TLD5542-1 Multichannel evalboard V4.6

User guide

About this document

Product description

The TLD5542-1 Multichannel evalboard V4.6 is an evaluation platform for the TLD5542-1, which can drive 3 LED functions (HB, LB, DRL), with a single efficient DC-DC converter. The board shows good EMC performance, EMC report available for download on the evaluation board webpage. Multichannel evalboard version 4.6 is composed of schematic version S4.5 and PCB version P4.3, software version SW_CostOptimized_4.3.

TLD5542-1QV: H-Bridge buck-boost DC-DC controller designed for high power, high efficiency automotive applications has:

- Constant current (LED) and constant voltage regulation
- SPI for diagnostics and control
- Limp home function (failsafe mode)
- EMC optimized device: Spread spectrum

Scope and purpose

Scope of this user manual is to provide to the audience instructions on usage of the TLD5542-1 Multichannel evaluation board V4.6 (sales product name TLD5542-1_MULTI_EVAL) and relative PC GUI.

Intended audience

Hardware engineers, software engineers, system architects

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1 Description

The TLD5542-1 multichannel evalboard it is an evaluation platform for the TLD5542-1, which can drive 3 LED functions (HB, LB, DRL), with a single efficient DC-DC converter.

In the single DC-DC multichannel system night-time functions (e.g. HB and LB) are connected in series and the complementary daytime (DRL) function in parallel by mean of switches (Figure 1). The switches properly distribute the DC-DC converter output current in order to obtain the requested LED currents. This approach is called multi floating switch (MFS) architecture.

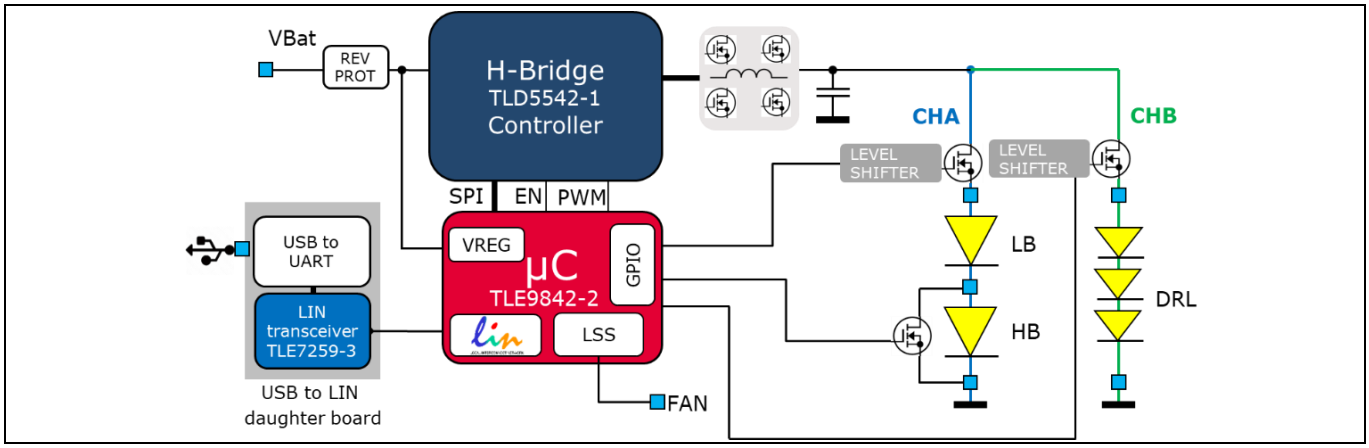


Figure 1 LED driver with 3 functions on MFS architecture

The TLD5542-1 Multichannel evalboard has an ePower microcontroller TLE9842-2 pre-programmed with the application software V4.3 or higher. A PC GUI can configure load currents and duty cycles via USB (UART over LIN).

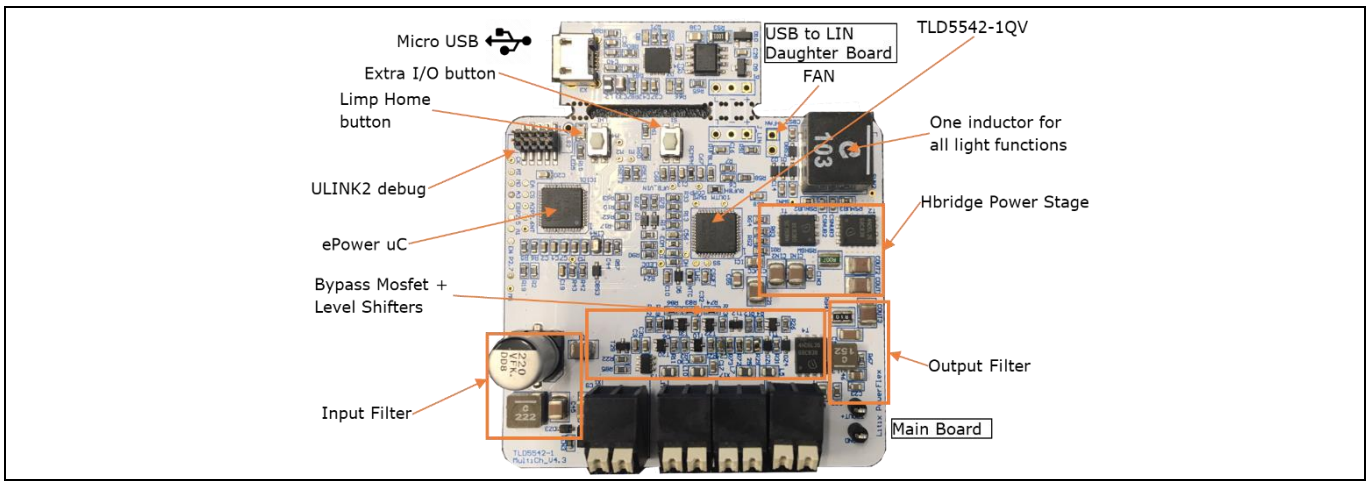


Figure 2 TLD5542-1 Multichannel evalboard V4.6

Additionally, the following are present on the board:

- A 300 mA LS switch to drive an external FAN
- LIN interface and a detachable USB serial to LIN daughter board

2 Quick start procedure

All the functionalities described in this document refer to the TLD5542-1_MULTI_EVAL with a SW_CostOptimized_4.3 software. If a different software is flashed, the behavior, power limits and GUI may differ.

The TLD5542-1 multichannel evalboard comes with USB to LIN daughter board, avoid detaching it from the main board in order to be able to control the board via USB.

Humming noise may be heard from the board due to piezoelectric effect on output capacitors, this does not affect the performance.

