ILD2111 - Digital DC/DC Buck Controller IC

.dp digital power 2.0

ILD2111 Evaluation System

Board, Tools and Features

Application Note

About this document

Scope and purpose

This document presents the details about the ILD2111 evaluation system and how to design with ILD2111. It illustrates all necessary steps to get the board and related environment up and running, and clarifies all information required to become familiar with this comprehensive solution.

The ILD2111 is a digital DC/DC buck controller IC for dimmable LED light applications using floating buck topology. The ILD2111 evaluation board is designed to evaluate the performance and flexibility of the ILD2111. It supports an output current from 250 mA up to 800 mA, easily configurable by parameter setting with the user-friendly graphical user interface tool .dp vision.

Intended audience

This document is intended for anyone who needs to use the ILD2111 evaluation system, either for their own application tests or to use it as a base/reference for a new ILD2111-based development.

Table of Contents

1 Important Safety Instructions

Please read and understand the application note and the following safety warnings.

The design operates with unprotected high voltages. The direct connection of the open and unprotected board to a power supply poses a severe risk of electric shock. Extra caution must be exercised when handling the exposed conductor, terminals of components or charged capacitors (even after disconnection) as high voltages may be present there or at other points across the board. Therefore, the board may only be handled in a laboratory environment by persons with sufficient electrical engineering training and experience wearing suitable personal protective equipment, such as eye protection. The customer assumes all responsibility and liability for the correct handling and/or use of the board and undertakes to indemnify and hold Infineon Technologies free of liability from any third party claim in connection with or arising out of the use and/or handling of the board by the customer.

The board is a sample to be used by the customer solely for the purpose of evaluation and testing. It is not a commercialized product and must not be used for series production. Due to the purpose of the system, it is not subject to the same procedures regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Withdraw (PWD) as regular products. See the Legal Disclaimer and Warnings for further restrictions on Infineon Technologies warranty and liability.

European legislation in relation to, inter alia, the restriction of hazardous substances (RoHS), waste from electrical and electronic equipment (WEEE), electromagnetic compatibility, as well as duties to comply with FCC or UL standards may not apply to the board and the board may not fulfill such requirements.

Attention: ***Any input voltage to the evaluation board should be switched off for at least 30 seconds before accessing any circuits or components.***

Changing the number of the LEDs while the device is running and current is generated could potentially be dangerous to the LEDs, especially in a situation when changing from a high number of LEDs to a low number, when discharge of the output capacitor could damage the LEDs. Therefore, it is advisable to change the number of LEDs when the evaluation board is not powered from any source.

The output voltage to LEDs is referenced to the input DC voltage, therefore this voltage is present at the +LED output. If the input DC voltage is non-SELV, direct exposure to this line can be hazardous to health and could cause serious injuries or death.

2 Introduction

The ILD2111 is a high-performance digital microcontroller-based DC/DC buck LED controller IC designed as a constant current source. High-precision hysteretic output current regulation is achieved by means of the digital control loops. The driving current can be adjusted with a simple external resistor. The controller typically uses a floating buck topology operating in a Continuous Conduction Mode (CCM). In order to reduce switching losses and increase efficiency, as well as to control the switching frequency over a wide variety of external component's values, input voltage and load variations, a frequency ripple control is introduced. Both internal and external temperature measurements are performed and accompanied by an intelligent temperature protection algorithm with two threshold values. The controller utilizes a variety of protection features, including overpower, open and short load conditions. The ILD2111 is a dimmable device controllable by external PWM signal. An ASSP digital microcontroller-based engine is highly configurable thanks to a comprehensive parameter set providing fine-tuning of operation and protection features. The device can be parameterized through a single pin UART interface at the REF/SC pin by using the .dp vision tool (see Section **5.2**).

The ILD2111 evaluation board (see **Figure 1**) exhibits a high efficiency level over wide input and output ranges as well as high accuracy of +/-5% over the output current range and specified temperature range.

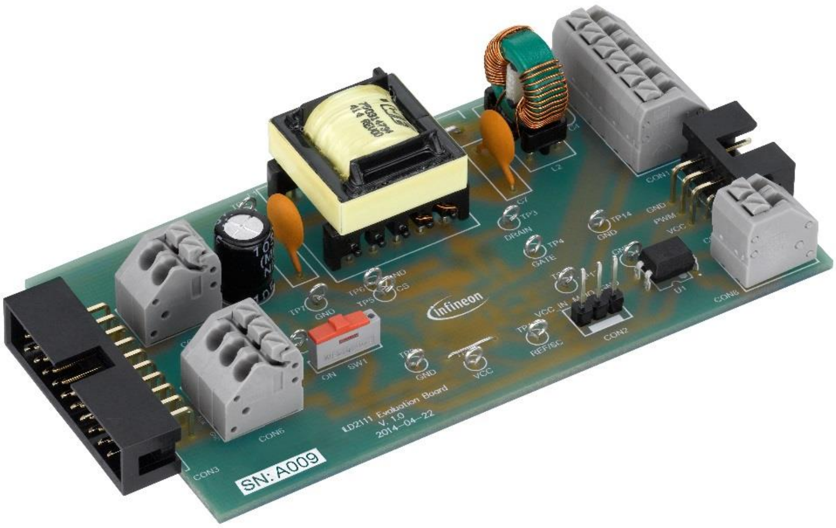


Figure 1 ILD2111 Evaluation Board

3 List of Features and Technical Specification

The ILD2111 evaluation system supports the following features:

- Standalone board for evaluation of ILD2111 (dimensions: 98 x 54 x 23 mm)
- Primary side connected to 1st stage flyback solution with PFC (e.g. TDA4863-2G) for power classes up to 50 W or dual stage PFC + LLC solution (e.g. ICL5101) for power classes above 50 W or DC voltage source
- Hysteretic current regulation
- Output current adjustable for up to 16 steps with a dynamic range of 1:4 between minimum and maximum configurable by an external resistor
- Flickerfree and phase-aligned PWM dimming based on input PWM signal
- Fully configurable internal and external smart overtemperature protection
- Open/short load protection
- Overpower protection
- ILD2111 with firmware and default parameter set
- Device parameters optionally configurable by graphical user interface (.dp vision)

Table 1 lists the technical specification of the ILD2111 evaluation system.

Table 1 Design Specification

Parameter	Value	Unit
Input Voltage	30 – 65	V
Output Voltage	8 – 55	V
Output Current[1)]	250 – 1000	mA
Output Power[2)]	20	W
Input External PWM Signal Frequency	100 – 1000	Hz
Input External PWM Signal Voltage[3)]	0 – 3.3	V
Switching Frequency	30 – 250	kHz

[1)] Output current range is defined by user (maximum dynamic range 1:4)

[2)] Actual output power depends on the output voltage and selected output current (P_{MAX} = 23 W)

[3)] Non-isolated direct external PWM dimming signal connection – see **Figure 5**

The Altium source files of the ILD2111 evaluation board can be provided on request.

The evaluation board top view is shown in **Figure 2** while the bottom view can be seen in **Figure 3**.

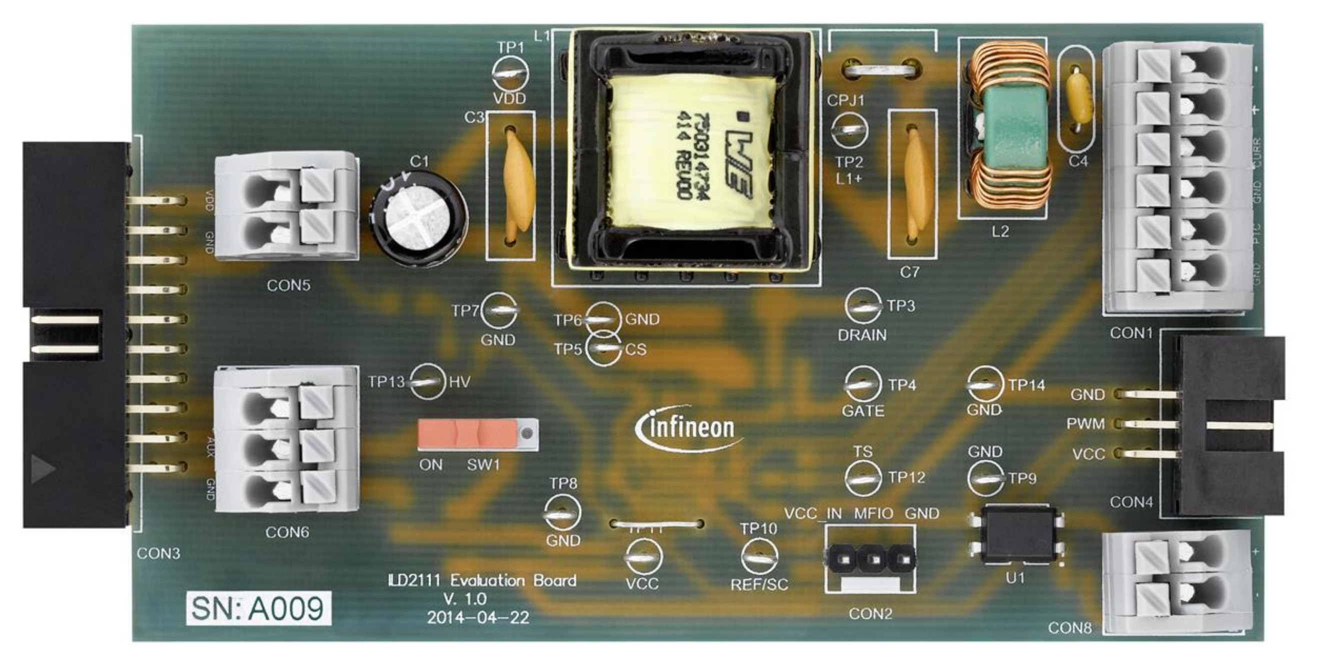


Figure 2 **ILD2111 Evaluation Board PCB – Top View**

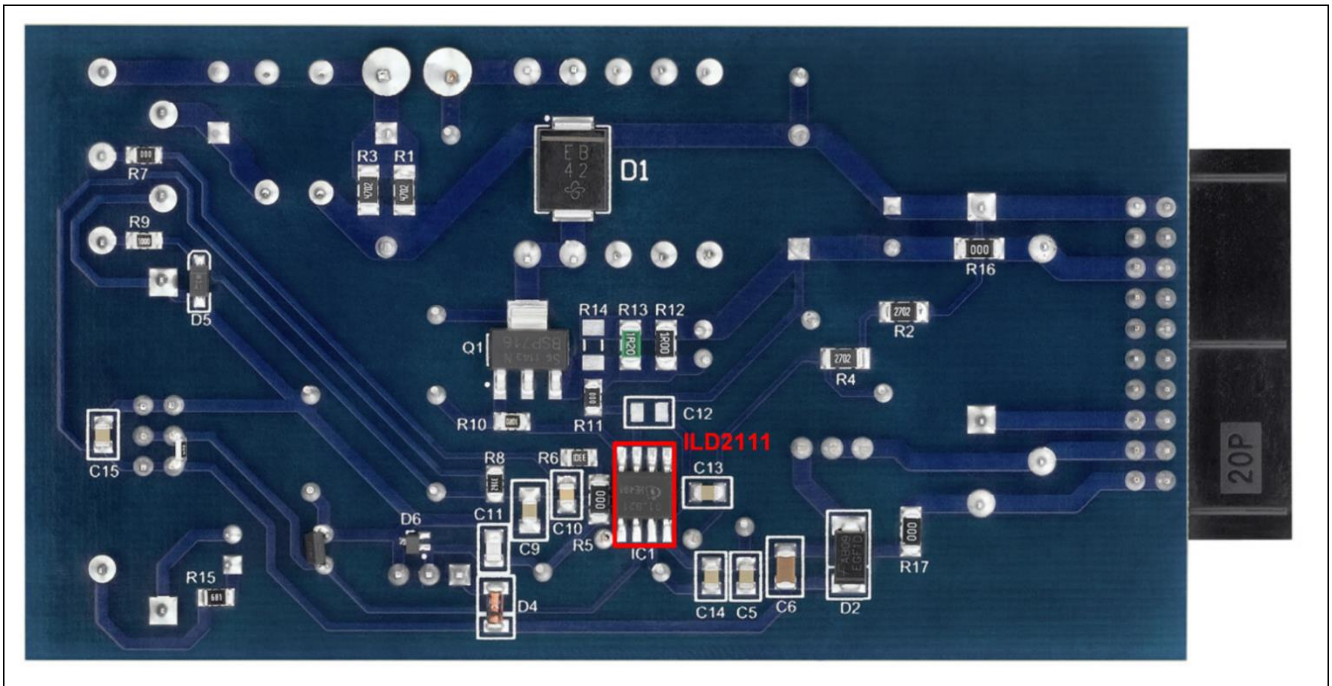


Figure 3 **ILD2111 Evaluation Board PCB – Bottom View**

4 Schematic

Figure 4 shows the schematic of the ILD2111 evaluation board, dimensioned to support a 20 W non-isolated dimmable LED light solution. The evaluation board supports various test points, TP1 to TP14, to check related signals.

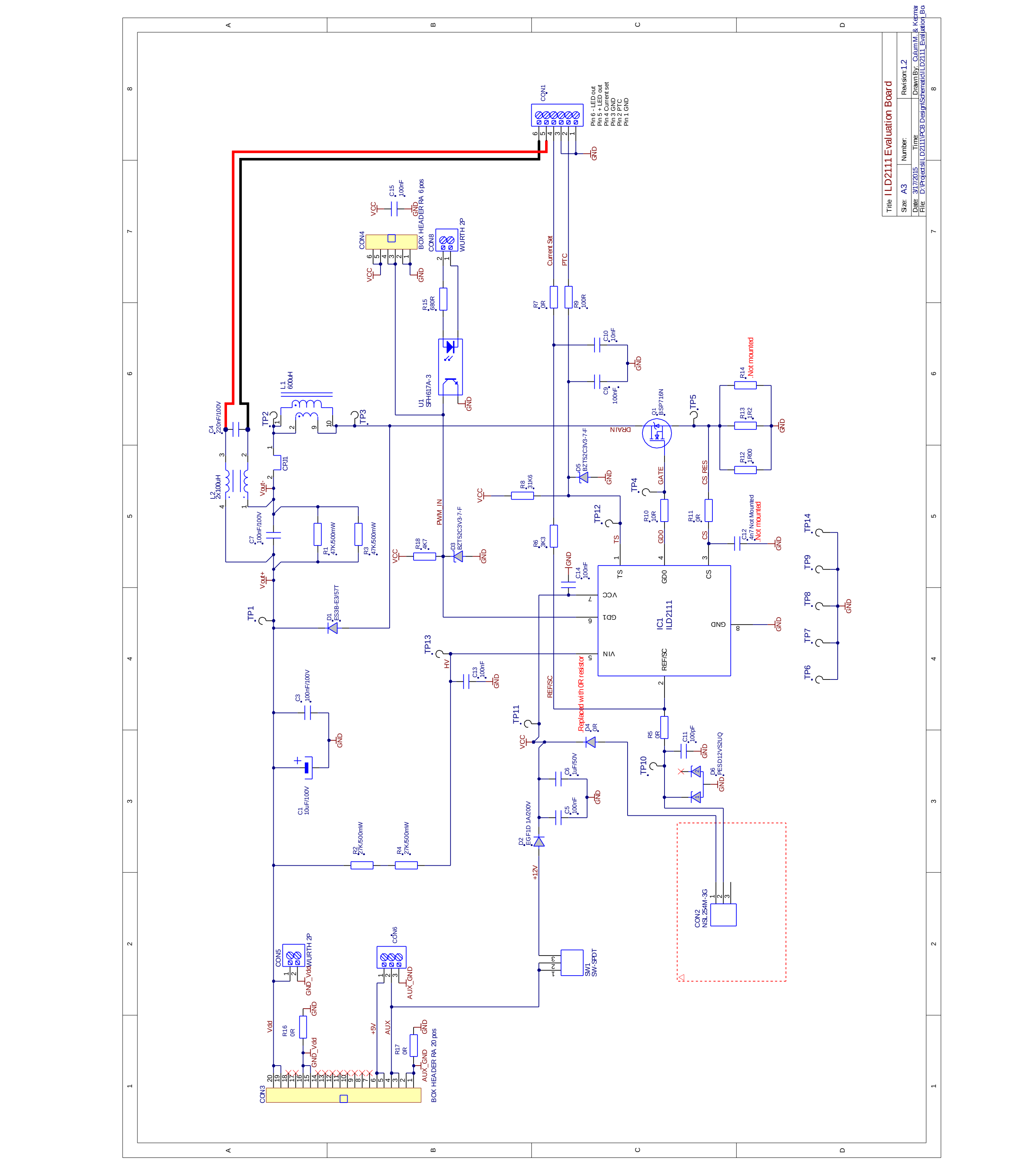


Figure 4 ILD2111 Evaluation Board Schematic

5 Environment Setup

5.1 Hardware Setup

Figure 5 shows the ILD2111 evaluation board with all relevant connections.

