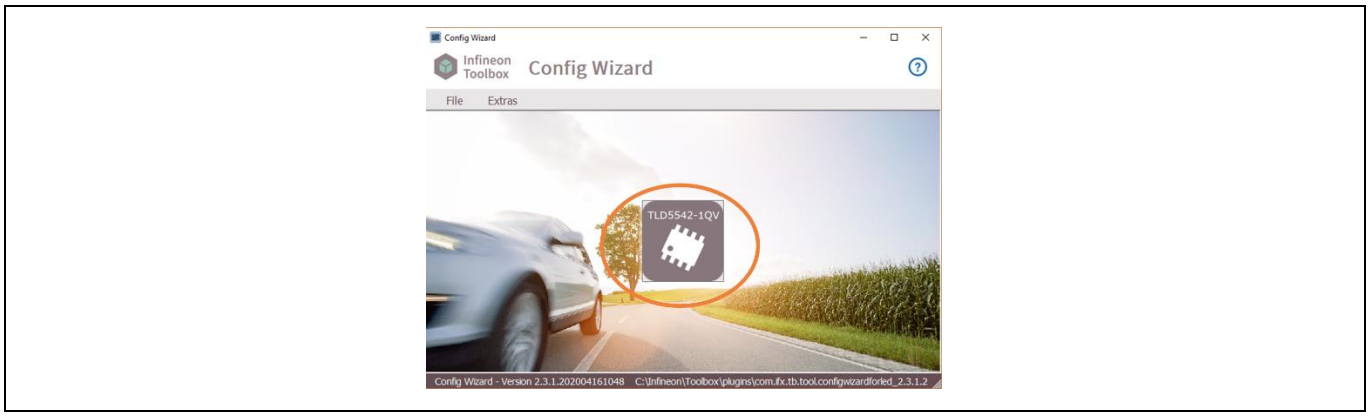


Figure 14 Launch TLD5542-1 GUI

4 Board control with PC GUI

The TLD5542-1 PC GUI consists of 2 interfaces:

- Basic user interface
- Engineering user interface

The GUI works only if the TLD5542-1 evaluation board is correctly connected to the µIO stick and power supply is applied to the V_{IN} connector.

4.1 Basic user interface

Basic user interface allows simplified access to the main registers on TLD5542-1 (e.g. analog dimming with a knob) and provides direct feedback on TLD5542-1 status, showing indicators for each standard diagnosis register bit.

It is possible to provide EN signal and PWMI without the need for a function generator.

In order to turn on the device press the EN button, 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 “Dimming” tab.

Correct startup sequence is:

- Have a power supply connected at V_{IN}
- Set EN to ON with PWMI kept to OFF (blue LED on the PCB turns ON)
- Set desired analog dimming level (RSET trimmer if limp home mode otherwise via GUI)
- Set PWMI to ON