Step by step procedure

1. Connect the load(s) to the HB, LB, DRL connectors as shown in Figure 3 , the software will automatically disable unconnected terminals

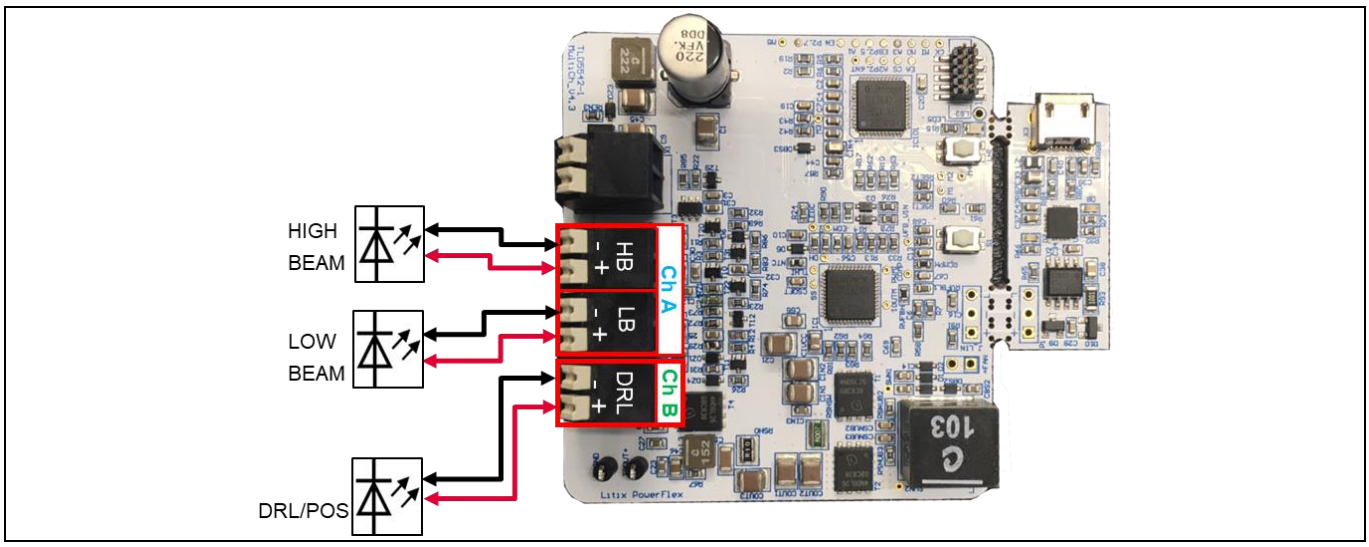


Figure 3 TLD5542-1 Multichannel evalboard - connect loads

2. Connect a 12 V 5 A power supply to the V_{IN} connector

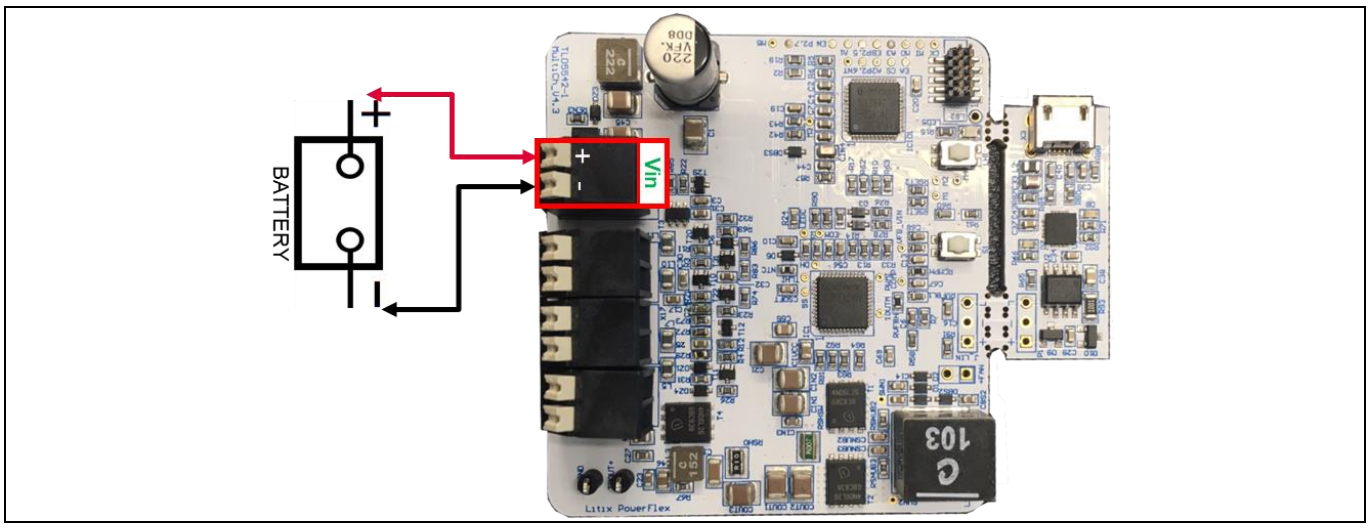


Figure 4 TLD5542-1 Multichannel evalboard - connect power supply

3. Load will be powered with default configuration:
   LB 1000 mA, HB 800 mA , POS 28 mA (400 mA @ 7%)
4. In order to control the TLD5542-1 multichannel evalboard through its USB interface install FT231x (VCP) drivers
5. Connect a micro USB cable from the TLD5542-1 evalboard to the PC (Figure 5)