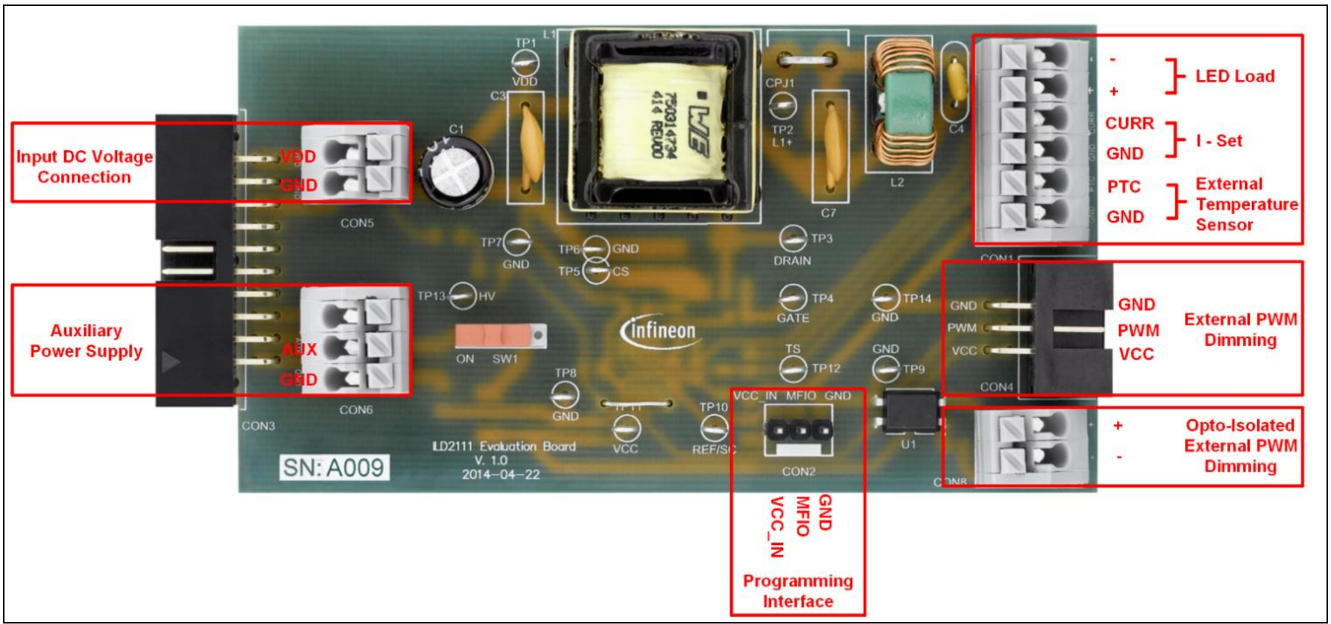


Figure 5 ILD2111 Evaluation Board Connections

Power supply options for the ILD2111 evaluation board are described in **Table 2** below.

Table 2 Power Supply for the Evaluation Board

Power Supply	SW1	Description
Auxiliary power supply	ON (left position)	The evaluation board is powered by the auxiliary power supply
Power supply via Interface board	OFF (right position)	The evaluation board is powered by the interface board
Both of the above power supplies are connected	ON (left position)	The evaluation board will be supplied by the voltage which has a higher value

The following connections are supported and listed in **Table 3** below.

Table 3 ILD2111 Evaluation Board Connections

Interface name	Interface pins	Description
Input DC Voltage Connection	VDD	CON5 - Input DC voltage (35 V – 50 V) connection.
	GND	
Auxiliary Power Supply	AUX	CON6 – Auxiliary power supply (11 – 24 VDC).
	GND	
Programming Interface[1)]	VCC_IN	CON2 - UART communication interface. The UART interface uses a single line (MFIO) for receiving Rx and transmitting Tx data.
	MFIO	
	GND	
LED Load	-	CON1 - Output LED light module connection (8 LEDs ~ 25 V, 800 mA ~ 20 W).
	+	
I – Set	CURR	CON1 - Resistance connection for output current determination.
	GND	
External Temperature Sensor	PTC	CON1 - External PTC temperature sensor connection.
	GND	
External PWM Dimming	GND	CON4 - For dimming operation, an additional hardware interface should be connected to the input (non-isolated) according to the manufacturer's instructions.
	PWM	
	VCC[2)]	
Opto-Isolated External PWM Dimming	+	CON8 - For dimming operation, an additional hardware interface should be connected to the input (opto-isolated) according to the manufacturer's instructions.
	-	

[1)] If the evaluation board is connected to the DP interface board Gen2, then the evaluation board could be powered by the VCC_IN pin on the interface board – see **Table 2** and **Figure 5**.

[2)] Power supply for external hardware.

For parameterization of the ILD2111, the evaluation board needs to be connected to a USB port of a PC via Infineon's .dp Interface board Gen2 as illustrated in the following **Figure 6**. A connecting cable with switch box is used to connect the .dp Interface board Gen2 to the Evaluation board. The switch box provides two switches which connects/disconnects two lines: VCC (for power) and UART (for serial communication). The serial communication function is multiplexed with reference current selection feature (I-Set) which is executed at the power-up. Therefore UART switch needs to be in OFF position in order to properly select the reference current during power-on and later on it can be switched ON to establish communication with the IC on the Evaluation board. VCC can be switched ON/OFF depending on the environment setup (e.g. whether external VCC is used or not).

A quick guidance for getting started the ILD2111 evaluation system can be found in the Getting Started Application Note (see **[5]**).

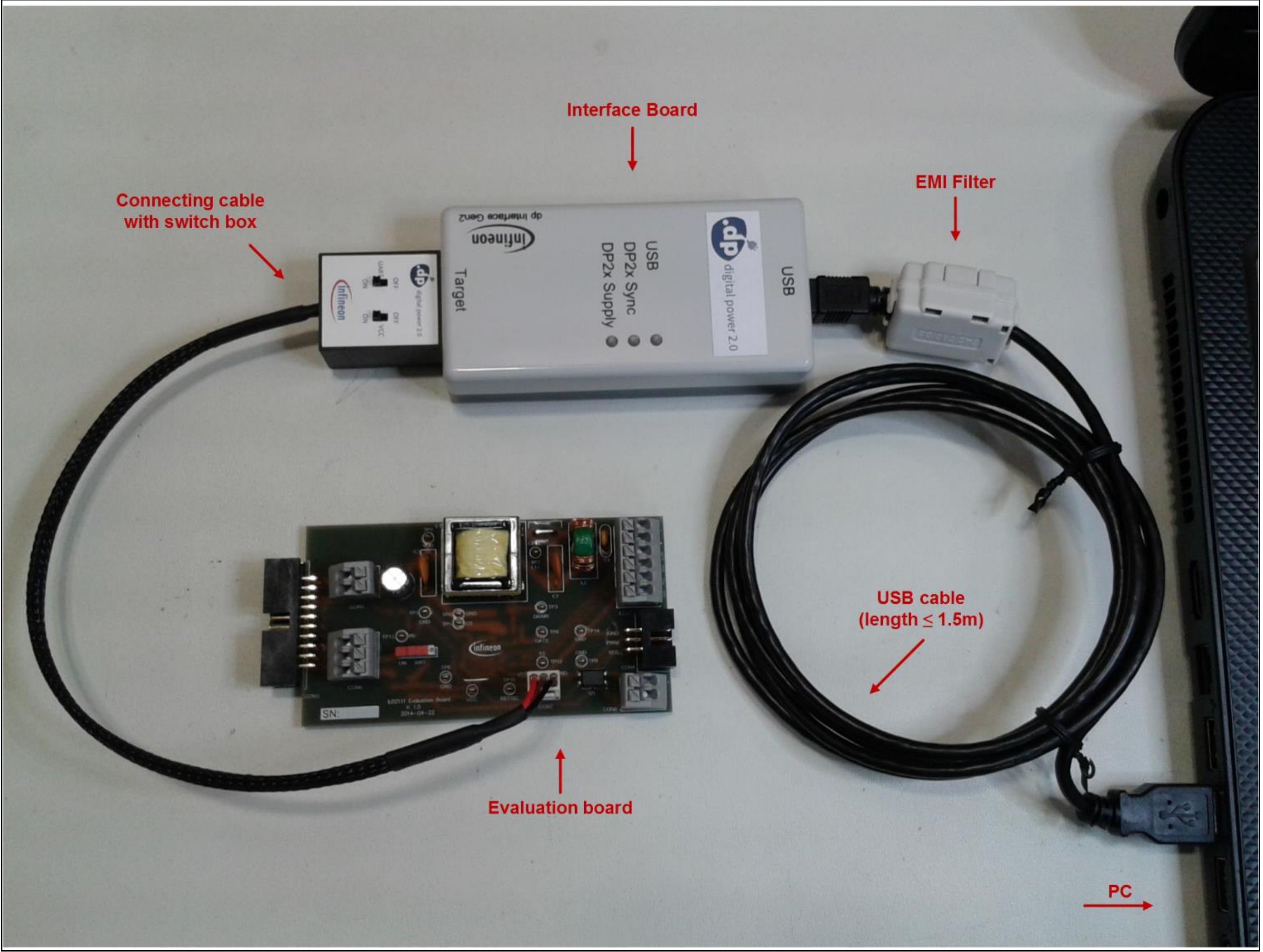


Figure 6 ILD2111 Evaluation Board Connection to PC

5.2 Graphical User Interface (GUI) – .dp vision

The ILD2111 evaluation system comes along with a powerful graphical user interface called .dp vision. The .dp vision software is a PC based tool whose purpose is to enable easy configuration and user-friendly selection and definition of the project-specific parameter settings, allow adaptation and fine-tuning of the firmware behavior with respect to the application hardware configuration and dimensioning, fulfilling the given system requirements[1]. Details about .dp vision can be found in the Tool User Manual (see **[3]**).

[1] *The ILD2111 chip is distributed with generic firmware which provides all parameters as set to zero.*

6 Parameter Setting

The ILD2111 evaluation system supports a predefined parameter setting that can be adapted with the .dp vision GUI (see **[3]**). The parameter setting and relevant description are stored in a configuration file in csv file format, which is supported with the ILD2111 evaluation system.

The predefined parameter settings contain the following groups:

1. Hardware configuration – Section **6.1**
2. Protections – Section **6.2**
3. Temperature guard – Section **6.3**
4. Startup & shutdown – Section **6.4**
5. Output current set – Section **6.5**

6.1 Hardware Configuration

Hardware configuration represents hardware component values that are assembled on the ILD2111 evaluation board as well as chip-specific hardware features that can be configured by the user (see **Figure 7**). The values that are entered in the default configuration csv file fully support the ILD2111 evaluation system hardware environment.

ILD2111 evaluation system (see schematic in **Figure 4**)

1. C_ref = C10 = 10 nF – Reference capacitor for I-Set procedure.
2. R_ref_sc = R6 = 3.3 kΩ – Reference resistance R_ref_sc - Used to decouple UART interface and current set resistance R_iset due to multiplexed functionality of the REF/SC pin.
3. R_vin = R2 + R4 = 54 kΩ – Input voltage external resistor - Its value is determined based on the maximal input voltage to be measured and Vin current range selected.
4. R_current_sense = R12 || R13 = 0.545 Ω – Current sense shunt resistor - Used for current measurement. Its value depends on selected current sense range.
5. R_TS_pull_up = R8 = 31.6 kΩ – Pull-up resistor on TS pin - Used for external temperature measurement procedure. Its value is selected such that ADC range fits to desired temperature range, based on resistance of PTC sensor on particular maximal temperature.
6. C_ref_tolerance and R_iset_tolerance are component tolerances of the reference capacitance C_ref and reference I-set resistance R_iset respectively.
7. Vin_current_range = 1.6 mA – Input voltage measurement current range.
8. Current_sense_OCP1 = 0.6 V – Current sense range - Input voltage range for CS pin is selected. Chosen value defines maximal value of OCP1 level.
9. GD_voltage = 15 V – Output gate-driver voltage. Select a voltage at which the MOSFET is fully switched on. Output gate-driver voltage is limited by Vcc voltage.
10. GD_current = 118 mA – Output gate-driver current. Higher currents switch on the MOSFET faster, but create a higher level of EMI.

Hardware configuration		
C_ref	10.00	nF
R_ref_sc	3.30	kOhm
R_vin	54000.00	Ohm
R_current_sense	0.545	Ohm
R_TS_pull_up	31600.00	Ohm
C_ref_tolerance	5	%
R_iset_tolerance	1	%
Vin_current_range	1.600	mA
Current_sense_OCP1	0.6	V
GD_voltage	15.0	V
GD_current	118	mA

Figure 7 Hardware Configuration

Note: UART communication problems are possible at the higher output current and higher temperature. The communication problems can be solved by increasing the capacitance value (e.g. 100 pF to 200 pF) of the ceramic filter capacitor C11 (see schematic in ***Figure 4****) which is used to filter noise, caused by the converter switching operation (it is mainly used to suppress noise for ADC measurement as well as UART communication). This change in capacitance affects the I-set procedure, so the parameter setting needs to be adapted. For more details see* ***[2]****.*

6.2 Protections

The following parameters are to be specified in this section (see **Figure 8**):

1. ETP_comp_Vcc – Enable/disable V_{CC} voltage value compensation (external temperature measurement)
2. ETP_enable – Enable/disable external temperature protection
3. Vin_min_start and Vin_min_oper – V_{IN}– Undervoltage hysteretic thresholds (see Section **7.3.1**)
4. Vin_max_start and Vin_max_oper – V_{IN}– Overvoltage hysteretic thresholds (see Section **7.3.2**)
5. Vout_min and Vout_max – V_{OUT}– Undervoltage and overvoltage thresholds respectively (see Sections **7.3.3** and **7.3.5**)
6. Pout_max – Maximum output power (see Section **7.3.6**)
7. Err_refcurrent_max and Err_refcurrent_min – Error current peak values during the shutdown procedure (see **[1]**)

Protections		
ETP_comp_Vcc	Enabled	
ETP_enable	Enabled	
Vin_min_start	35.00	V
Vin_min_oper	30.00	V
Vin_max_start	50.00	V
Vin_max_oper	55.00	V
Vout_min	8.00	V
Vout_max	40.00	V
Pout_max	23.00	W
Err_refcurrent_max	131	mA
Err_refcurrent_min	20	mA

Figure 8 Protection Parameters

6.3 Temperature Guard

It is necessary for temperature protection to enter the values of temperature thresholds that define the device's behavior regarding operating temperature conditions (see Section 7.3.7). Increment and decrement time steps should be defined as well as a reference V_{CC} power supply value, which is used for external temperature measurement compensation – see Figure 9.

Temperature guard		
ITP_temperature_hot	120	degreeC
ITP_temperature_critical	123	degreeC
ETP_temperature_hot	1.27	V
ETP_temperature_critical	1.37	V
ITP_PWM_inc_time_step	10	s
ITP_PWM_dec_time_step	10	s
ETP_PWM_inc_time_step	10	s
ETP_PWM_dec_time_step	10	s
Vcc_reference	15.00	V

Figure 9 Temperature Guard Parameters

6.4 Startup & Shutdown

There are two parameters that the user can utilize to set time steps for soft-start and soft-shutdown procedures (see Figure 10). This feature has the role of ensuring the stability of a preceding stage (see Section 7.1).