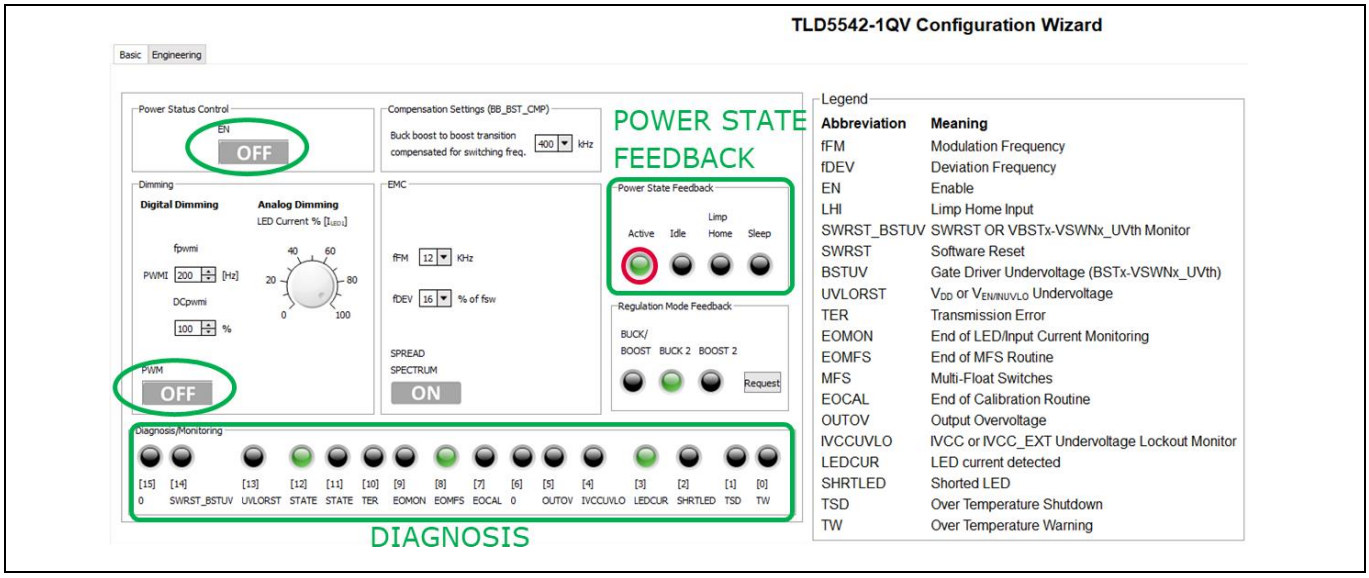


Figure 15 TLD5542-1 GUI – Basic user interface

On the “Diagnosis/Monitoring” tab, (see Figure 15) the standard diagnosis register is provided, showing information on the working status of the device.

On the “Compensation Setting” tab (see Figure 16), it is possible to tune the compensation transfer function in order to have the smoothest transition from buck-boost to boost mode, which depends on the switching frequency (385 kHz for the TLD5542-1 HIPOW _EVAL board)