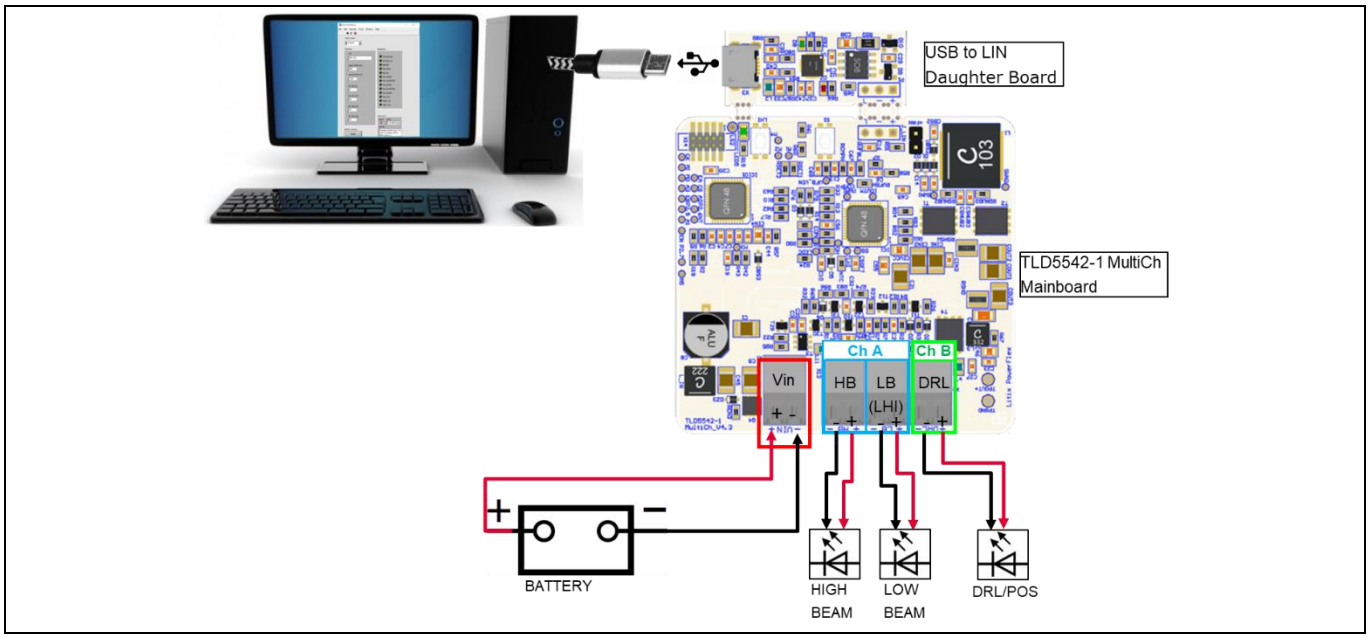


Figure 5 Connect a microUSB cable from the PC to the evalBoard

6. Launch the “TLD5542-1_MULTICH_GUI_V1.0.xlsm” to execute the excel GUI (Figure 6)

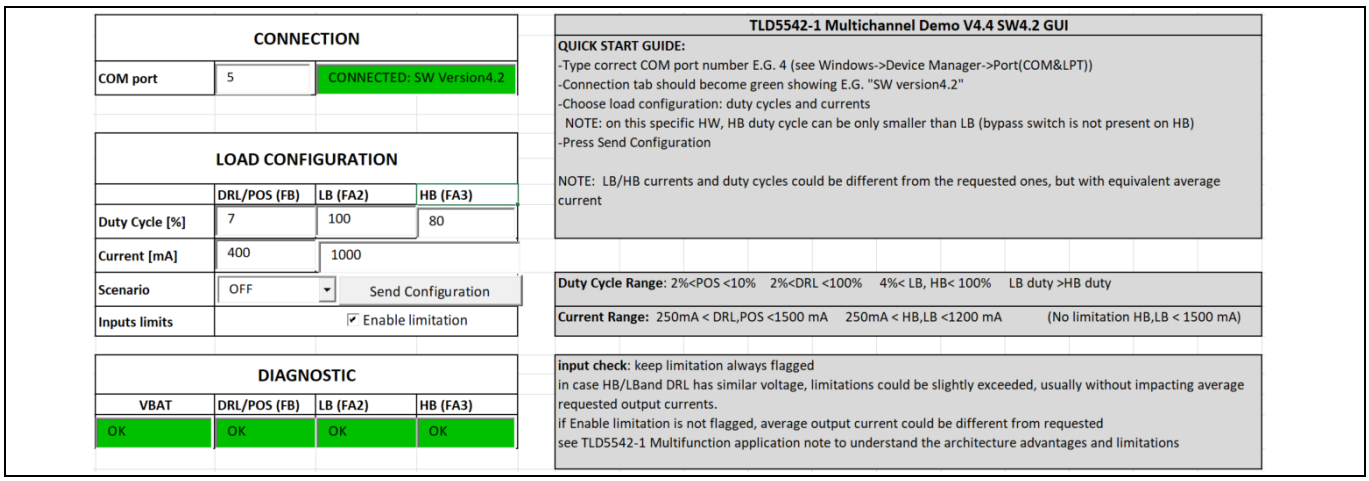


Figure 6 TLD5542-1 Excel GUI V1.0 screenshot on communication established

7. Connection cell will turn green (Figure 6) on the GUI if the right COM port is selected
8. Select desired load current and duty cycle and press “Send Configuration” button
9. LED load will be powered with selected configuration

Note:

Due to the schematic implementation, if POS is ON, then the maximum possible duty cycle on LB/HB is reduced by the POS duty cycle and load change time (duty cycle losses: Figure 7). The software automatically increases the LB/HB current to keep average current equal to the requested current, so peak current could be different than the requested current. During LB/HB and POS scenario, POS duty cycle has to be < 10% in order to minimize LB/HB current increase.

Example: User requested scenario is:

LB current = 1 A @ 100% duty POS = 300 mA @7% duty

Produced scenario (depending by LB and DRL voltage):

LB current = 1.14 A @ 88% duty → 1 A avg POS = 300 mA @ 7% duty

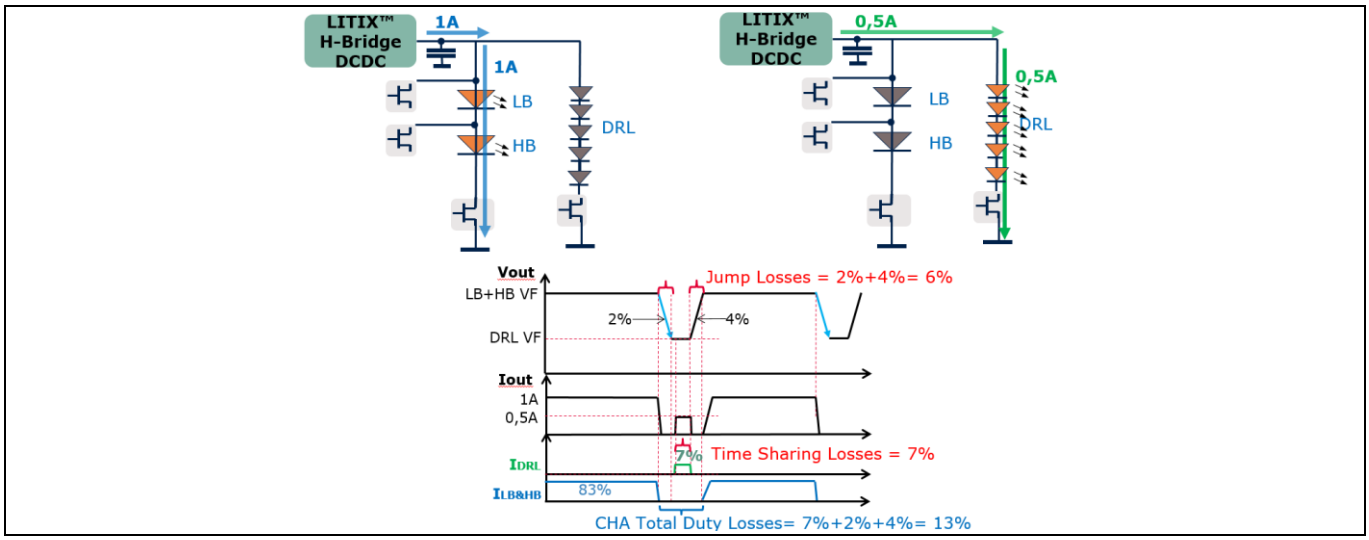


Figure 7 Time sharing and duty cycle losses

For further information please read the TLD5542-1 cost optimized application note and SW description documents [1] and [2].