Startup & shutdown		
Softstart_time_step	1	ms
Softshutdown_time_step	2	ms

Figure 10 Startup and Shutdown Parameters

6.5 Output Current Set

Three parts of the output current set must be completed (fulfilled) by the user:

- **Reference current values:** A maximum of 16 values (I_ref_01 – I_ref_16) must be specified for the reference currents (for the ILD2111 evaluation board) in descending order, as shown in **Figure 11**. The initial current ripple percentage (during startup) should be set too (Curr_ripple_perc).

Output current set		
I_ref_01	800	mA
I_ref_02	750	mA
I_ref_03	700	mA
I_ref_04	650	mA
I_ref_05	600	mA
I_ref_06	550	mA
I_ref_07	500	mA
I_ref_08	450	mA
I_ref_09	400	mA
I_ref_10	350	mA
I_ref_11	300	mA
I_ref_12	250	mA
I_ref_13	0	mA
I_ref_14	0	mA
I_ref_15	0	mA
I_ref_16	0	mA
Curr_ripple_perc	40.00	%

Figure 11 Reference Currents Set

- **Reference currents arrangement:** Although, typically, the application uses less than 16 reference currents, all parameters (Ref_current_01 – Ref_current_16, see **Figure 12**) must be filled (arranged) in 4 groups using copies with the same reference current drop-down menu (see **Figure 12**). One example of arranging is given in **Table 4**. It is assumed that approximately the same currents have approximately the same parameters. The currents from the same group will have the same minimum and maximum switching frequency limits and minimum and maximum current ripple limits as well (these values are predefined constants).

Ref_current_01	800	mA
Ref_current_02	750	mA
Ref_current_03	700	mA
Ref_current_04	700	mA
Ref_current_05	650	mA
Ref_current_06	600	mA
Ref_current_07	550	mA
Ref_current_08	550	mA
Ref_current_09	500	mA
Ref_current_10	450	mA
Ref_current_11	400	mA
Ref_current_12	400	mA
Ref_current_13	350	mA
Ref_current_14	300	mA
Ref_current_15	250	mA
Ref_current_16	250	mA

Ref_current_01	800	mA
Ref_current_02	750	mA
Ref_current_03	700	mA
Ref_current_04	700 / 650 / 600 / 550 / 500 / 450 / 400 / 350	mA
Ref_current_05		mA
Ref_current_06		mA
Ref_current_07		mA
Ref_current_08		mA
Ref_current_09		mA
Ref_current_10	450	mA
Ref_current_11	400	mA
Ref_current_12	400	mA
Ref_current_13	350	mA
Ref_current_14	300	mA
Ref_current_15	250	mA
Ref_current_16	250	mA

Figure 12 Output Reference Currents Arrangement

Table 4 Reference Currents Arrangement

Group Number	Group Content	Reference Currents
1.	Ref_current_01 – Ref_current _04	800 mA, 750 mA, 700 mA
2.	Ref_current_05 – Ref_current _08	650 mA, 600 mA, 550 mA
3.	Ref_current_09 – Ref_current _12	500 mA, 450 mA, 400 mA
4.	Ref_current_13 – Ref_current _16	350 mA, 300 mA, 250 mA

- **Reference resistance values:** All appropriate reference resistance values (R_iset_01 – R_iset_16) need then to be set in ascending order – see **Figure 13**. The number of different reference resistor values must match the number of different reference currents.

R_iset_01	2.15	kOhm
R_iset_02	10.00	kOhm
R_iset_03	15.00	kOhm
R_iset_04	21.50	kOhm
R_iset_05	33.20	kOhm
R_iset_06	43.20	kOhm
R_iset_07	53.60	kOhm
R_iset_08	63.40	kOhm
R_iset_09	71.50	kOhm
R_iset_10	82.50	kOhm
R_iset_11	90.90	kOhm
R_iset_12	100.00	kOhm
R_iset_13	1000.00	kOhm
R_iset_14	1000.00	kOhm
R_iset_15	1000.00	kOhm
R_iset_16	1000.00	kOhm

Figure 13 Reference Resistances Set

7 Feature Description

All features that are supported by this device are explained (with more details) in the ILD2111 data sheet (see [1]). The following sections give a brief description of each feature and display waveforms of appropriate signals recorded during the measurements.

7.1 Current Startup, Soft-Start and Shutdown Control

Current soft-start and shutdown control is implemented in order to keep the input voltage V_{IN} and supply voltage V_{CC}, which come from the primary stage (usually a flyback converter with a transformer auxiliary winding for V_{CC} voltage), stable within the operating range.

During the soft-start time, the output (mean) current increases slowly with programmable parameters (startup current, current step and time step). The time step can be set as a number of system ticks (the default value is 100 µs). If any of the step values is zero, the buck converter will start with a 100% current, and without soft-start.

*Note: During the startup sequence, Frequency Ripple Control is disabled. The current ripple is defined by the parameter Curr_ripple_perc (see Section **6.5**).*

Figure 14 Soft-start Startup Waveforms: Gate Drive Output (CH1, yellow), Supply Voltage VCC (CH2, pink) and Output Current (CH4, green)

During soft shutdown time, the output current decreases slowly with programmable current and time steps. Hence, the input voltage V_{IN} and supply voltage V_{CC} remain in the operating range and the device will work correctly. If the soft shutdown is not enough to provide an appropriate operating range (for V_{IN} and V_{CC}), some minimum current defined by the parameters will be generated for a defined time period (error time). When this interval has elapsed, the output current is zero. If the current soft shutdown is not needed, it is necessary to set at least one of the parameters to zero. The soft-shutdown current waveform can be seen in any of the protections waveforms – see Section **7.3**.

7.2 Current Ripple vs. Switching Frequency Control Scheme

The switching frequency and output current ripple must be handled in such a way as to ensure that the efficiency is as high as possible and that the ripple is in a proper range with sufficient margin to the specified maximum.

The ILD2111 supports a powerful Frequency Ripple Controller (FRC) because the switching frequency of the BUCK converter is not constant due to different loads (different number of LEDs leading to different output voltages). The main idea is to stabilize the operating point within configurable limits (e.g. to keep the switching frequency above the audible range, or limit current ripple according to requirements) – the operating area, which is defined by minimum and maximum current ripples and minimum and maximum switching frequencies. As can be seen in **Figure 15**, in steady state of operation current, the ripple will be reduced (compared to the startup current ripple) and the switching frequency will be automatically increased to obtain the operating point within a predefined area. For more details, see **[1]**.

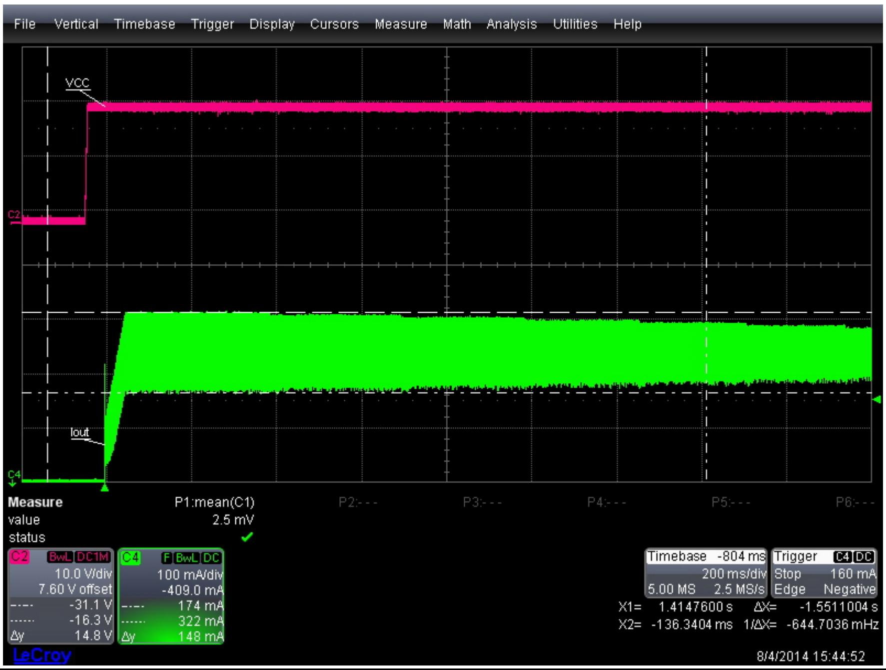


Figure 15 Frequency-Ripple Control Waveform: Supply Voltage VCC (CH2, pink) and Output Current (CH4, green)

7.3 Protection Features

Table 5 gives an overview of the supported protection features. Two protection modes are implemented (auto restart mode and latch mode), which can be entered. Protection features can be configured by parameters. An error counter counts errors up to 4 restarts. The error counter is reset when the device operates without additional errors for the predefined time or at the startup sequence.

Table 5 Protection Features

Protection	Section
Undervoltage Protection for DC Input Line – V_{IN} Undervoltage	7.3.1
Overvoltage Protection for DC Input Line – V_{IN} Overvoltage	7.3.2
Output Undervoltage Protection – V_{OUT} Undervoltage	7.3.3
Open Output Protection	7.3.4
Output Overvoltage Protection – V_{OUT} Overvoltage	7.3.5
Output Overpower Protection – P_{OUT} Overpower	7.3.6
Temperature guard - Overtemperature Protection	7.3.7
Overcurrent Protection – Level 2 (OCP2)	7.3.8

7.3.1 Undervoltage Protection for DC Input Line – V_{IN} Undervoltage

Undervoltage protection for the DC input line prevents the device from operating with an excessively low V_{IN} voltage. If the input voltage is below the specified value, the output current is turned off. The device waits until the undervoltage condition (low input voltage) is removed and then starts with output current generation again. There are two hysteretic input voltage values (defined by parameters) that are used as thresholds during the operation (lower value) and during the startup sequence (higher value). This event does not affect the error counter. As can be seen in **Figure 16** below, two hysteretic voltage threshold values are set (30 V and 35 V). For more details, see **[1]**.

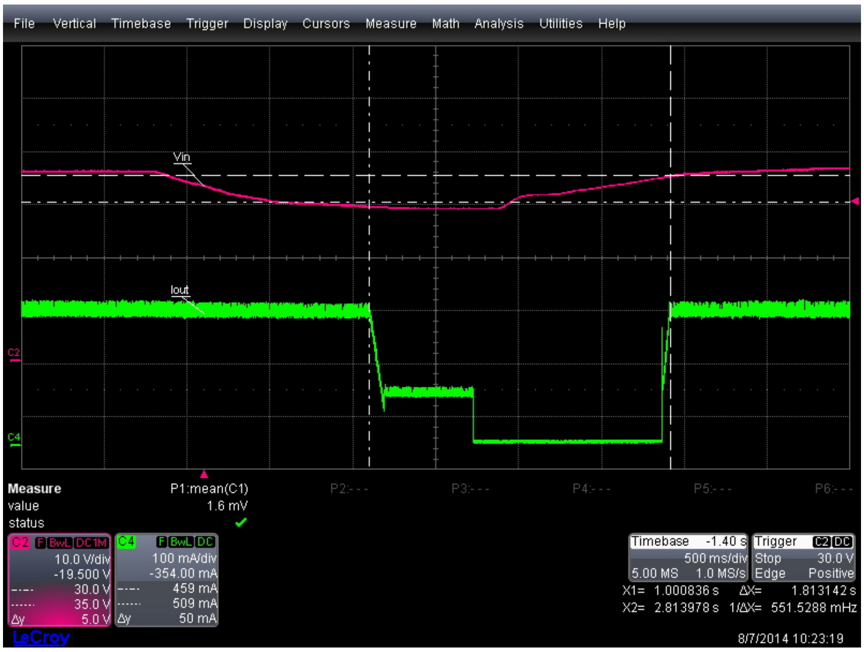


Figure 16 Undervoltage Protection for DC Input Line – V_{IN} Undervoltage Waveform: Input Voltage (CH2, pink) and Output Current (CH4, green)

7.3.2 Overvoltage Protection for DC Input Line – V_{IN} Overvoltage

Overvoltage protection for the DC input line prevents the device from operating with an excessively high V_{IN} voltage. After the overvoltage condition on input is detected, the output current is turned off. The device waits for the input overvoltage condition to be removed and then starts output current generation again. There are two hysteretic input voltage values (defined by parameters) that are used as thresholds during the operation (higher value) and during the startup sequence (lower value). This event does not affect the error counter. As can be seen in **Figure 17** below, two hysteretic voltage threshold values are set (55 V and 50 V). For more details, see **[1]**.

Figure 17 **Overvoltage Protection for DC Input Line – V_{IN} Overvoltage Waveform: Input Voltage (CH2, pink) and Output Current (CH4, green)**

7.3.3 Output Undervoltage Protection – V_{OUT} Undervoltage

Output undervoltage protection prevents the device from operating with an excessively low output voltage V_{LEDmin} or when LED output is lowered. If the output voltage is lower than the predefined minimum value (see **Figure 18**), an undervoltage output is detected, and the device enters error auto-restart mode with 4 tries (restarts). After 4 failed attempts, the device enters latch mode. Otherwise, the device can be recovered (by removing the cause of the auto-restart sequence, see **Figure 19**). The minimum output operating voltage value is programmable (8 V, see **Figure 18**). Undervoltage output is checked during steady-state condition after completing soft-start. The restart timeout startup delay is a predefined constant. For more details, see **[1]**.

Figure 18 Output Undervoltage Protection – V_{OUT} Undervoltage Waveform: Output Voltage (CH1, yellow) and Output Current (CH4, green)

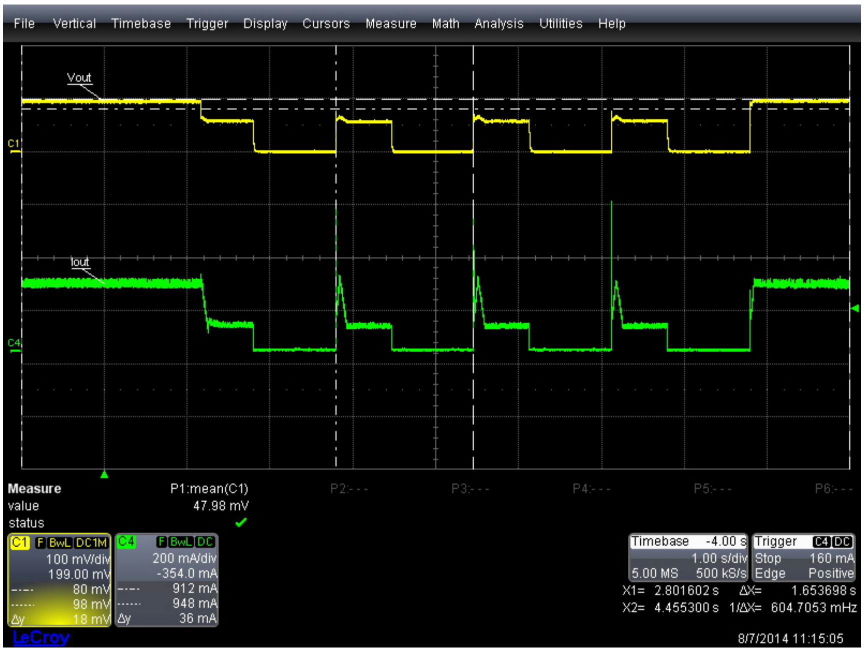


Figure 19 Output Undervoltage Protection – V_{OUT} Undervoltage Recovery Waveform: Output Voltage (CH1, yellow) and Output Current (CH4, green)

7.3.4 Open Output Protection

Open output protection prevents the device from operating when no load on output is detected. It is detected when the time to achieve I_{MAX} exceeds the value of the predefined parameter. If the open output condition is detected, the device enters error auto-restart mode with 4 tries (restarts). In each attempt, the device executes the reference resistor reading procedure (I-set procedure). After 4 failed attempts, the device enters latch mode – see **Figure 20**. Otherwise, the device can be recovered (by removing the cause of the auto-restart sequence, see **Figure 21**). For more details, see **[1]**.