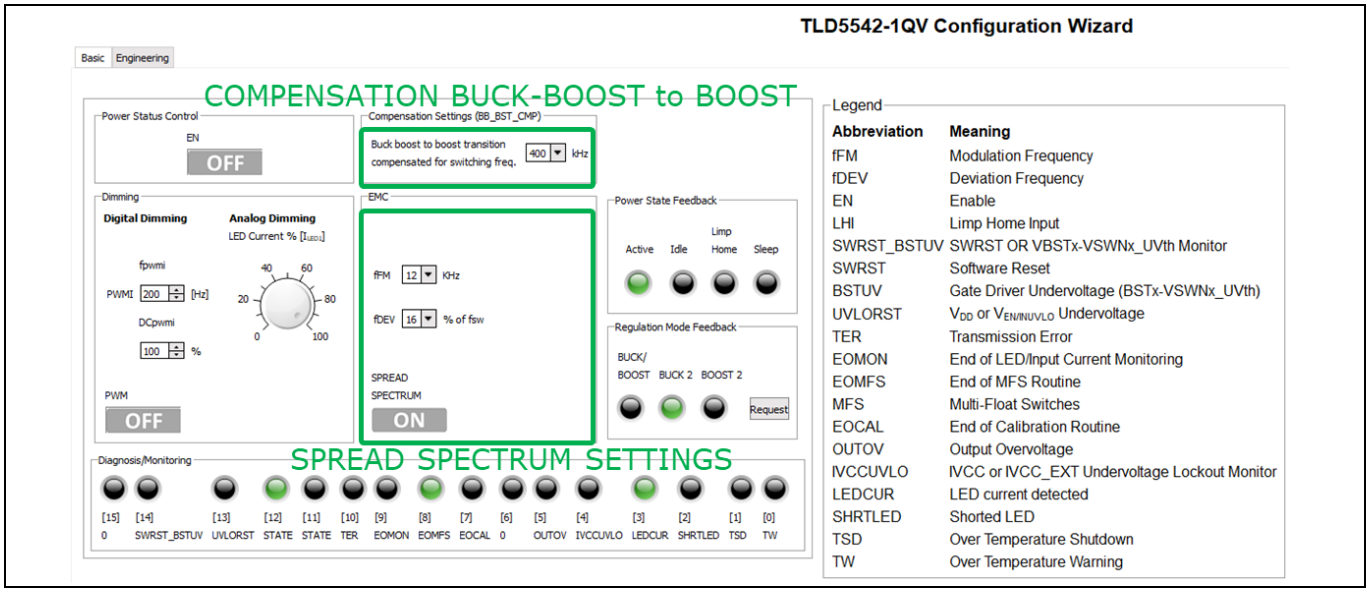


Figure 16 TLD5542-1 GUI basic user interface – compensation and EMC tabs

4.2 Engineering user interface

The engineering user interface allows the user to send a sequence of SPI commands to the TLD5542-1. PWMI and EN pin control is also possible on this interface.

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

1. Write the list of SPI commands that has to be sent
2. Turn on the device by pressing the EN button
3. Press the SEND button to send commands on the list, starting from the black row in the list Figure 17
4. Enable the switching activity by pressing PWMI button

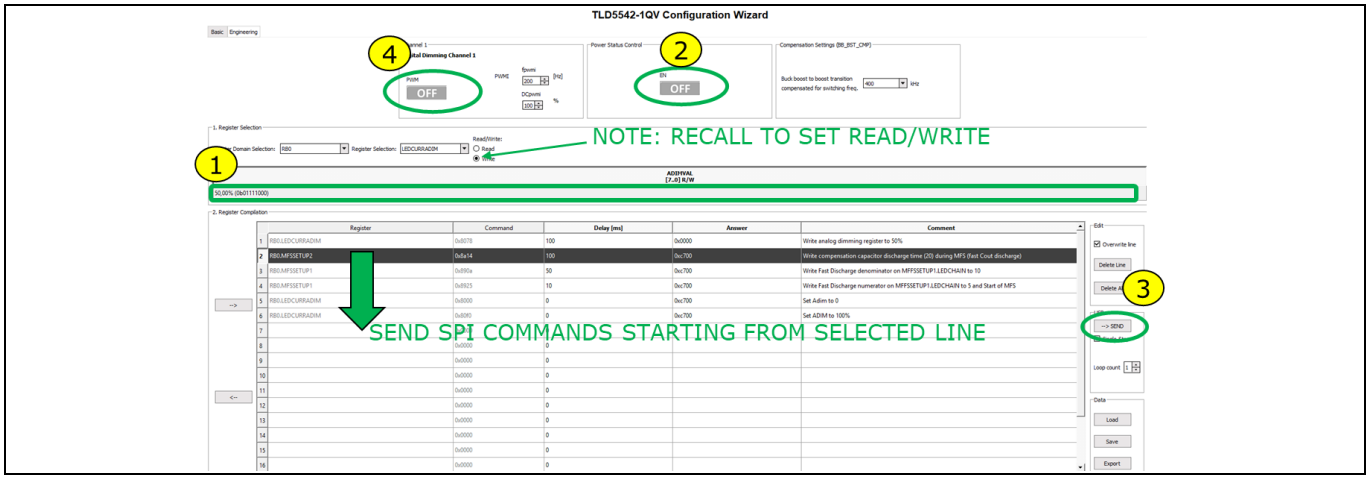


Figure 17 TLD5542-1 GUI – Engineering user interface

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.