3 Possible light scenarios

On the TLD5542-1 multichannel evalboard, LB (master) and HB (slave) channels are connected in series, so that the instantaneous current on the 2 strings is the same. Different average current can be achieved by applying PWM dimming to the HB.

HB duty cycle can be smaller or equal to the LB duty cycle.

Table 1 TLD5542-1MULTI_EVAL - possible light scenarios -SW_CostOptimized_4.3

	LB	**HB**	**DRL**	**POS (<10% duty)**
LB	ON	ANY	OFF	ANY
HB	ON	ON	OFF	ANY
DRL	OFF	OFF	ON	OFF
POS	ANY	ANY	OFF	ON
DEFAULT	ON (1000 mA)	ON (800 mA)	OFF	ON (28 mA = 400 mA@7%)

By pressing Limp Home button on the evalboard, LHI pin of the TLD5542-1 is activated, and the bypass switches are configured by a dedicated circuitry in order to power LB only @ 850 mA. The µC SPI commands and GPIOs are ignored, simulating a failsafe operation. The resistor divider on the SET pin configures the output current in limp home operation (850 mA).

4 Operating range and power derating

Software power derating is implemented in SW_CostOptimized_4.3 and it reduces output current (and thus the output power) when the battery voltage drops below 9 V at the board connector. Power derating profile is set as shown in Figure 8.

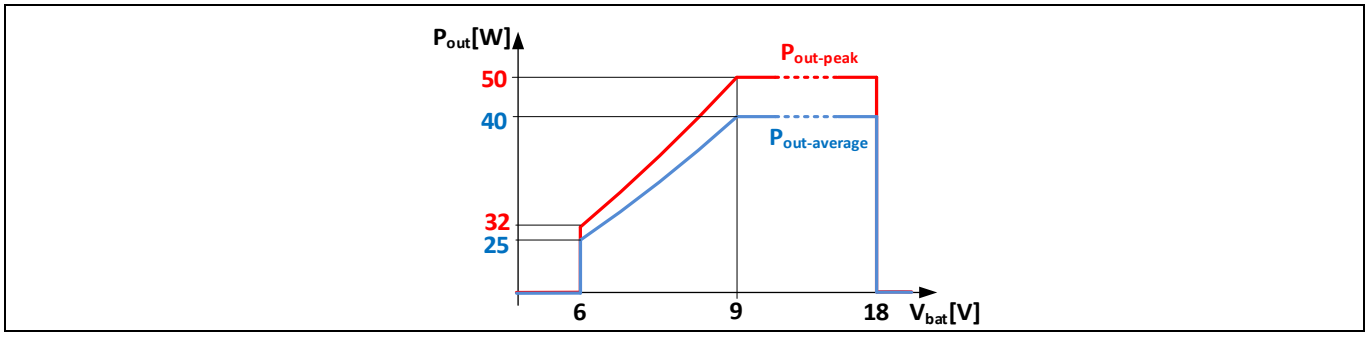


Figure 8 Average (blue) and peak (red) output power derating profile

The SW_CostOptimized_4.3, is limited only by the peak output power (red curve on Figure 8), but if POS function is ON, then the effective LB/HB average power available on LB is reduced to $P_{out\text{-}average}$ (blue curve in Figure 8).

Please note that the module does not implement thermal protection, so ensure proper cooling when output power is above 40 W. Place a heat sink below switching MOSFETs as shown on Figure 9.

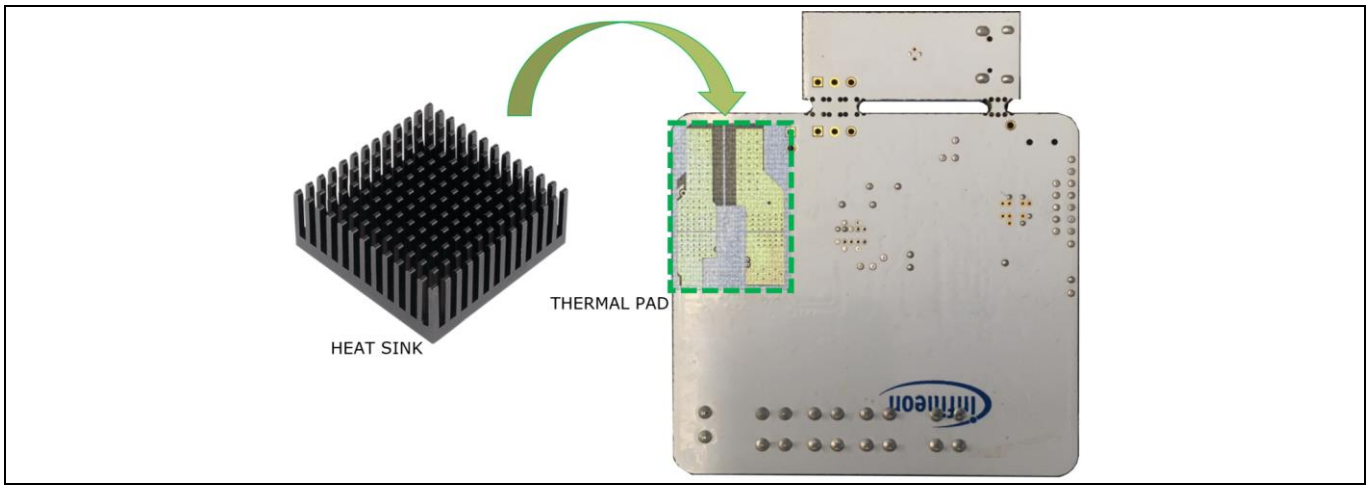


Figure 9 TLD5542-1 Heat sink placement

The heat sink should be thermally coupled but electrically insulated from the PCB by means of a thermal pad.