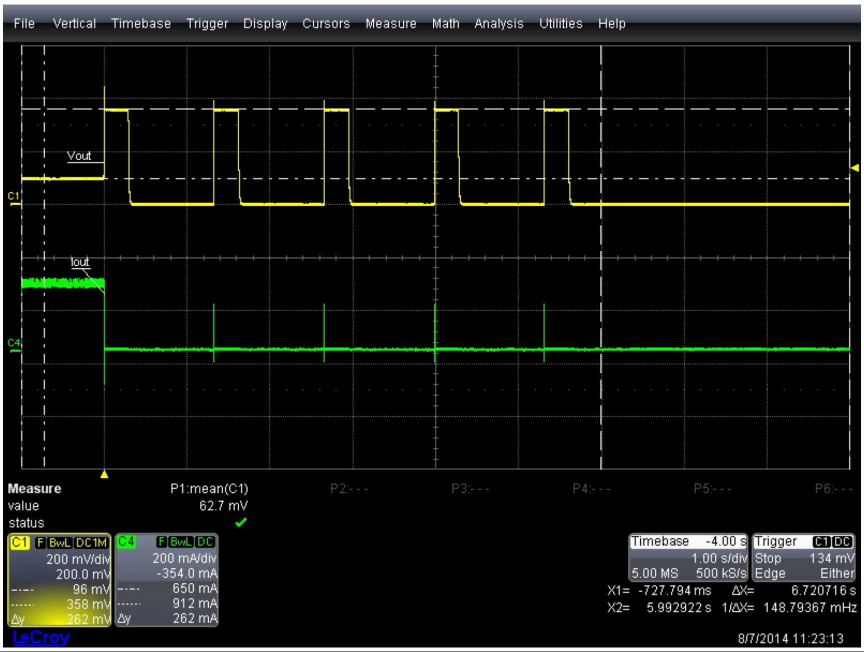


Figure 20 Open Output Protection Waveform: Output Voltage (CH1, yellow) and Output Current (CH4, green)

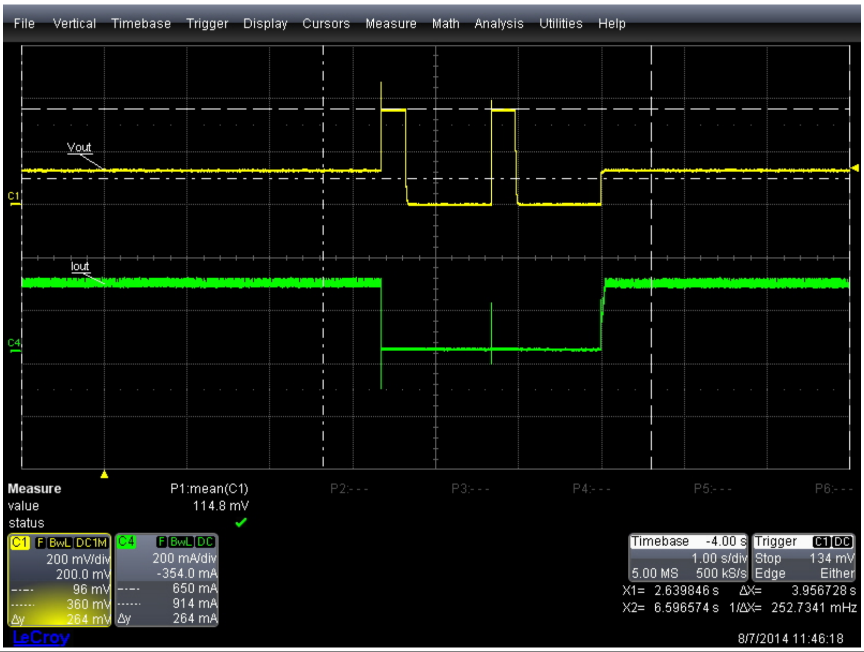


Figure 21 Open Output Protection Recovery Waveform: Output Voltage (CH1, yellow) and Output Current (CH4, green)

7.3.5 Output Overvoltage Protection – V_{OUT} Overvoltage

Output overvoltage protection prevents the device from operating when the high voltage on output V_{OUT} is detected. If the output voltage is higher than the predefined maximum value (see **Figure 22**), the device enters error auto-restart mode with 4 tries (restarts). After 4 failed attempts, the device enters latch mode. Otherwise, the device can be recovered (by removing the cause of the auto-restart sequence, see **Figure 23**). The maximum output operating voltage value is programmable (40 V, see **Figure 22**). Output voltage is checked during the steady-state condition after completing soft-start. The restart timeout startup delay is a predefined constant. For more details, see **[1]**.

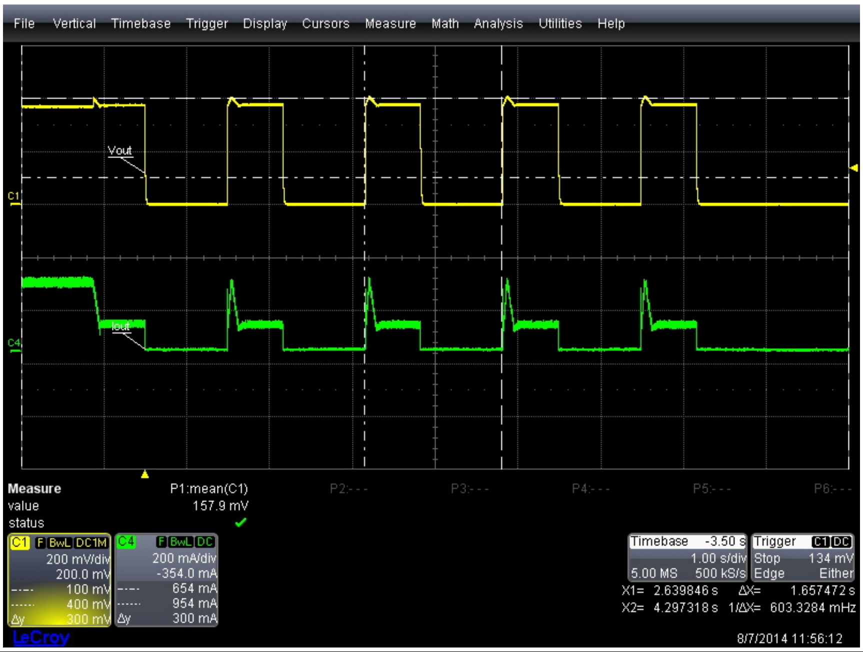


Figure 22 Output Overvoltage Protection – V_{OUT} Overvoltage Waveform: Output Voltage (CH1, yellow) and Output Current (CH4, green)

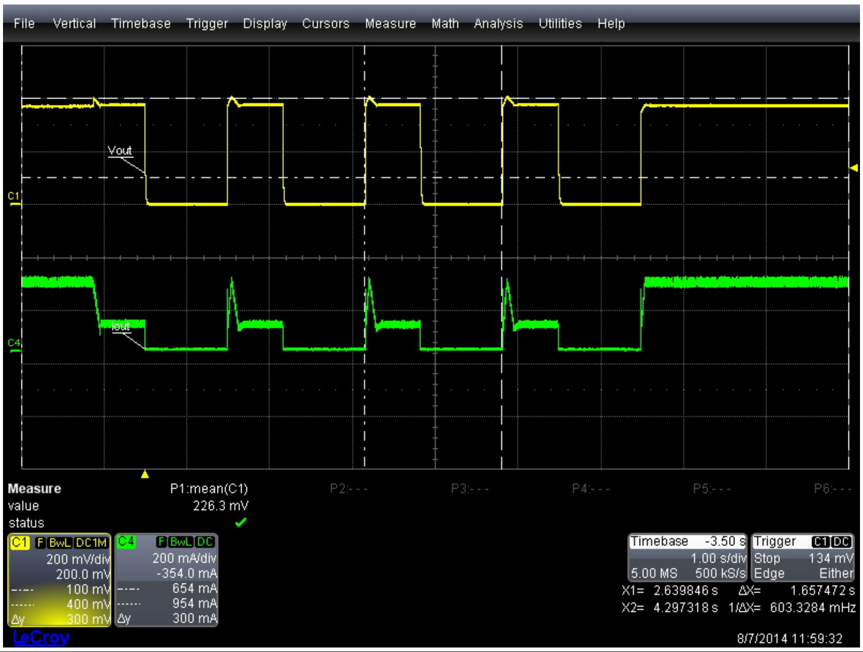


Figure 23 Output Overvoltage Protection – V_{OUT} Overvoltage Recovery Waveform: Output Voltage (CH1, yellow) and Output Current (CH4, green)

7.3.6 Output Overpower Protection – P_{OUT} Overpower

Output overpower protection prevents damage to output components due to high output power. The maximum allowed output power values are stored in the parameters. If the output power exceeds the maximum allowed operational value, the device enters error auto-restart mode with 4 tries (restarts). After 4 failed attempts, the device enters latch mode (see **Figure 24**). Otherwise, the device can be recovered (by removing the cause of the auto-restart sequence, see **Figure 25**). Output overpower is checked during the steady-state condition after completing soft-start. The restart timeout startup delay is a predefined constant. For more details, see **[1]**.

Figure 24 Output Overpower Protection – P_{OUT} Overpower Waveform: Output Voltage V_{OUT} ~ 29 V (CH1, yellow) and Output Current I_{OUT} = 800 mA (CH4, green), P_{OUTmax} ~ 23 W

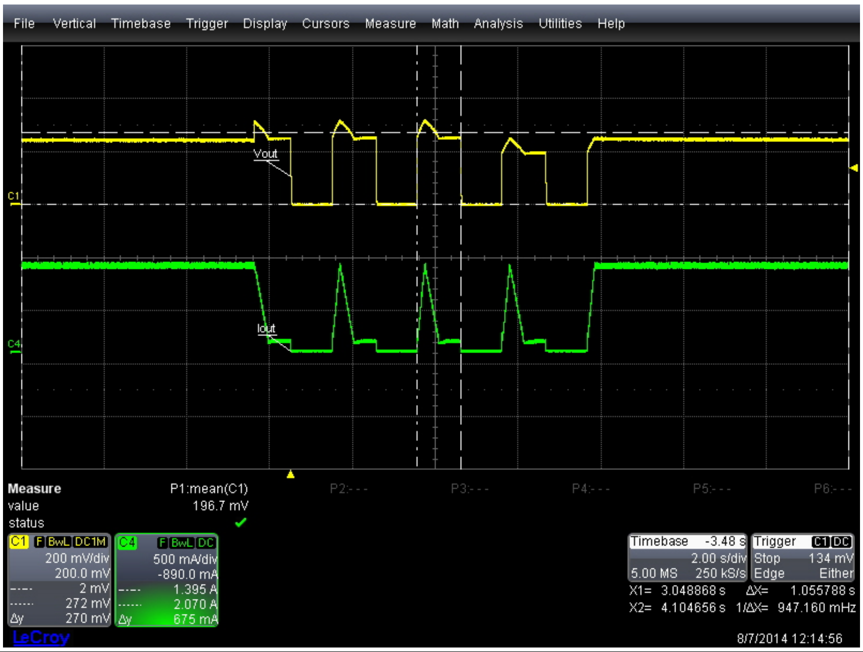


Figure 25 Output Overpower Protection – P_{OUT} Overpower Recovery Waveform: Output Voltage V_{OUT} ~ 29 V (CH1, yellow) and Output Current I_{OUT} = 800 mA (CH4, green), P_{OUTmax} ~ 23 W

7.3.7 Temperature Guard - Overtemperature Protection

The ILD2111 supports overtemperature protection by means of internal and external temperature sensors. The internal sensor is always active while the external sensor could be enabled or disabled. In the event that both internal and external temperature protection requests for the current level change, the lower current level will prevail. If the external sensor is not used (disabled by configuration or disconnected), only internal temperature protection is processed.

7.3.7.1 Internal Temperature Protection – Internal PWM Dimming 1

Internal temperature-based protection uses internal temperature sensor measurement for reduction of the output current in the case that device temperature increases. Two temperature thresholds, HOT and CRITICAL, as well as one current-time up-slope and one current-time down-slope are programmable (see Section **6.3** and **Figure 26**). The output current level is reduced by PWM modulation – see Section **7.5** and **Figure 27**. For more details, see **[1]**.