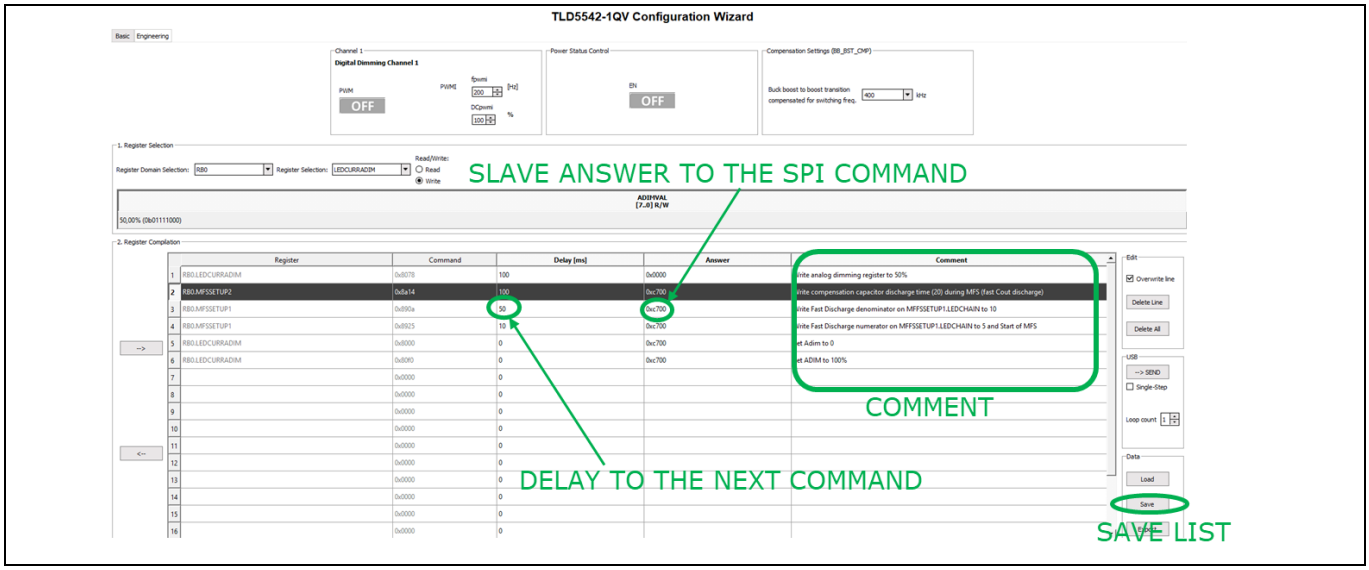


Figure 18 TLD5542-1 GUI – writing comment - saving command list - delay between commands

5 Operating range and power derating

The TLD5542-1HIPOW-EVAL has very high efficiency, so it can deliver up to 300 W at the output without a heatsink at T_A = 25°C, for V_{IN} down to 9 V.

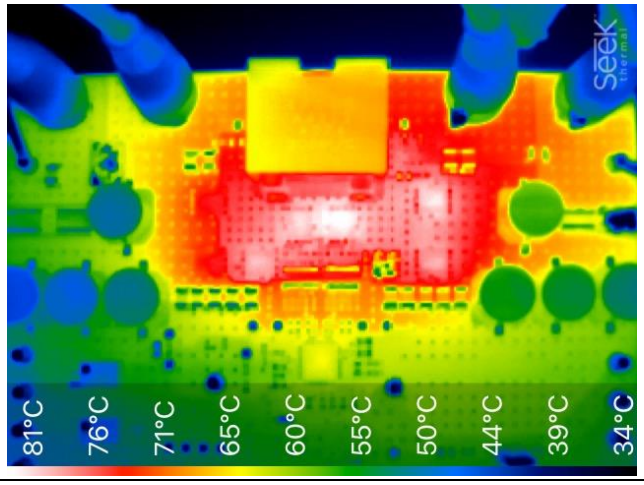


Figure 19 Thermal acquisition, voltage REG, V_{IN} = 12 V, V_{OUT} = 12 V, I_{OUT} = 25 A, T_A = 25°C no heatsink

Please note that the module does not implement thermal protection, so ensure proper cooling when output power exceeds the power-derating curve. The heatsink must be positioned below the switching MOSFETs as shown in Figure 20.

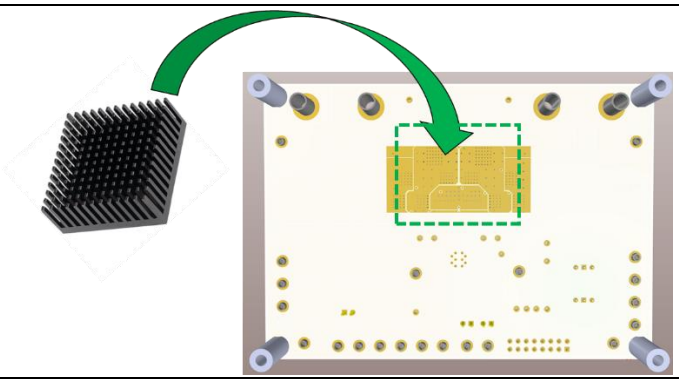


Figure 20 Optional heatsink placement

The heatsink shall be electrically insulated from the PCB, by means of a thermal pad.