5 Electrical characteristics

Table 2 TLD5542-1 multichannel evalboard V4.6 – electrical characteristics

Parameter	Symbol	Value			Unit	Note/Test Condition
		Min	Typ	Max		
Input Voltage	V_{IN} (Normal) V_{IN} (Extended) V_{IN} (Survival)	9 6 -18	–	18 18 +40	V	–
Output voltage	V_{OUT}	3	–	50	V	–
Output current HB,LB average	I_{OUT} (HB,LB)	250 250	– –	1350 1200	mA mA	scenario = LB/HB only POS = OFF scenario = LB/HB + POS, POS duty cycle < 10% CHA and CHB string voltage difference < 30 V
Output current DRL	I_{OUT} (DRL/POS)	250	–	1500	mA	–
Output Power	$P_{OUT\text{-}AVERAGE}$ (LB,HB) $P_{OUT\text{-}AVERAGE}$ (DRL)	3	–	40	W	Limited by software SW_V4.3 power derating. Average P_{OUT} for V_{IN} down to 9 V
Switching frequency	Switching frequency	–	384	–	kHz	Spread Spectrum deviation is present
PWM frequency	PWM_{freq}	200	–	–	Hz	–
System efficiency	η	–	93	–	%	Board efficiency, including µC. LB 5 LED 1200 mA, HB 4 LED 960 mA , POS 10 LED 400 mA @ 7% V_{IN} = 13.5 V P_{IN} = 34.7 W P_{OUT} (LB+HB+DRL)= 32.4 W

6 Diagnostic

TLD5542-1 multichannel software version 4.3 (or higher) is able to detect several failures on the LED load:

Table 3 Failure detection

	Failure type	Description
LB (FA2)	Open Short	FA2 open is always reported as FA2 & FA3 open due to schematic implementation When FA2(LB) fails, also FA3(HB) is disabled, DRL/POS is available
HB (FA3)	Open/Short	When FA3(HB) fails , FA2 (LB) and DRL/POS are still available
DRL/POS	Open/Short	When DRL/POS fails , FA2 (LB) and FA3(HB) are still available
V_{IN}	Undervoltage (V_{IN} < 6 V) Overvoltage (V_{IN} > 20 V)	Restart after V_{IN} undervoltage when V_{IN} > 8 V Restart after V_{IN} overvoltage when V_{IN} < 18 V

A function is considered shorted if its voltage is below 2 V.

Diagnostic is visible also on the PC GUI for the SW_CostOptimized_4.3 as shown in Figure 10.