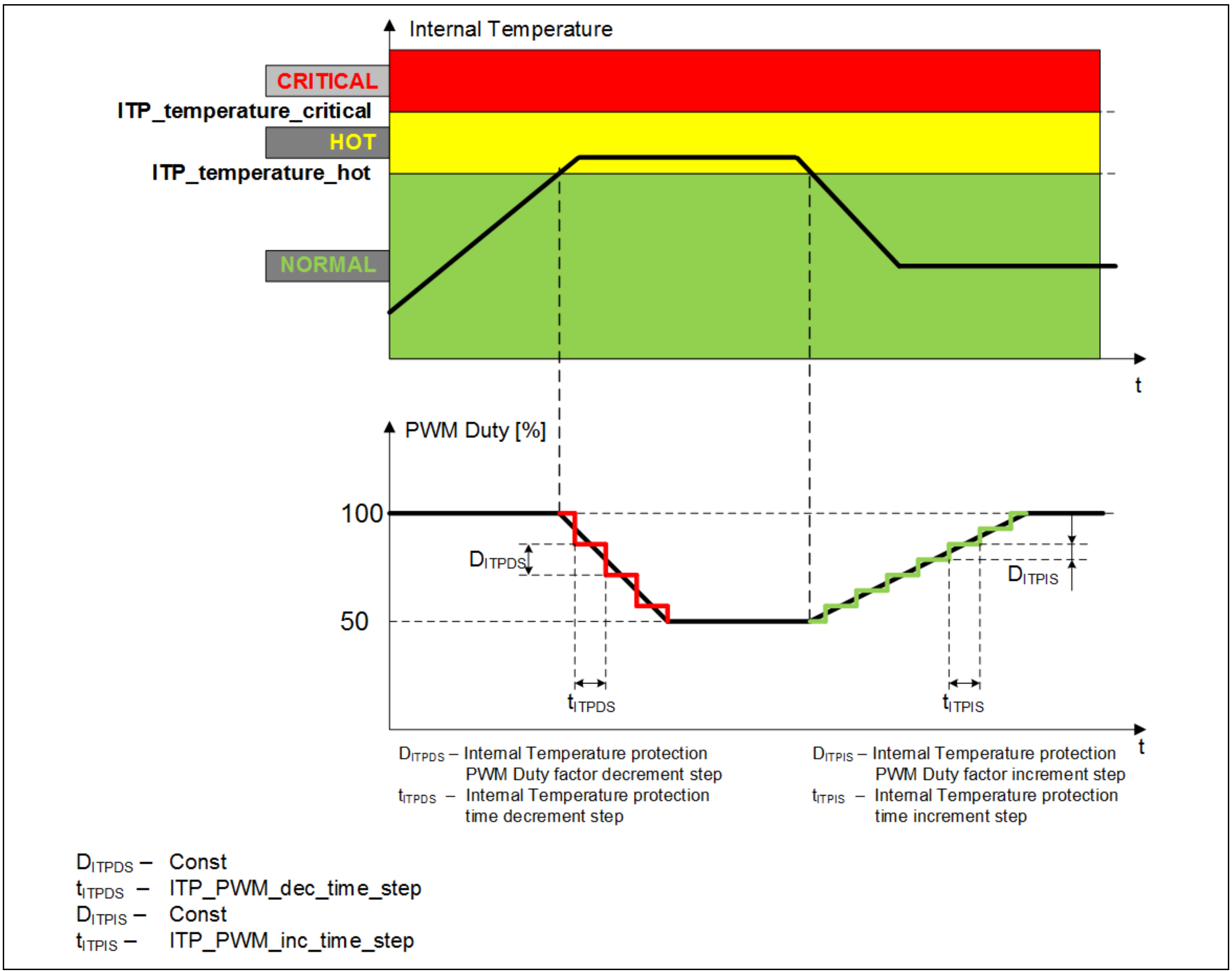


Figure 26 Internal Temperature Protection – Internal PWM Dimming 1

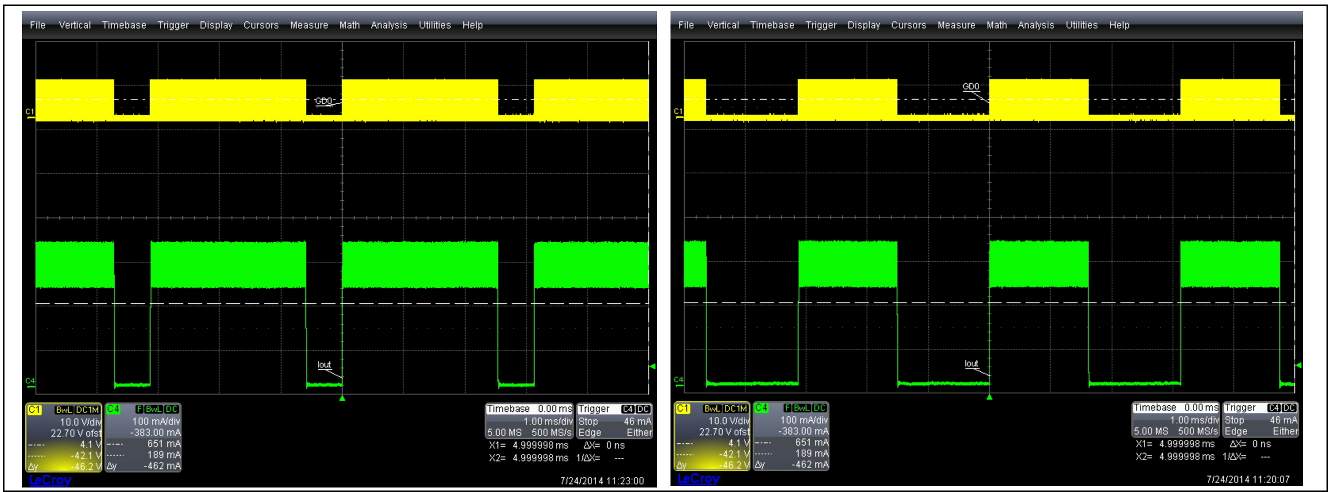


Figure 27 Temperature Protection PWM Duty Decreasing Waveform: Gate Driver Signal (CH1, yellow) and Output Current (CH4, green)

7.3.7.2 External Temperature Protection – Internal PWM Dimming 2

External temperature-based protection uses a PTC resistor connected between two access points PTC and GND (2-wire connection – see **Figure 5**). External temperature is meant to reduce the output current in the case that the temperature of the light element increases. Two temperature thresholds, HOT and CRITICAL, as well as one current-time up-slope and one current-time down-slope are programmable – see **Figure 28**. The output current level is reduced by PWM modulation – see Section **7.5**. If the sensor is disconnected during operation, the PWM duty will be set to a predefined constant value (50%). If the disconnection is detected during startup, the sensor will be ignored during operation. For more details, see **[1]**.

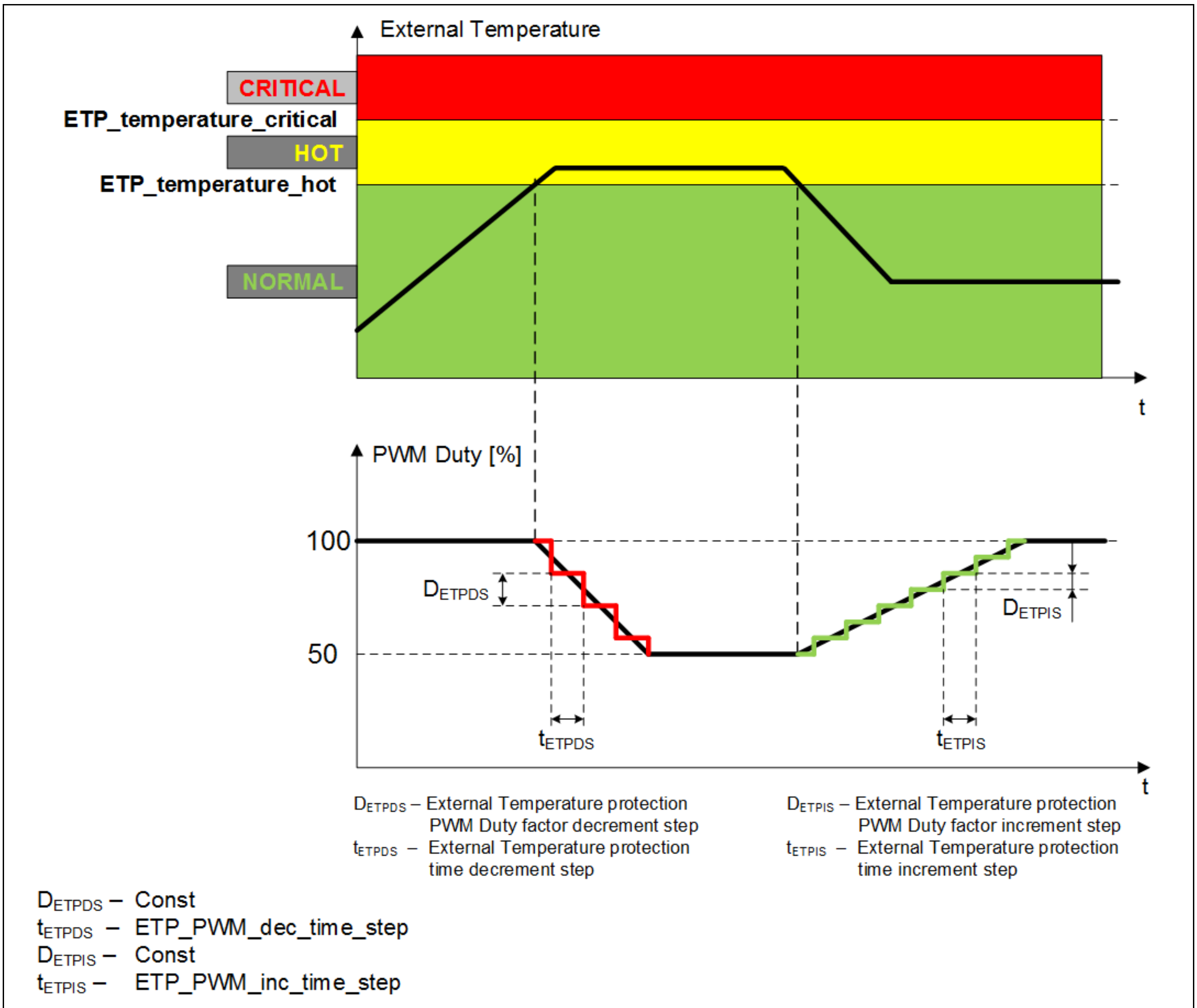


Figure 28 External Temperature Protection – Internal PWM Dimming 2

There is no dedicated protection against open/short condition of the external temperature sensor. If an open condition during start-up (power-up) is detected, the sensor will be disregarded. If the sensor disconnects during operation, the PWM duty will be gradually reduced to a 50%. It could also happen, due to the filtration of this measurement that the IC will restart due to Over Temperature Error (OTE) and following a subsequent start-up will disregard the sensor.

7.3.8 Overcurrent Protection – Level 2 (OCP2)

To avoid damage to the shunt resistor or MOSFET due to the rapid increase (inrush) of the current through the shunt resistor (detected as the voltage on the CS pin), the overcurrent protection OCP2 is implemented as a hardware threshold. If the OCP2 threshold is reached (regardless of the cause of its appearance), the gate driver (power MOSFET) will be turned off automatically and can only be turned on again by firmware intervention. In the case of an OCP2 event, the firmware checks an internal counter of OCP2 events and applies a delay according to the predefined time loop durations (see **Table 6**). After the delay the engine is reinitialized and the device starts operation. The OCP2 counter will be reset after a predefined time in the case that there are no new OCP2 error events in the meantime. Otherwise, if the OCP2 event occurs again before the counter is reset, the number of errors is increased in increments up to the limit. For more details, see **[1]**.

Table 6 Time-loop Durations

Number of the OCP2 events	Previous value of the OCP2 counter	Next value of the OCP2 counter	Time-loop duration
1	0	1	100 µs
2	1	2	500 µs
3	2	3	2500 µs
≥4	3	3	130 ms

If the OCP2 condition is removed and the device is in internal or external PWM dimming, the device continues to operate in one of two modes (internal or external dimming), depending on which of the conditions for these modes is fulfilled.

*Note: In **Figure 29** below, two levels of the current can be noticed. It is the impact of the electronic circuit which is used to generate OCP2 level event.*

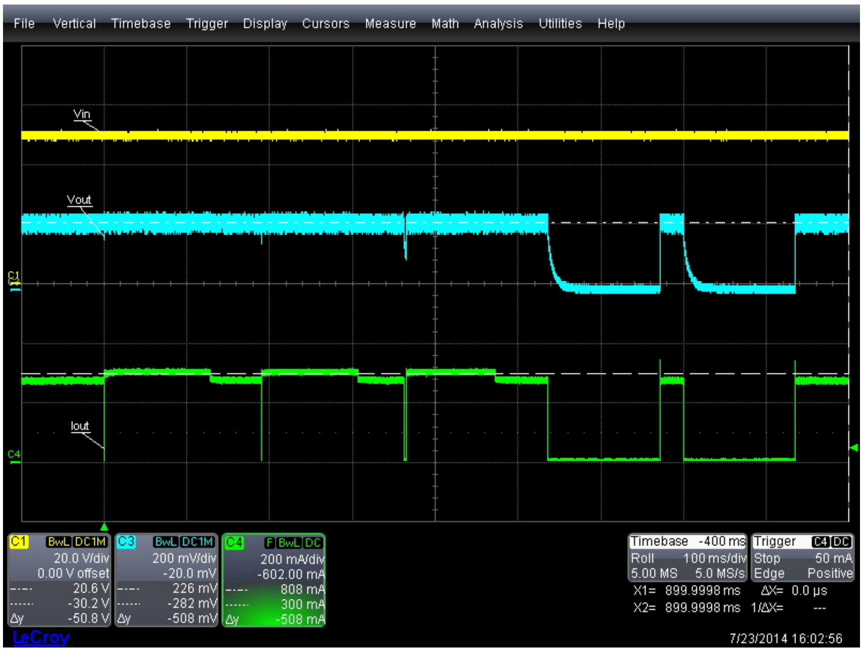


Figure 29 OCP2 Overcurrent Protection

7.4 External PWM Dimming

For external dimming, the EPWM duty (DT_{EPWM} – duty factor range 1% to 99%) and EPWM period (T_{EPWM}) can be measured at the PWM input pin – see **Figure 30**.

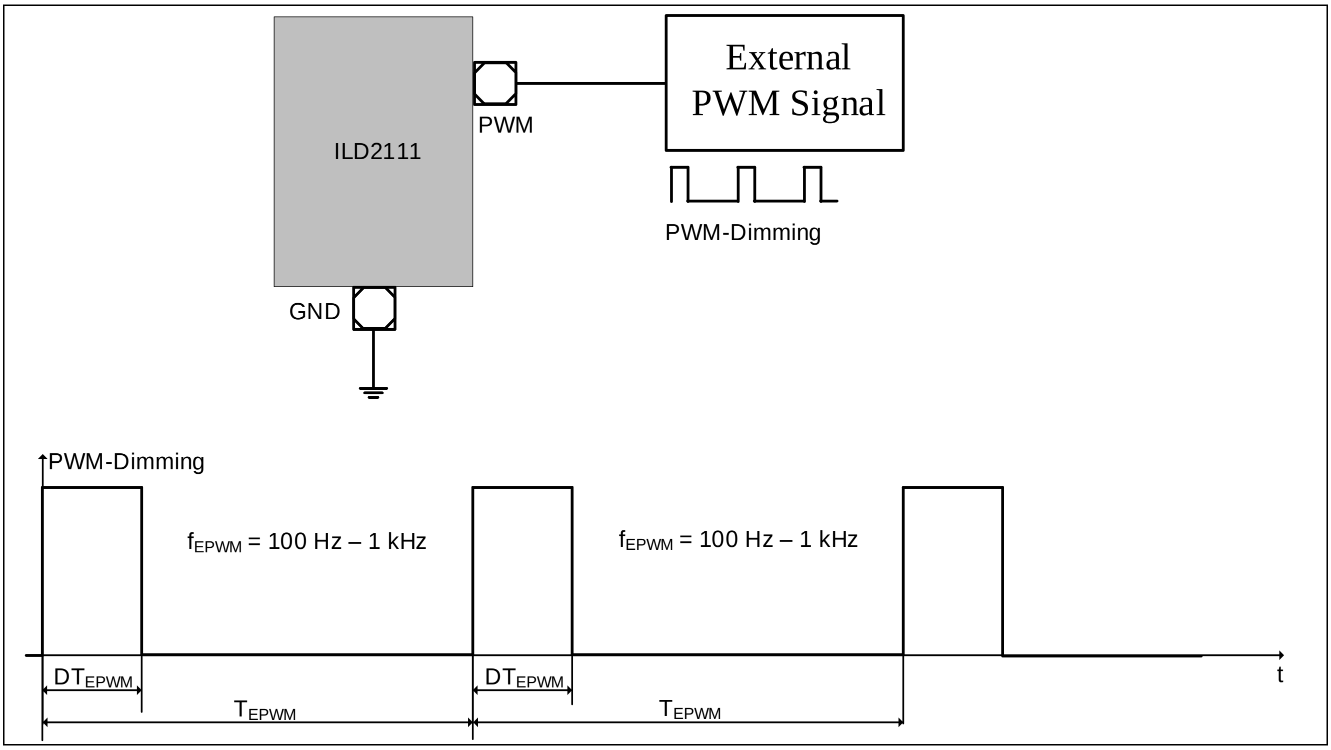


Figure 30 External PWM Dimming

The external PWM duty factor and external PWM frequency are obtained by measuring the on-time T_{ON_EPWM} (DT_{EPWM}) and PWM period T_{EPWM}. The timeout for external PWM detection is 50 ms, the complete output current PWM modulation is described in the following Section **7.5**.

7.5 Output Current PWM Modulation – Dimming

Modulation of the output current can be requested by:

1. External PWM dimming signal (see Section **7.4**) and
2. Internal PWM dimming signal (internal temperature protection – See section **7.3.7.1** and external temperature protection – see Section **7.3.7.2**).

The output current dimming PWM frequency, f_{PWM}, will be defined by the external PWM dimming signal EPWM (the range of f_{EPWM} is 100 Hz – 1 kHz; $f_{EPWM} = 1 / T_{PWM}$) or by the internal PWM signal (f_{IPWM} is 300 Hz; $f_{IPWM} = 1 / T_{PWM}$) if EPWM is not detected (the external EPWM frequency has a higher priority than the internal IPWM frequency). The final duty factor (PWM_Duty, see **Figure 31**) of the PWM signal will be determined by a minimum value of one of two calculated values (external epwm_duty or internal ipwm_duty).

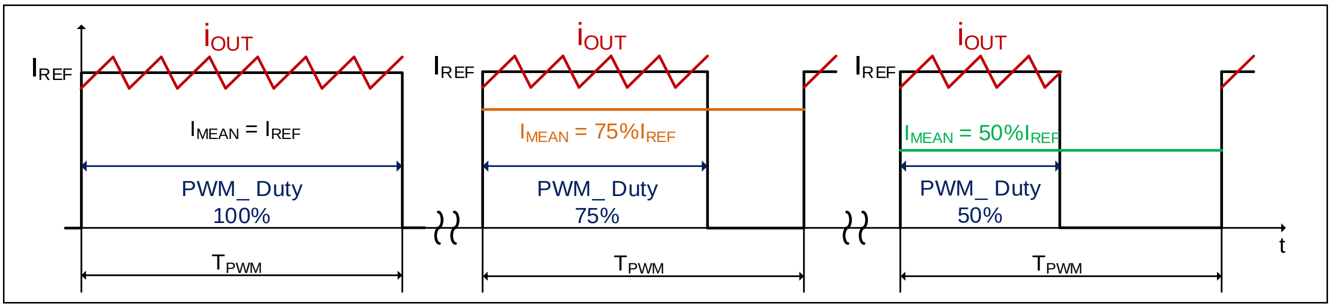


Figure 31 Output Current PWM Modulation

The following figures **Figure 32**, **Figure 33** and **Figure 34**, show three cases of the output current PWM dimming.