6 Electrical characteristics

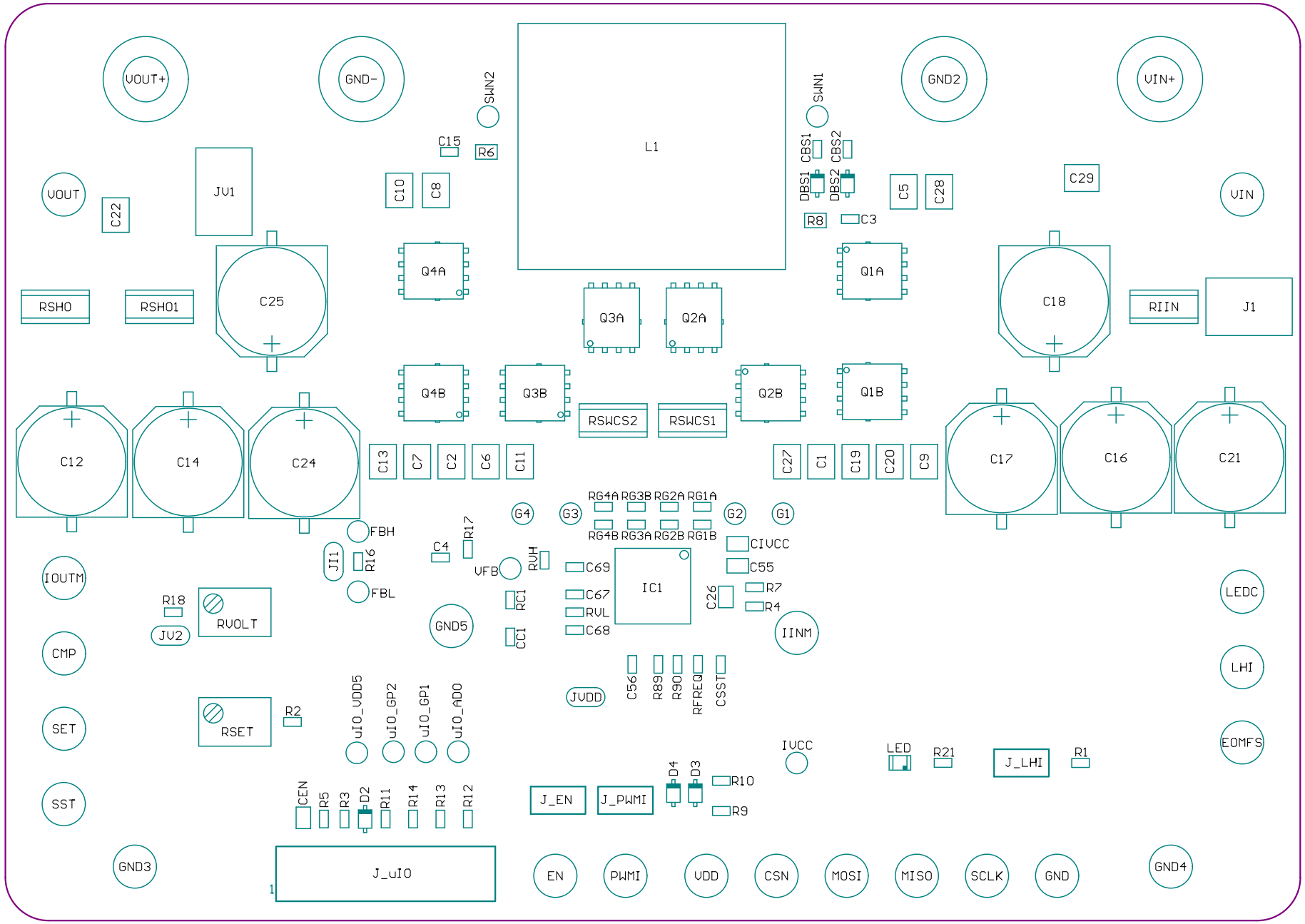
Table 3 TLD5542-1 HIPOW -EVAL version S03 P01 – electrical characteristics