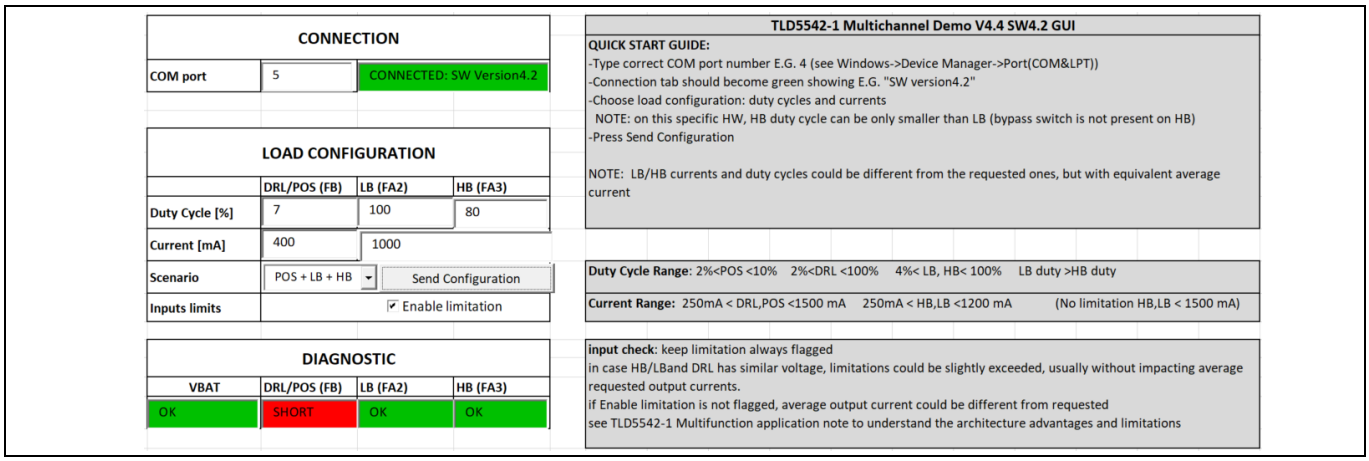


Figure 10 TLD5542-1 PC GUI: diagnostic indicators

7 PCB layout

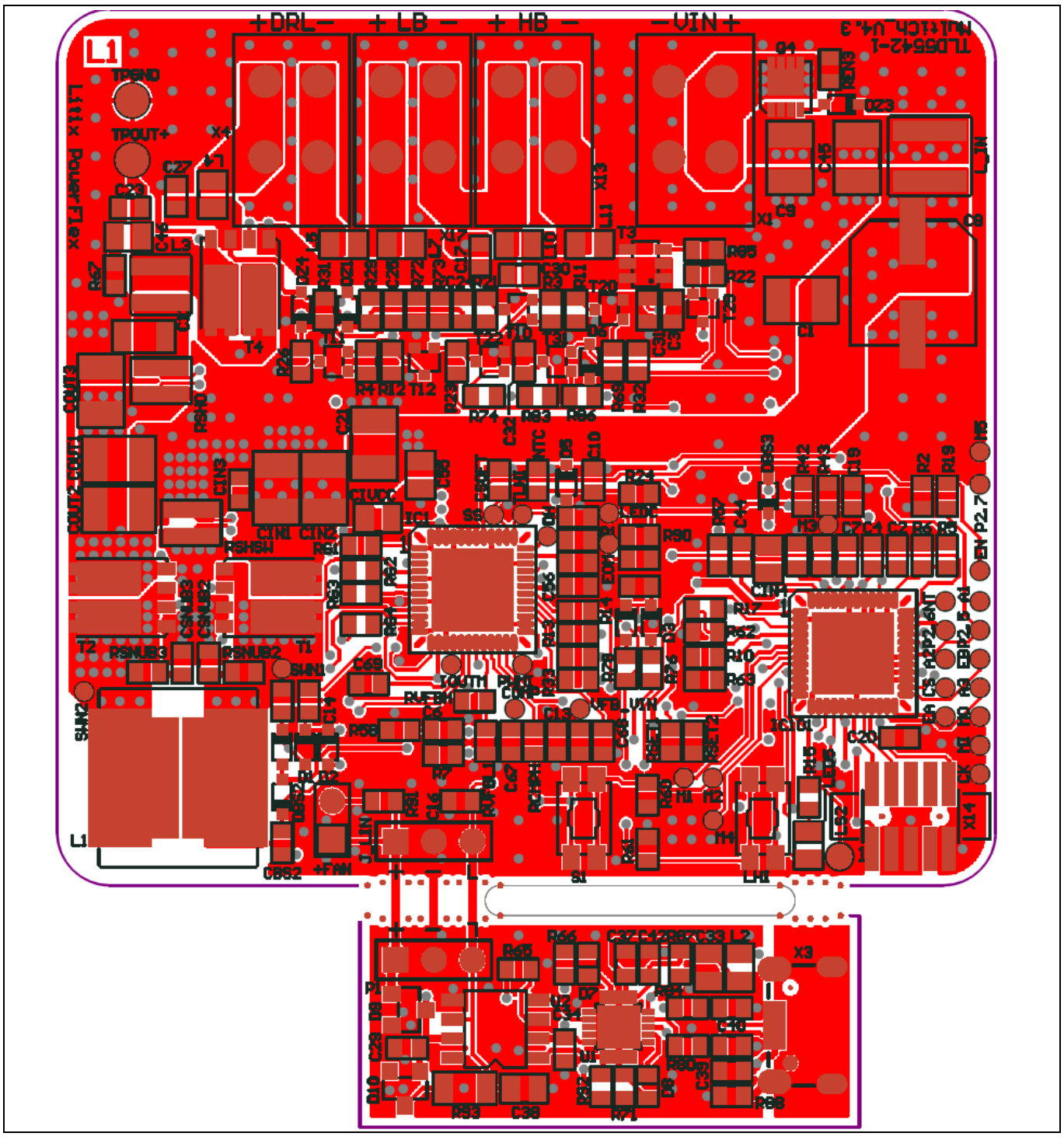
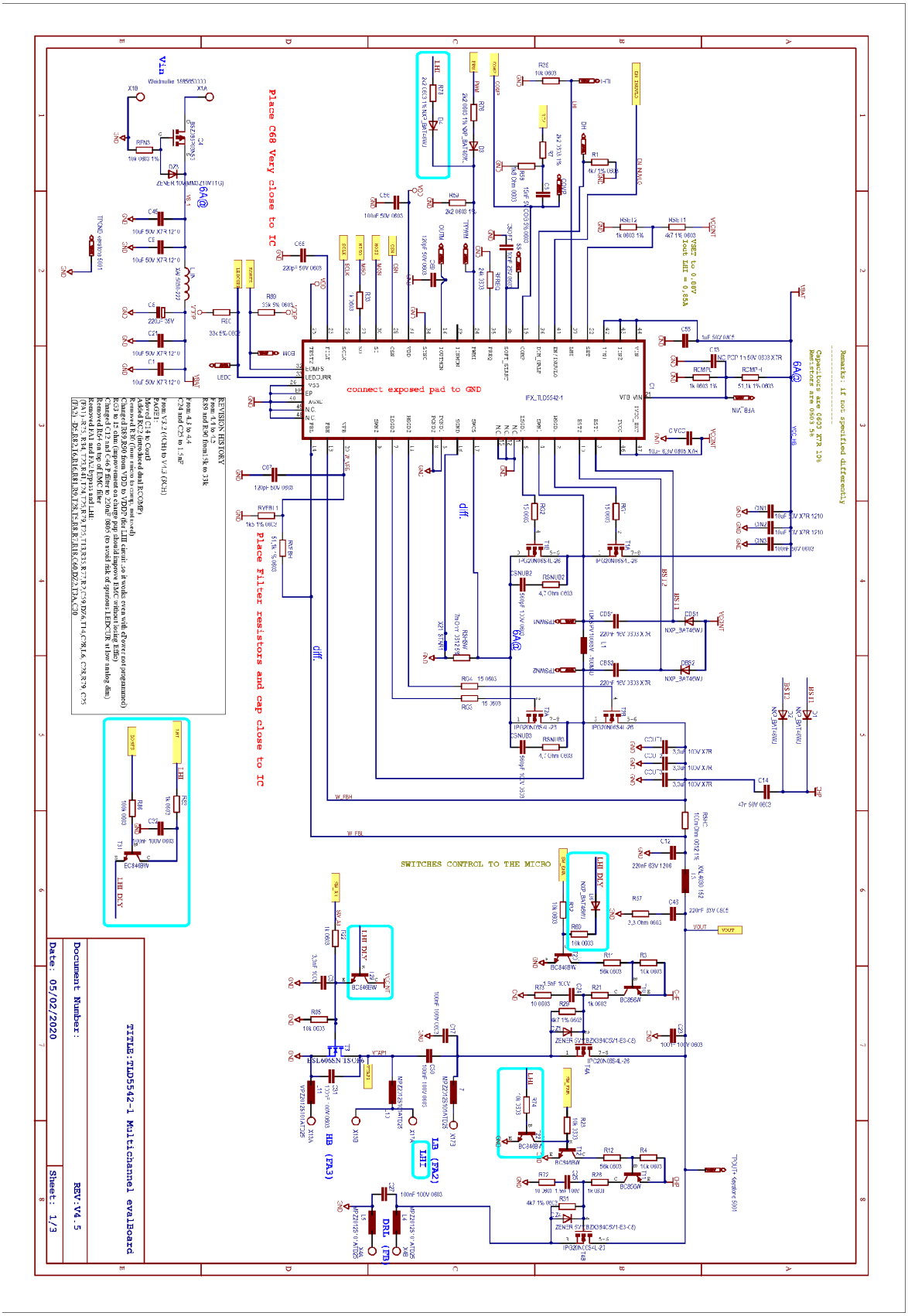
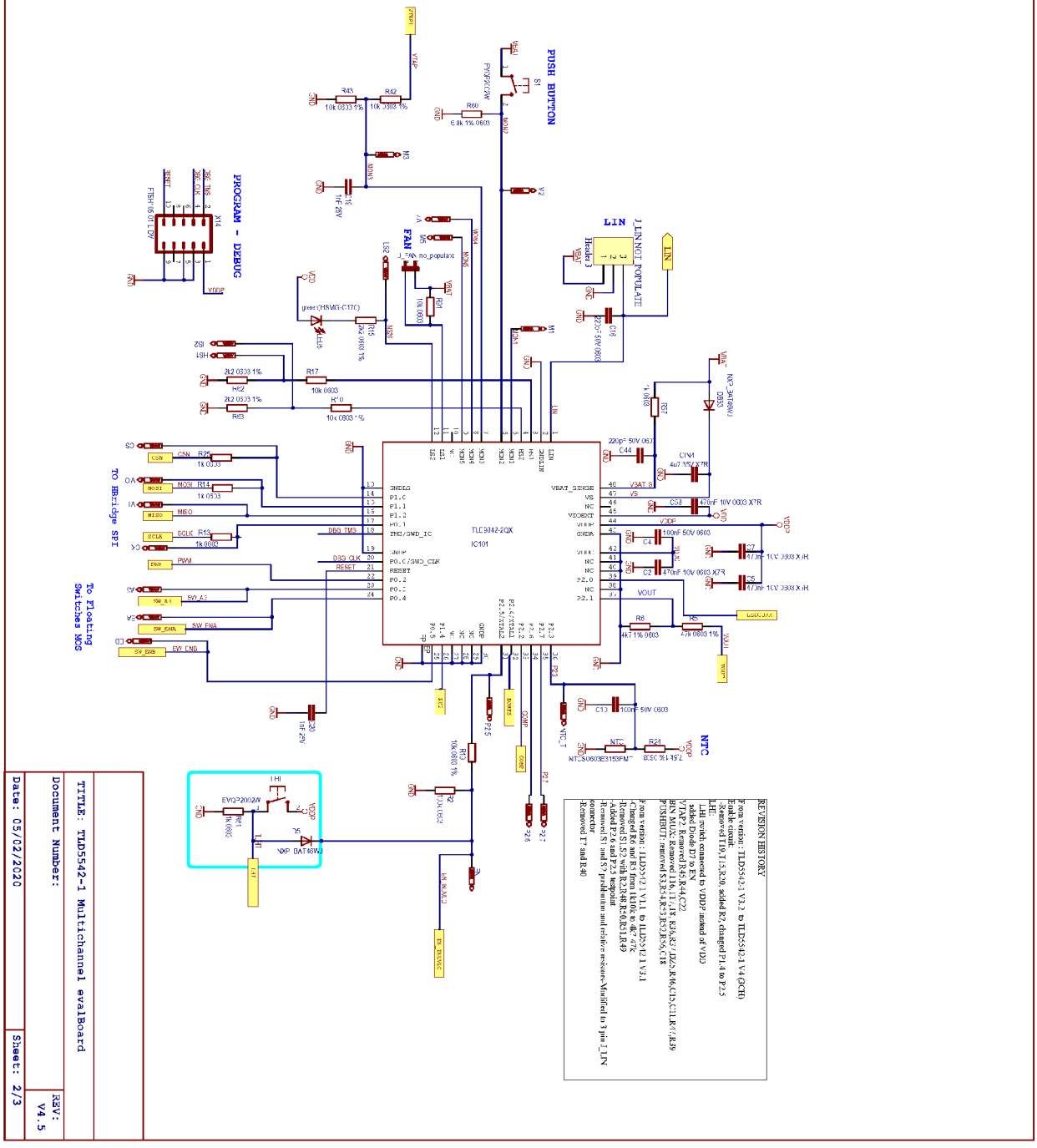
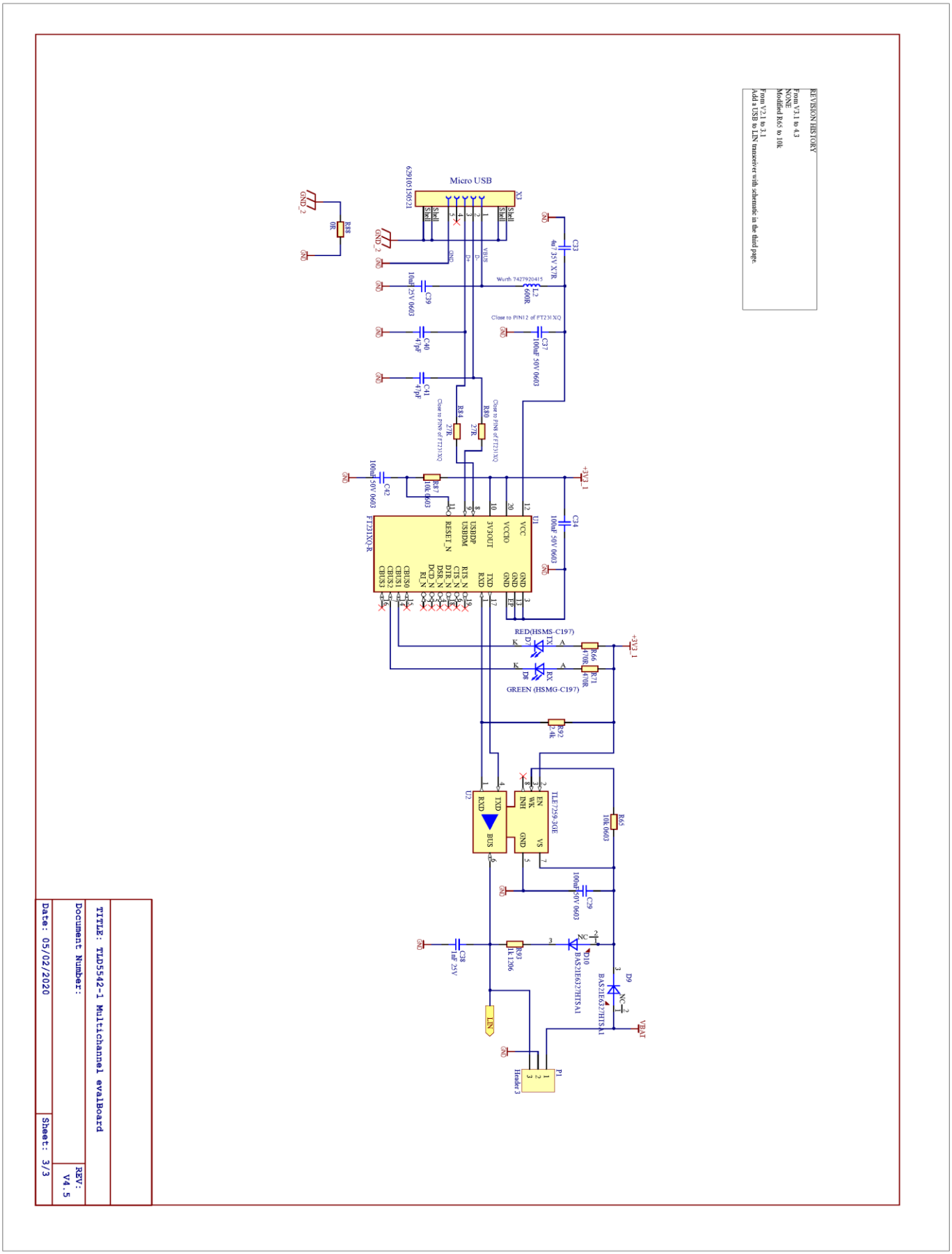