Figure 32 Output Current PWM Dimming – Case 1 Waveform: Gate Driver Signal (CH1, yellow), External PWM Signal (f_{EPWM} = 300 Hz, epwm_duty = 75%, CH2, pink) and Output Current (f_{PWM} = 300 Hz, ipwm_duty = 50%, CH4, green)

Figure 33 Output Current PWM Dimming – Case 2 Waveform: Gate Driver Signal (CH1, yellow), External PWM Signal (f_{EPWM} = 500 Hz, epwm_duty = 75%, CH2, pink) and Output Current (f_{PWM} = 500 Hz, ipwm_duty = 50%, CH4, green)

Figure 34 **Output Current PWM Dimming – Case 3 Waveform: Gate Driver Signal (CH1, yellow), External PWM Signal (f_{EPWM} = 500 Hz, epwm_duty = 25%, CH2, pink) and Output Current (f_{PWM} = 500 Hz, pwm_duty = 25%, CH4, green)**

8 Measurement Results

This chapter illustrates measurement results based on the ILD2111 evaluation system:

1. Current Set – Section **8.1**
2. Current Accuracy and Stability – Section **8.2**
3. Load Regulation – Section **8.3**
4. Line Regulation – Section **8.4**
5. Efficiency – Section **8.5**
6. Dimming – Section **8.6**

Complete and more detailed measurement results can be found in the available test report **[4]**.

8.1 Current Set

Condition: C_{REF} = 10 nF.

Figure 13 shows reference resistor values for the specific current values for typical applications, which cover – for example – the outputs ranging from 250 mA to 800 mA (in 50 mA steps). The resistors in use are from the series E96 with a variation (tolerance) of 1%.

Table 7 Current Set Example

Iset [mA]	Riset min [kΩ]	Riset max [kΩ]	Riset [kΩ]	Resistance Margin [%]	
				Left Margin	Right Margin
800	0.000	5.182	2.15	-100.00%	141.02%
750	5.812	12.043	10.00	-41.88%	20.43%
700	12.558	18.190	15.00	-16.28%	21.27%
650	18.627	26.773	21.5	-13.36%	24.53%
600	27.498	37.514	33.2	-17.17%	12.99%
550	38.077	47.89	43.2	-11.86%	10.86%
500	48.190	57.59	53.6	-10.09%	7.43%
450	58.27	67.00	63.4	-8.09%	5.68%
400	67.68	76.48	71.5	-5.34%	6.97%
350	77.12	86.24	82.5	-6.52%	4.53%
300	86.84	94.95	90.9	-4.47%	4.46%
250	95.78	1000.00	100	-4.22%	900.00%

8.2 Current Accuracy and Stability

Conditions: V_{IN} = 48 V, P_{OUT} = 15 W.

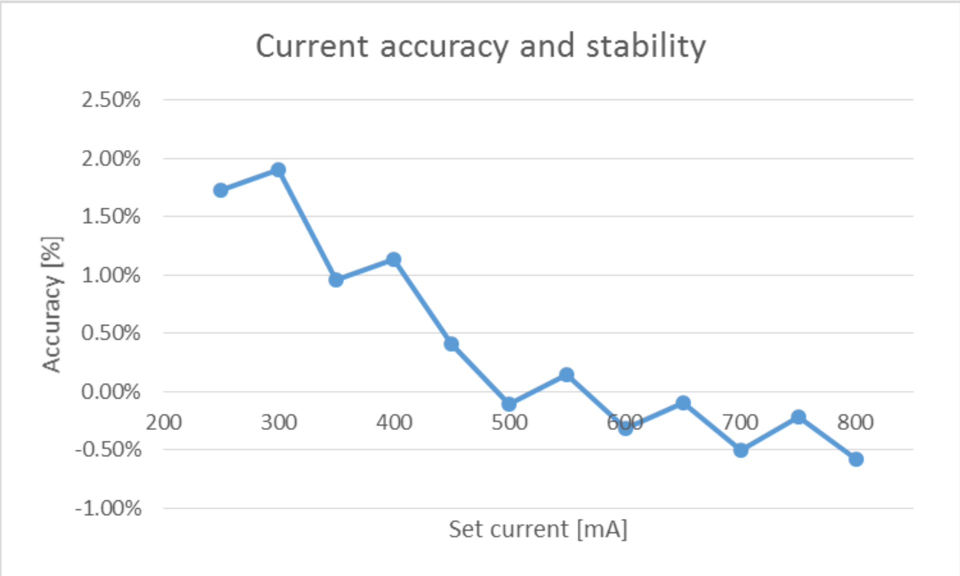


Figure 35 Current Accuracy and Stability

8.3 Load Regulation

Conditions: V_{IN} = 48 V, use different LED strings to create defined output power (5, 10 and 20 W).

Note: With output currents lower than 500 mA, output power (20 W) cannot be achieved due to the V_{out} overvoltage limit. Additionally the current of 250 mA cannot produce the third measurement point and therefore is not presented.

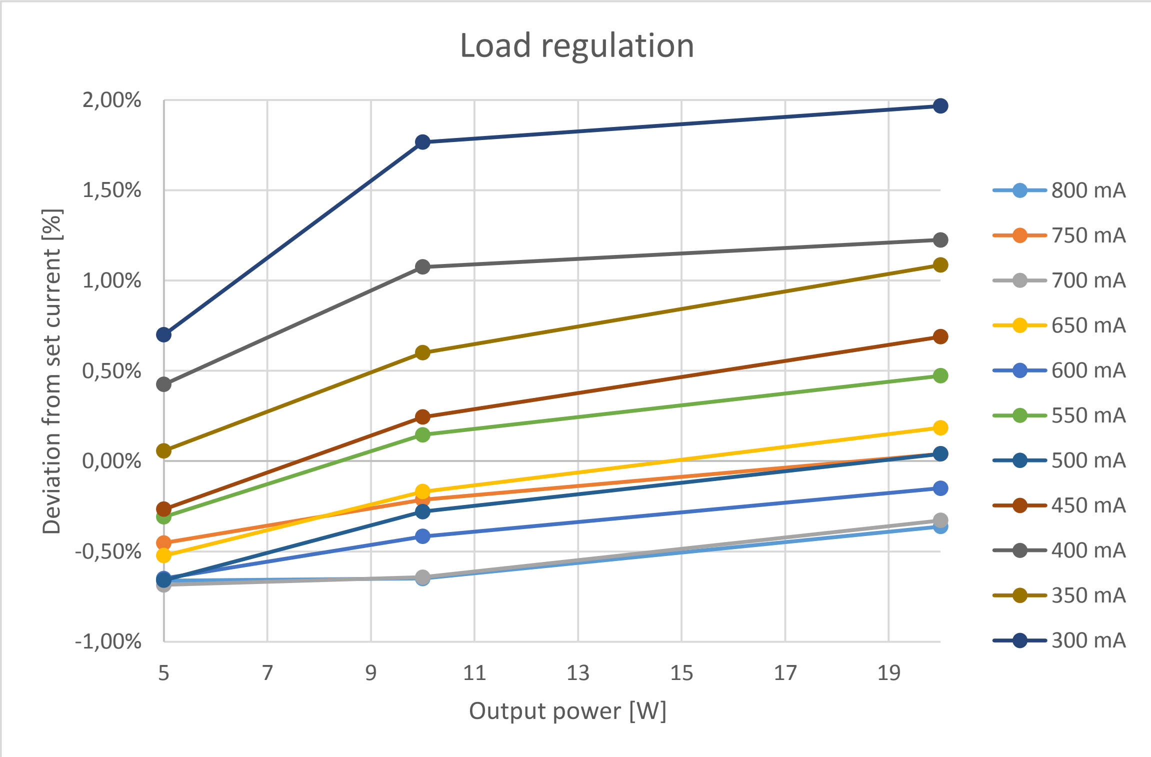


Figure 36 Load Regulation

8.4 Line Regulation

Condition: P_{out} = 15 W.

Note: With output currents lower than 400 mA, output power (15 W) cannot be achieved due to the V_{out} overvoltage limit.

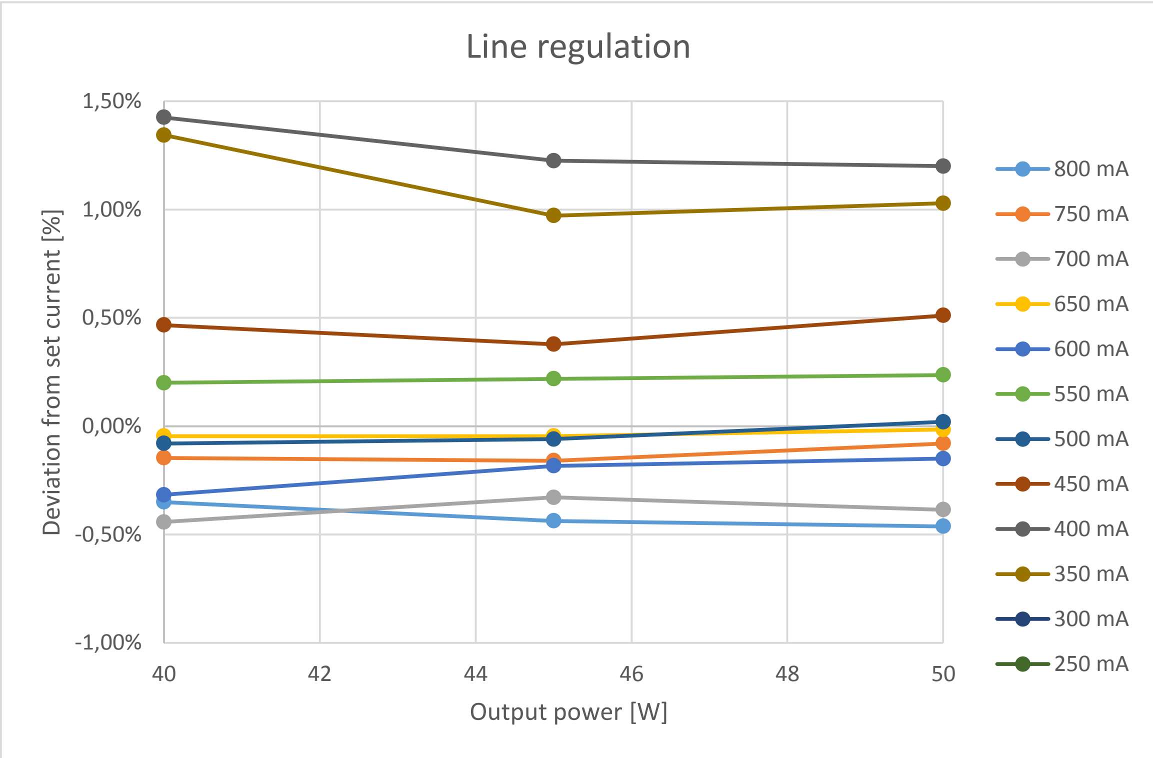


Figure 37 Line Regulation

8.5 Efficiency

Condition: P_{OUT} = 20 W.

Note: With output currents lower than 500 mA, output power (20 W) cannot be achieved. Therefore, the efficiency at low currents is not presented.

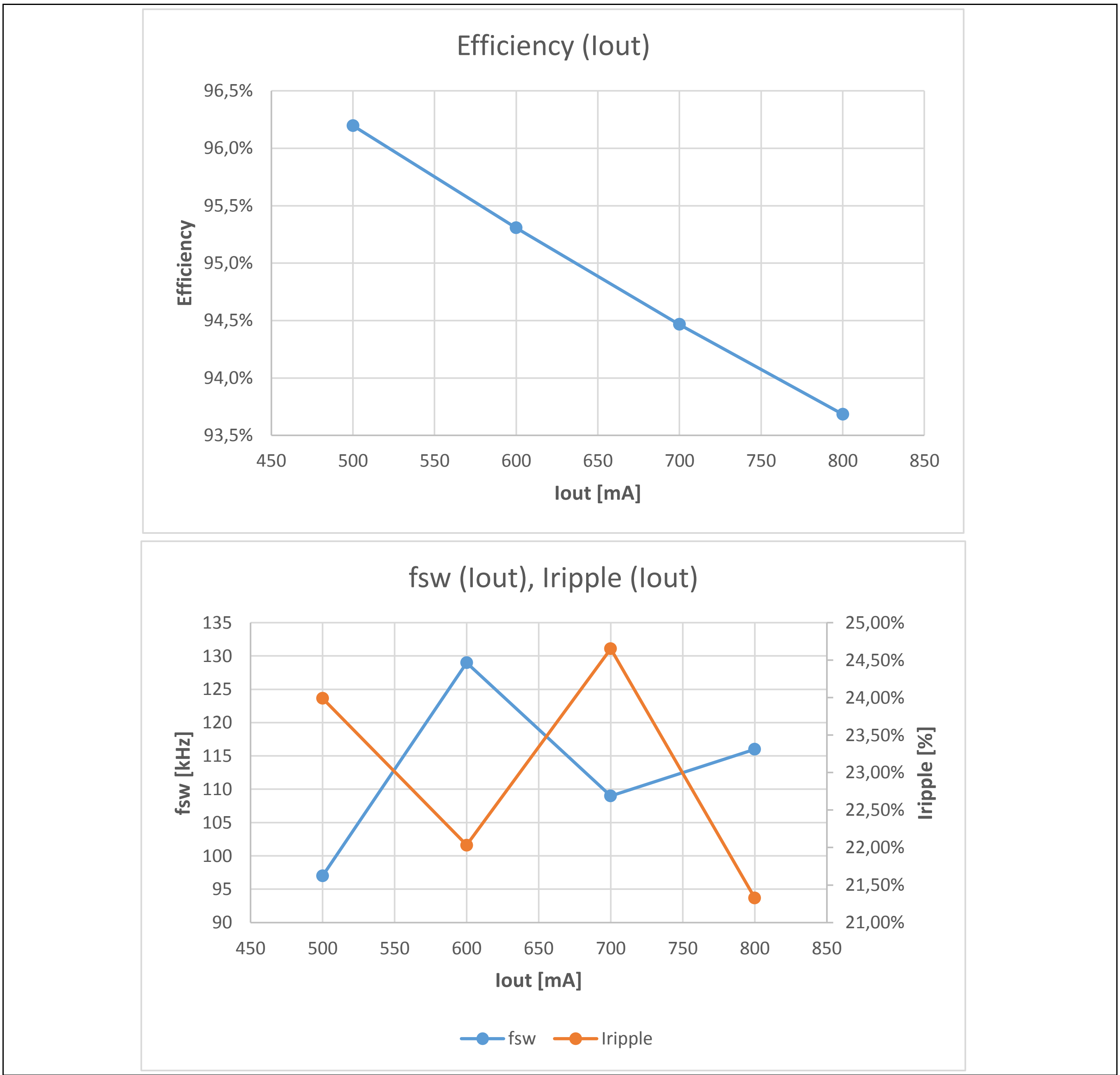
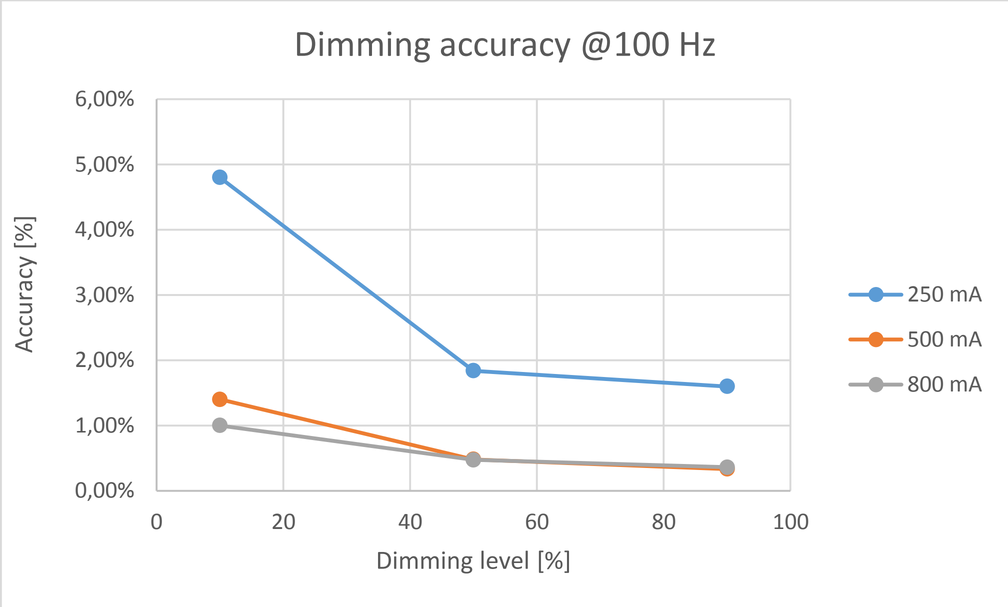
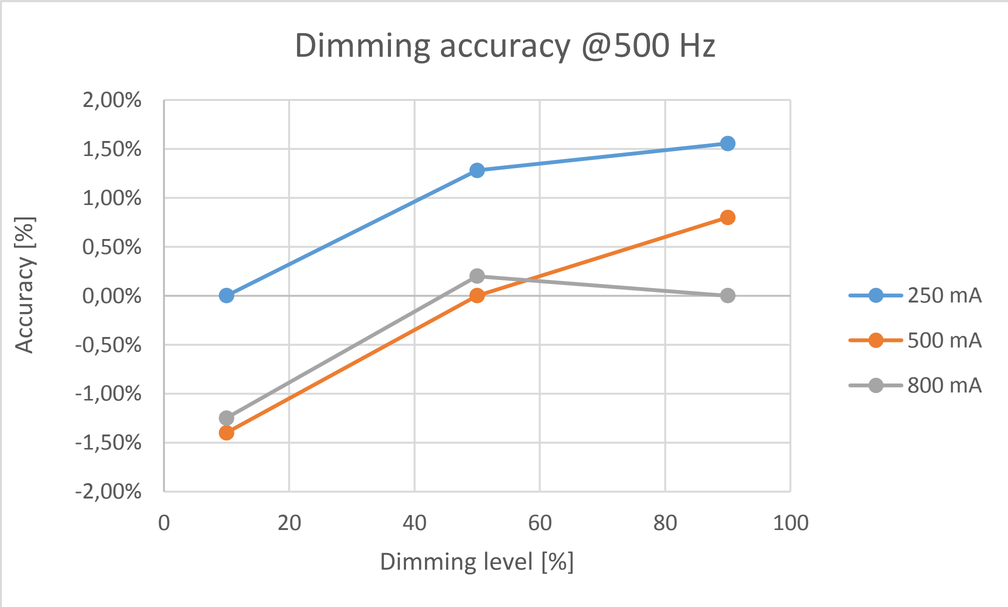