Parameter	Symbol	Value			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Input voltage	V_{IN}	7.5	–	35	V	Power derating may occur for V_{IN} < 9 V
Output voltage	V_{OUT}	2 5	–	24 24	V	Current regulator mode Voltage regulator mode
Output current	I_{OUT}	0	–	25	A	
Output power	P_{OUT}	-	300 400	–	W W	No heatsink V_{IN} 9 V to 35 V, T_A = 25°C With heatsink V_{IN} 9 V to 35 V, T_A = 25°C
Switching frequency	Switching frequency	–	250	–	kHz	Spread spectrum deviation is present
PWM frequency	PWM_{freq}	100	–	500	Hz	–
System efficiency	η	–	97 96	–	%	Voltage mode: V_{IN} = 12 V V_{OUT} = 12 V I_{OUT} = 25 A Current mode: V_{IN} = 12 V V_{OUT} = 12 V I_{OUT} = 20 A

7 Bill of material, PCB layout and schematic

Table 4 Bill of material

Designator	Value	Footprint	Quantity
C1, C5, C9, C19, C20, C27, C28, C29	10µF 50V X7R 1210	C1210	8
C2, C6, C7, C8, C10, C11, C13, C22	22µF 25V X7R 1210	C1210	8
C4, C69, CSST	22nF 50V	C0603	3
C12, C14, C24, C25	470µF 25V PCR1E471MCL1GS	CE D10 CASE G	4
C16, C17, C18, C21	330µF 35V PCR1V331MCL1GS	CE D10 CASE G	4
C26, C55, CEN	1µF 50V 0805	C0805	3
C56, CBS1, CBS2	100nF 50V	C0603	3
CC1	33nF 25V	C0603	1
CIVCC	10µF 6,3V 0805 X7R	C0805	1
CMP, CSN, EN, EOMFS, GND, GND3, GND4, GND5, IINM, IOUTM, LEDC, LHI, MISO, MOSI, PWMI, SCLK, SET, SST, VDD, VIN, VOUT	Mill-Max 2501-2-00-80-00-00-07-0	–	21
D2, D3, D4, DBS1, DBS2	NXP_BAT46WJ	SOD323F	5
GND2, GND-, VIN+, VOUT+	Keystone 575-8		4
IC1	TLD5542-1QV	VQFN48 7X7 P05	1
J_EN, J_LHI, J_PWMI	TSW-102-08-G-S	CON-M-THT-TSW-102-08-G-S	3
J_uIO	Header 8X2(tyco 5-146254-8)	HDR2X8	1
L1	TDK B82559A5332A024	IND SMD B82559A	1
LED	WURTH 150080BS75000	LED 0805 BLU	1
Q1A, Q1B, Q3A, Q3B	IAUC80N04S6L032	PG-TDSON-8-33	4
Q2A, Q4A, Q4B	IAUC100N04S6L020	PG-TDSON-8-33	3
R1, R9, R17, RC1, RVL, R5, R21	1.5kΩ 1%	R0603	7
RFREQ,R89, R90	47kΩ 1%	R0603	3
R3,R10,R18	4.7kΩ 1%	R0603	3
R4, R7, RG1A, RG1B, RG2A, RG2B, RG3A, RG3B, RG4A, RG4B	1Ω	R0603	10
R11, R12, R13, R14, R16	150Ω 1%	R0603	5
R2,RVH	24kΩ 1%	R0603	2
RSET, RVOLT	Bourns 3266Y-1-203LF	–	2
RSHO1,RSHO	10mΩ FC4L64R010FER	–	2
RSWCS2,RIIN	1.5mΩ PML100HZPJV1L5	–	2
C3, C15, C67, C68, FBH, FBL, G1, G2, G3, G4, IVCC, SWN1, SWN2, uIO_AD0, uIO_GP1, uIO_GP2, uIO_VDD5, VFB, Q2B, R6, R8, RSWCS1	NOT POPULATED	–	–
Spacer 12mm	Wurth 702935000	–	4