Figure 11 PCB layout top view

8 Schematic


Place C68 Very close to IC
connect exposed pad to GND
Place Filter resistors and cap close to IC
SWITCHES CONTROL TO THE MICRO
TITLE:TLD5542-1 Multichannel evalboard
Document Number:
REV:V4.5
Date: 05/02/2020
Sheet: 1/3


PUSH BUTTON
PROGRAM - DEBUG
FAN
LIN
TO Bridge SPI
To Floating Switches MOS
TLE9342-2QX
IC101
TITLE: TLD5542-1 Multichannel evalBoard
Date: 05/02/2020
Document Number:
Sheet: 2/3
REV: V4.5
REVISION HISTORY


REVISION HISTORY
From V3.1 to 4.3
NONE
Modified R65 to 10k
From V2.1 to 3.1
Add a USB to LIN transceiver with schematic in the third page.
Micro USB
RED(HSMS-C197)
GREEN (HSMG-C197)
TITLE: TLD5542-1 Multichannel evalBoard
Date: 05/02/2020
Document Number:
REV: V4.5
Sheet: 3/3

9 Flashing new software

The TLD5542-1 multichannel evalboard software can be updated by means of the USB interface without using dedicated debugger tools. This is possible only if the board has software version SW_CostOptimized_4.3 or higher. Software version is visible by means of the GUI (Figure 6).