Figure 38 Efficiency, Switching Frequency and Current Ripple

8.6 Dimming Accuracy

Conditions: V_{IN} = 48 V, V_{OUT} = 30 V.





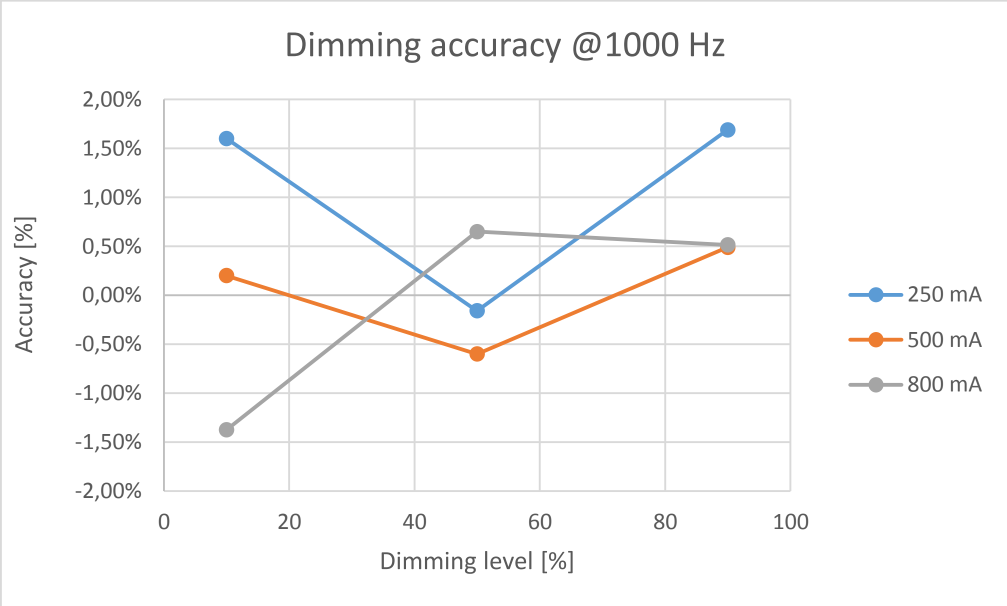


Figure 39 Dimming Accuracy

9 Board Layout

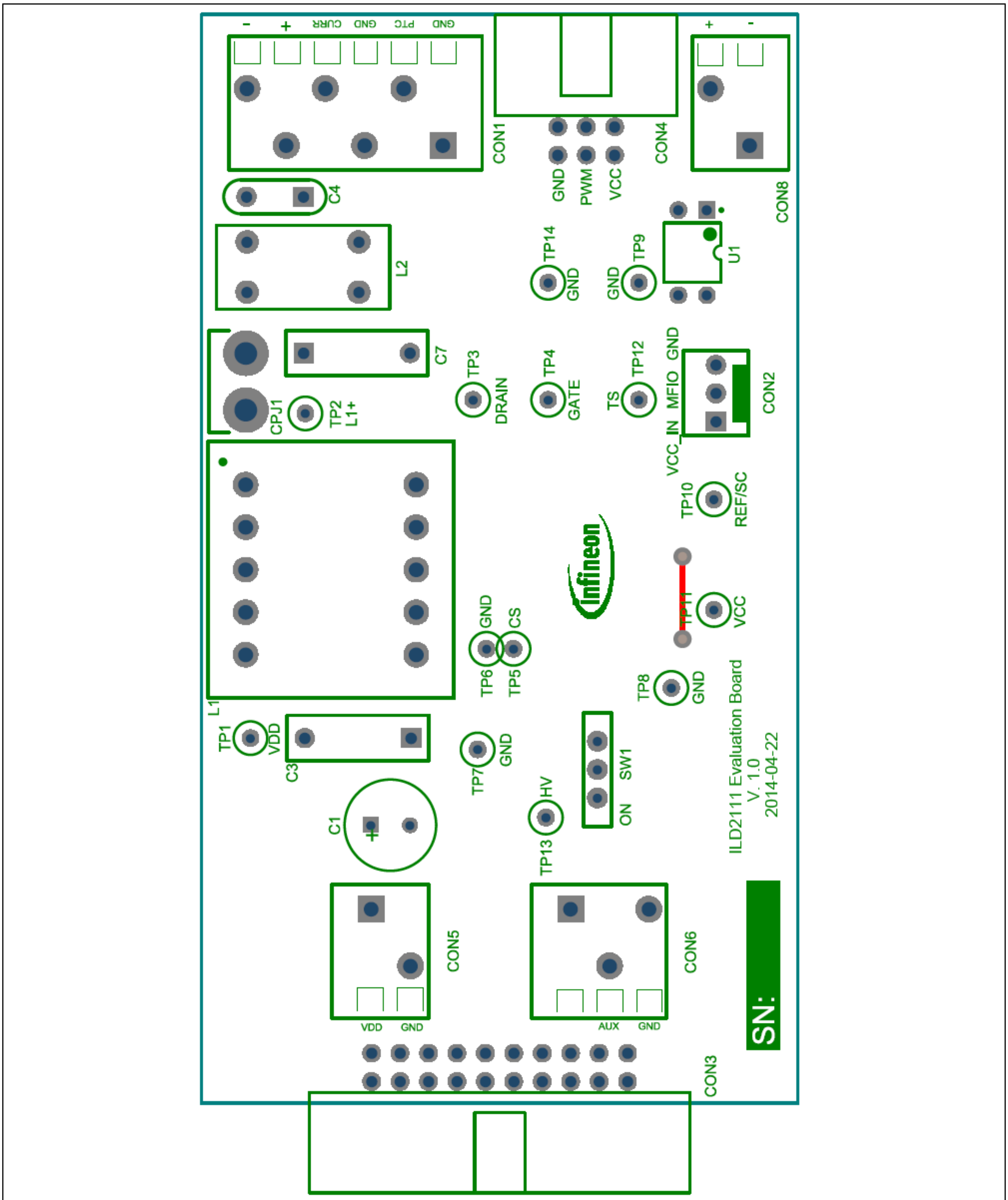


Figure 40 **ILD2111 Evaluation Board Top + Silkscreen**

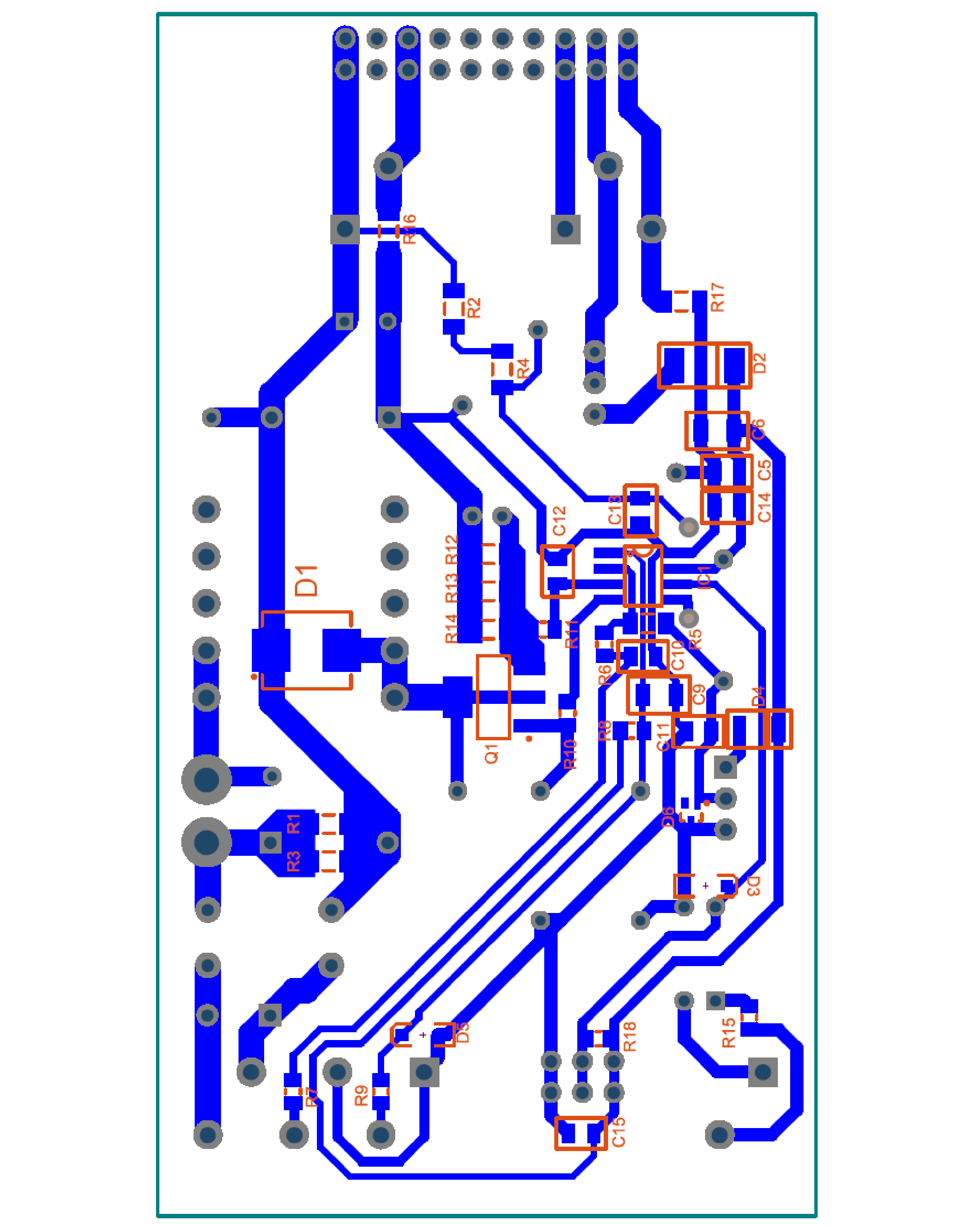


Figure 41 ILD2111 Evaluation Board Bottom + Silkscreen

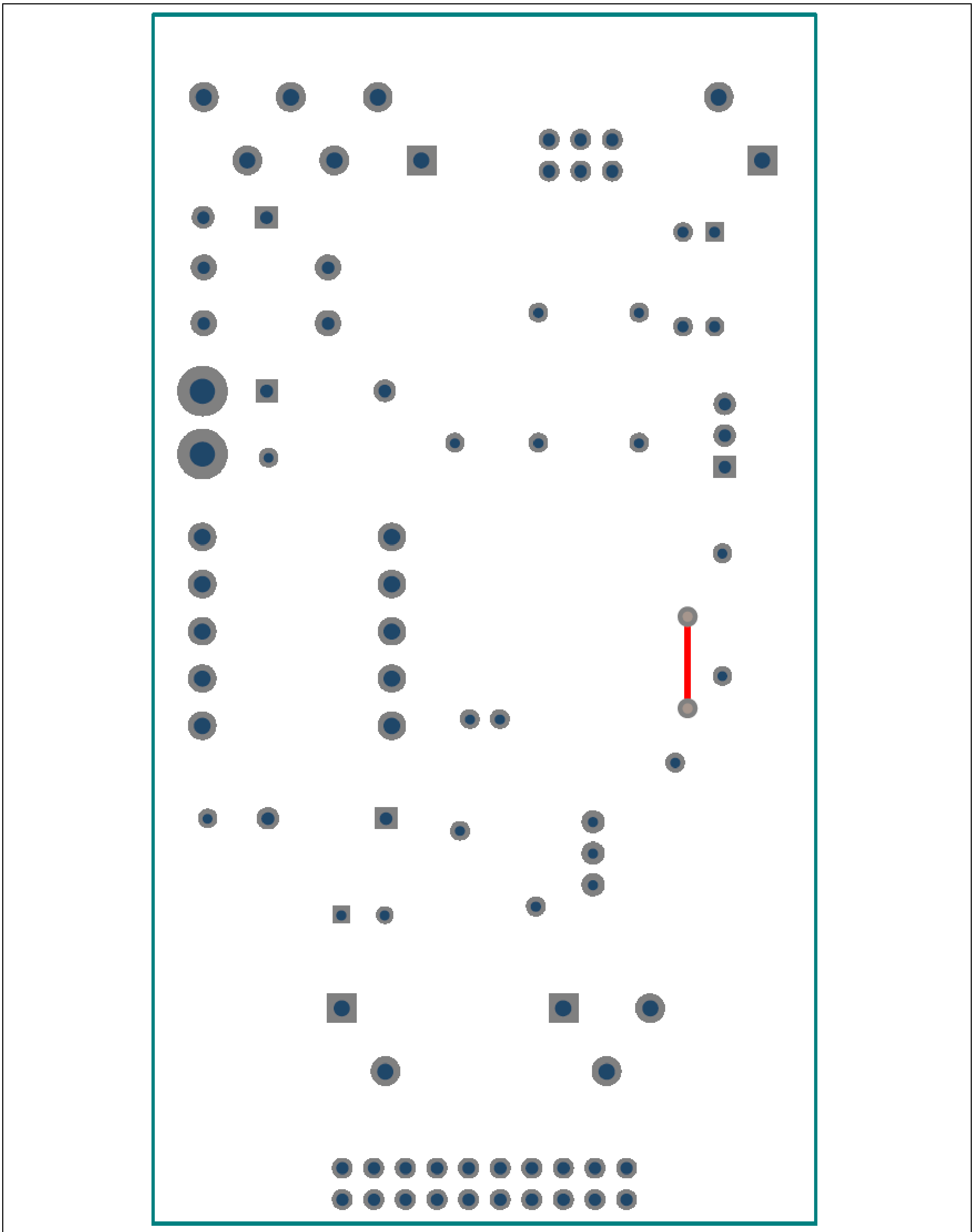


Figure 42 ILD2111 Evaluation Board Top

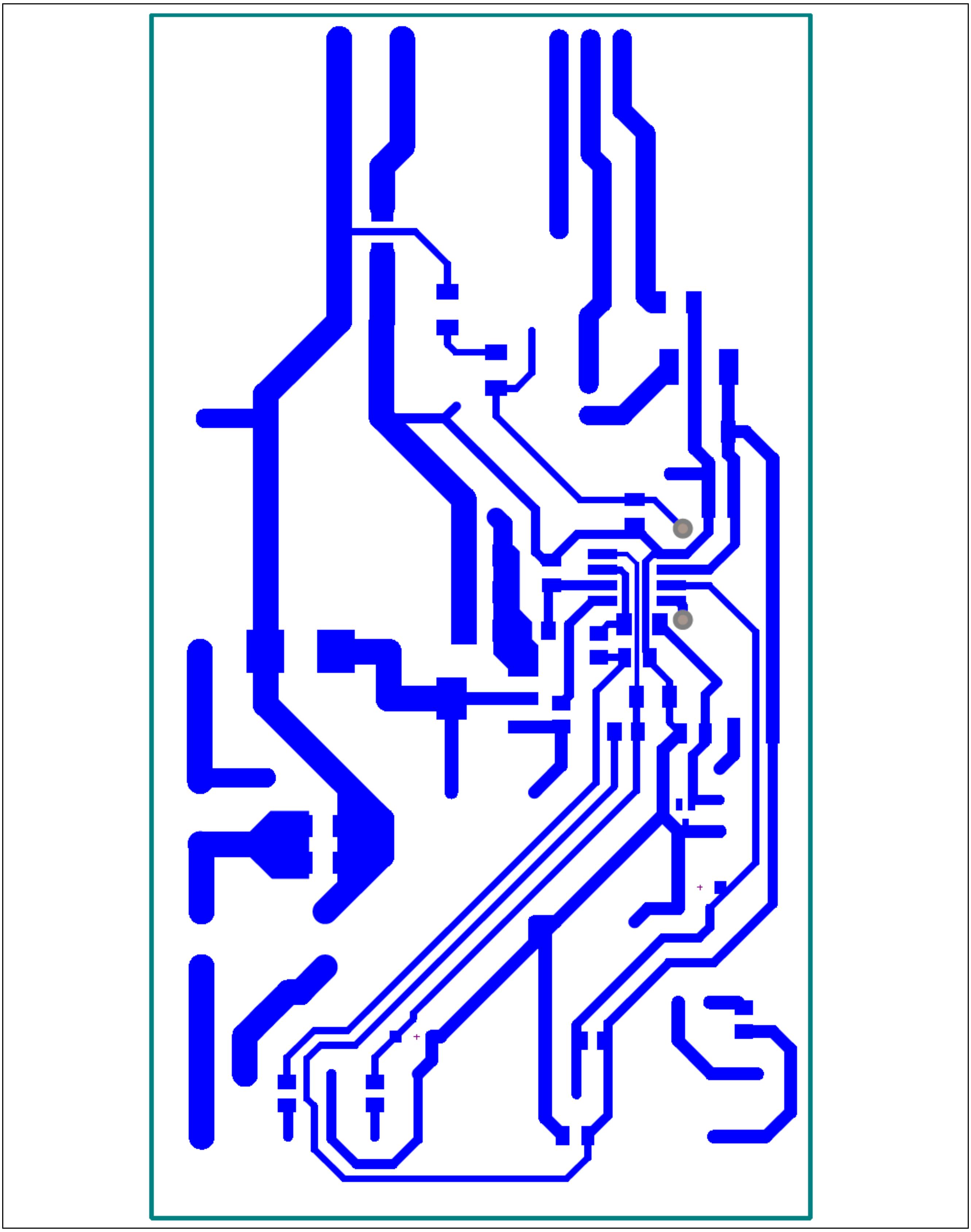


Figure 43 ILD2111 Evaluation Board Bottom

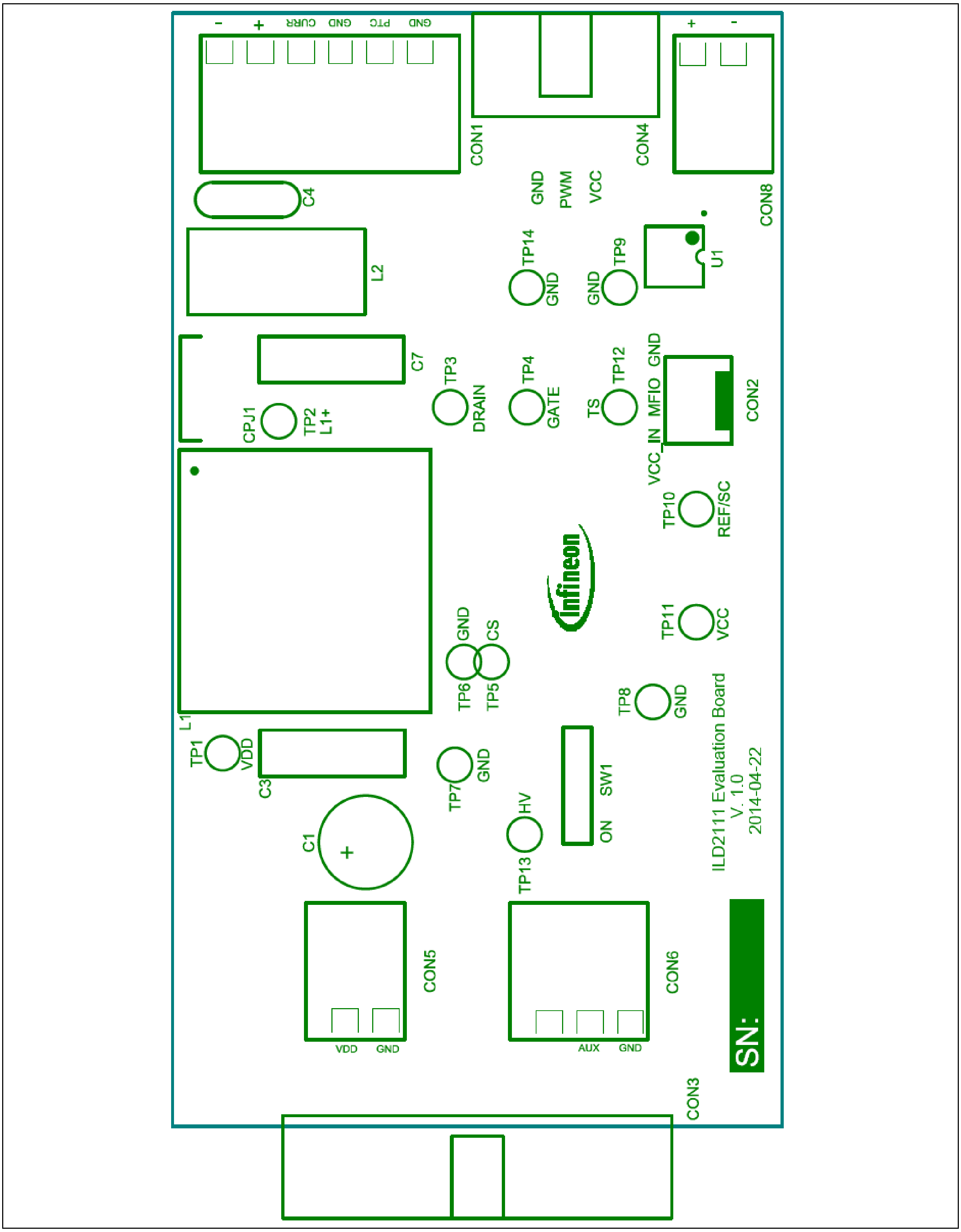


Figure 44 ILD2111 Evaluation Board Top Silkscreen

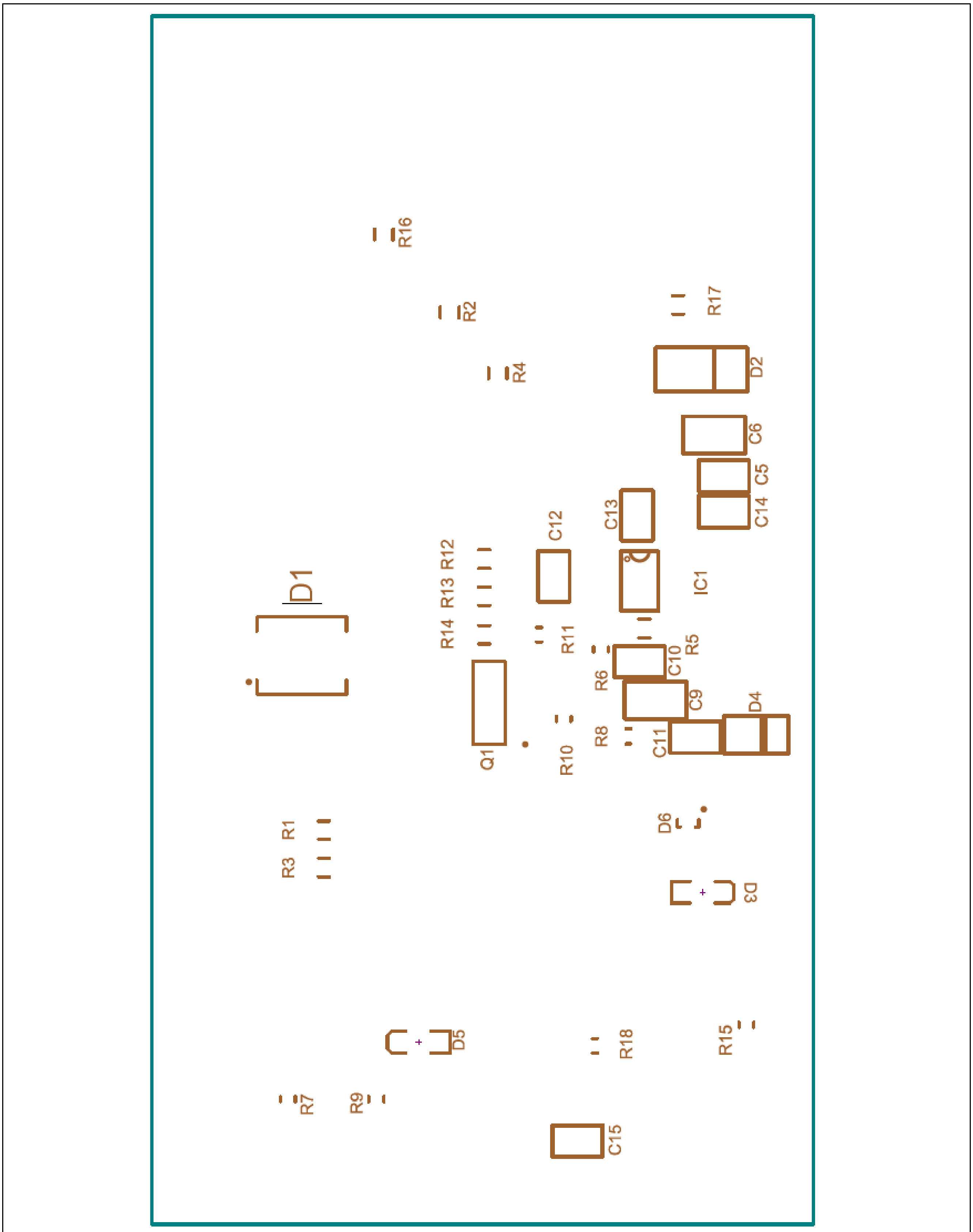


Figure 45 ILD2111 Evaluation Board Bottom Silkscreen

10 Bill of Material (BOM)

10.1 Board Components

The following **Table 8** provides a general list of the components used, while **Table 9** shows the same information, but with the components sorted in alphabetical order.

Table 8 BOM for ILD2111 Evaluation Board – General Overview

Designator	Value	Manufacturer	Part Number	Package	Description
C1	10 uF/100 V	MULTICOMP	NP100V106M8X11.5	Radial Leaded D8 mm LS3.5 mm	Non-polarized radial capacitor
C3,C7	100 nF/100 V	Xicon	140-100V9-104Z-RC	RM 9.5 mm	Ceramic disc capacitor
C4	220 nF/100 V	KEMET	C330C224K1R5TA	RM 5.08 mm	Multilayer ceramic capacitor
C5, C9, C13, C14, C15	100 nF	AVX	08055C104KAT2A	SMD 0805	X7R capacitance
C6	1 uF/50 V	TDK	C3216X7R1H105K160AB	SMD 1206	Multilayer ceramic capacitor
C10	10 nF	MULTICOMP	MC0805B103J500CT	SMD 0805	X7R capacitance