VOUT+
GND-
SWN2
L1
SWN1
GND2
VIN+
C15
R6
CBS1
CBS2
DBS1
DBS2
C5
C28
C29
VOUT
C22
JV1
C10
C8
R8
C3
VIN
Q4A
Q1A
RSHO
RSHO1
C25
Q3A
Q2A
C18
RIIN
J1
Q4B
Q3B
RSWCS2
RSWCS1
Q2B
Q1B
C12
C14
C24
C13
C7
C2
C6
C11
C27
C1
C19
C20
C9
C17
C16
C21
RG4A RG3B RG2A RG1A
RG4B RG3A RG2B RG1B
G4
G3
G2
G1
FBH
C4
R17
CIVCC
JI1
R16
VFB
RVH
C69
C55
IOUTM
C67
IC1
C26
R7
LEDC
R18
RVOLT
RVL
R4
C68
JV2
GND5
RC1
CC1
IINM
CMP
LHI
C56
R89
R90
RFREQ
CSST
JVDD
SET
RSET
R2
uIO_VDD5
uIO_GP2
uIO_GP1
uIO_ADD
IVCC
LED
R21
J_LHI
R1
EOMFS
SST
CEN
R5
R3
D2
R11
R14
R13
R12
D4
D3
R10
R9
J_EN
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GND3
J_uIO
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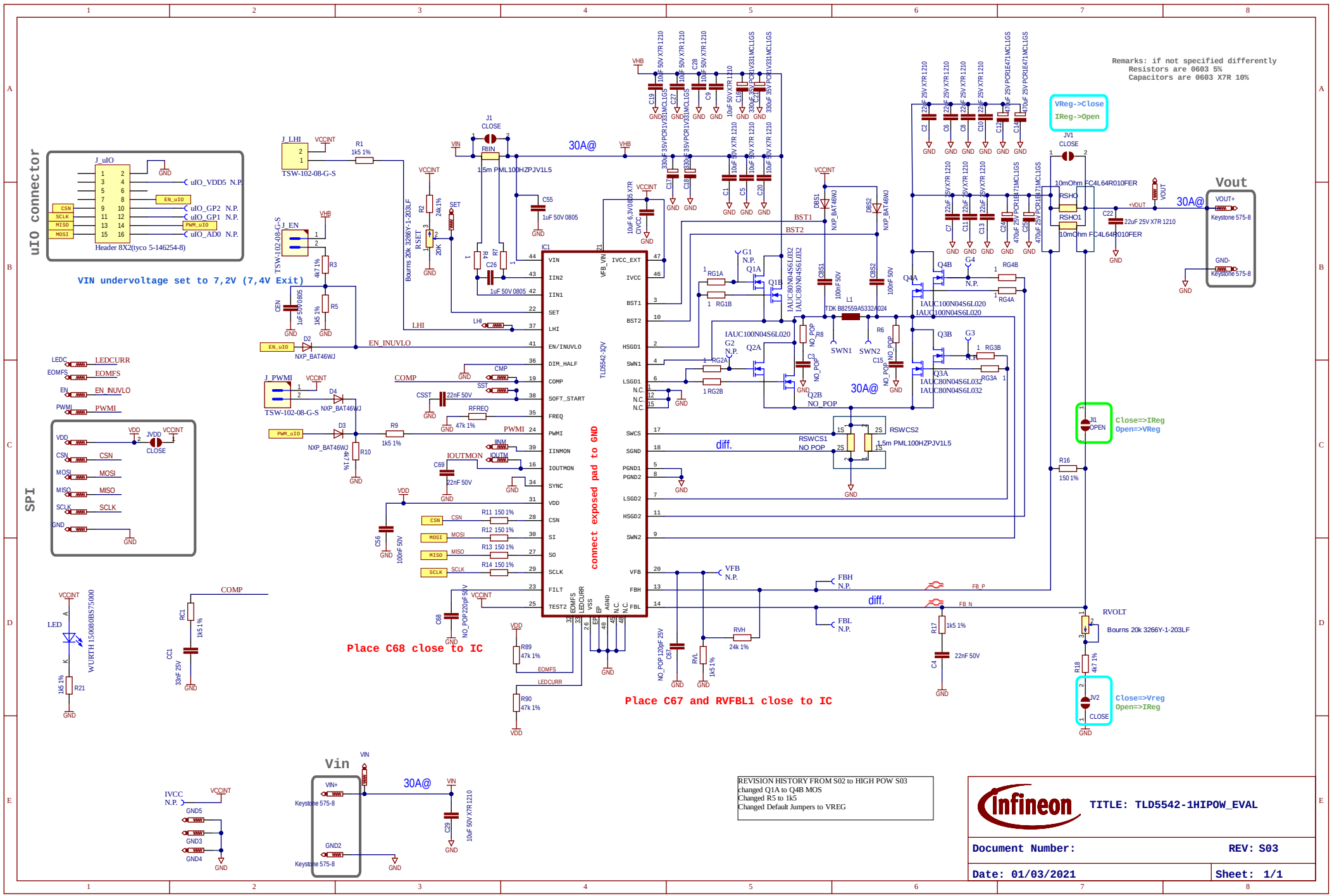
EN
PWMI
VDD
CSN
MOSI
MISO
SCLK
GND
GND4