1. Connect the board to an USB port on the PC (be sure FT231X VCP driver is installed)
2. Download and unzip the TLE98xx_BSL (bootstrap loader) file from the TLD5542-1_MULTI_EVL webpage
3. Copy the binary file <code_name>.hex that has to be flashed, into TLE98xx_BSL folder
4. Open a command prompt in the same directory (write „cmd“on the explorer address bar, press enter)
5. Execute the following command line in the command prompt:
   Flash_TLE984x_viaDLL.bat <code_name>.hex
6. Keep S1 button on the evalboard while powering the board ON, by connecting a 12 V power supply
7. Release the S1 button when connection is established. The command line reports:
   - Connect OK, NAD = 0x80, Success!
8. Flashing procedure take up to 1 minute, do not disconnect power supply or the cable during flashing
9. The command lines should report: “INFO: Verify Successful!” Success!”
   - Power-off the board when procedure is over
10. (Optional) repeat from step 4 if the procedure has failed

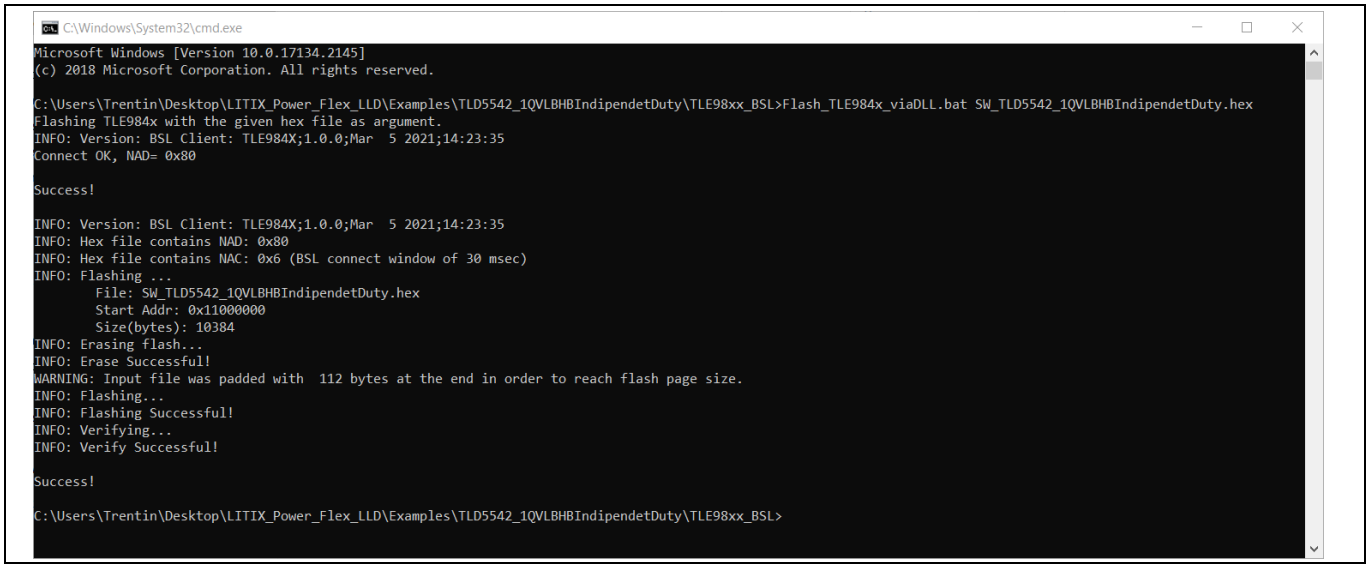


Figure 12 Programming TLE984x

10 Glossary

DRL: Daytime Running Light function

POS: position light obtained by dimming down the DRL function

LB: Low Beam function

HB: High Beam function

H-Bridge: 4 switches topology buck-boost DC-DC converter (see Figure 13)

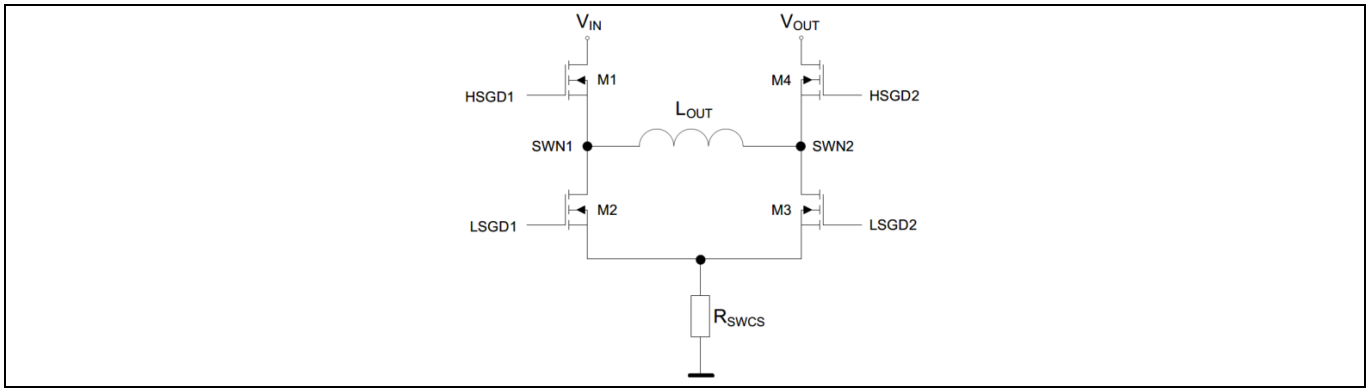


Figure 13 4 switches H-Bridge architecture overview

11 List of references

[1] Infineon-Z8F67062262_Cost_Optimized_TLD5542-AN.pdf

[2] Infineon-Z8F64914635_TLD5542-1_Software_Description-AN.pdf

Revision history

Document version	Date of release	Description of changes
Rev. 1.20	2021-05-31	Added Chapter 9: “How to flash new firmware with bootloader”
Rev. 1.12	2020-04-02	Updated with excel GUI V1.0
Rev. 1.11	2020-02-05	Updated SCH to version 4.5
Rev. 1.10	2020-01-16	Corrected: Switching frequency to 384 kHz on Electrical characteristics
Rev. 1.10	2020-01-16	Updated LED load symbol polarity on Figure 3
Rev. 1.10	2020-01-16	Added USB connection image: Figure 5
Rev. 1.10	2020-01-16	Updated GUI screenshots with SW version
Rev. 1.10	2020-01-16	Updated Labview installation version 2018
Rev. 1.00	2020-01-14	Initial User Manual

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