uIO connector
J_uIO
Header 8X2(tyco 5-146254-8)
uIO_VDD5 N.P.
uIO_GP2 N.P.
uIO_GP1 N.P.
uIO_AD0 N.P.
VIN undervoltage set to 7,2V (7,4V Exit)
SPI
LEDCURR
EOMFS
EN_INUVLO
PWMI
CSN
MOSI
MISO
SCLK
J_LHI
TSW-102-08-G-S
J_EN
J_PWMI
J1
CLOSE
RIIN
1.5m PML100HZPJV1L5
30A@
VHB
VCCINT
BST1
BST2
IC1
TLD5542-1QV
VIN
IIN2
IIN1
SET
LHI
EN/INUVLO
DIM_HALF
COMP
SOFT_START
FREQ
PWMI
IINMON
IOUTMON
SYNC
VDD
CSN
SI
SO
SCLK
FILT
TEST2
VFB_VIN
IVCC_EXT
IVCC
BST1
BST2
HSGD1
SWN1
LSGD1
N.C.
SWCS
SGND
PGND1
PGND2
LSGD2
HSGD2
SWN2
VFB
FBH
FBL
EP
AGND
connect exposed pad to GND
Place C68 close to IC
Place C67 and RVFBL1 close to IC
diff.
RSWCS1
NO POP
RSWCS2
1.5m PML100HZPJV1L5
IAUC100N04S6L020
IAUC80N04S6L032
TDK B82559A5332A024
Bourns 20k 3266Y-1-203LF
RSHO
RSHO1
10mOhm FC4L64R010FER
Vout
VOUT+
GND-
Keystone 575-8
VReg->Close
IReg->Open
Close=>IReg
Open=>VReg
Close=>Vreg
Open=>IReg
JV1
JI1
JV2
OPEN
RVOLT
RVH
RVL
FB_P
FB_N
Vin
VIN+
GND2
IVCC
GND3
GND4
LED
WURTH 150080BS75000
COMP
Remarks: if not specified differently
Resistors are 0603 5%
Capacitors are 0603 X7R 10%
REVISION HISTORY FROM S02 to HIGH POW S03
changed Q1A to Q4B MOS
Changed R5 to 1k5
Changed Default Jumpers to VREG
TITLE: TLD5542-1HIPOW_EVAL
Document Number:
REV: S03
Date: 01/03/2021
Sheet: 1/1

8 List of references

[1] Infineon Toolbox and Config Wizard **www.infineon.com**

Revision history

Document version	Date of release	Description of changes
Rev.1.0	2021-03-04	Initial User Manual

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