C11	100 pF	MULTICOMP	MC0805N101J500CT	SMD 0805	X7R capacitance
CON1	WURTH 6P	WURTH ELEKTRONIK	691412120006MB	3.5 mm, 45° Entry – 2.1 mm^2 wires	Screwless connector
CON2	NSL254M-3G	MPE Garry	428-1-003-0-T-KS0	3 way, 1 row, Pitch 2.54 mm	PCB Connector Header
CON3	BOX HDR RA 20 positions	WURTH ELEKTRONIK	61202021721	2.54 mm, R/A, 20 way	Header
CON4	BOX HDR RA 6 positions	WURTH ELEKTRONIK	61200621721	2.54 mm, R/A, 6 way	Header
CON5, CON8	WURTH 2P	WURTH ELEKTRONIK	691412120002MB	3.5 mm, 45° Entry – 2.1 mm^2 wires	Screwless connector

Designator	Value	Manufacturer	Part Number	Package	Description
CON6	WURTH 3P	WURTH ELEKTRONIK	691412120003MB	3.5 mm, 45° Entry – 2.1 mm² wires	Screwless connector
D1	ES3B-E3/57T, 3 A/100 V	VISHAY GENERAL SEMICONDUCTOR	ES3B-E3/57T	SMC	Ultrafast rectifier diode
D2	EGF1D 1 A/200 V	Fairchild Semiconductor	EGF1D	SMA	Fast rectifier diode
D3, D5	BZT52C3V3-7-F	DIODES INC.	BZT52C3V3-7-F	SOD-123	Zener diode, 3.3 V/0.5 W
D6	PESD12VS2UQ	NXP	PESD12VS2UQ	SOT-663	Double ESD protection diode
IC1	ILD2111	Infineon Technologies	ILD2111	PG-DSO-8-58	
L1	600 µH	WURTH ELEKTRONIK	750314734rev00		Inductor, See section 10.2
L2	2x100 µH	WURTH ELEKTRONIK	744841210		Common-Mode Power Line Choke
Q1	BSP716N	Infineon Technologies	BSP716N	SMD PG-SOT	
R1, R3	47 K/500 mW	VISHAY DRALORIC	CRCW120647K0FKEAHP	SMD 1206	High power thick film resistor
R2, R4	27 K/500 mW	TE CONNECTIVITY	CRGH1206F27K	SMD 1206	High power thick film resistor
R5, R16, R17, D4	0 R	VISHAY DRALORIC	CRCW12060000Z0EA	SMD 1206	Standard thick film resistor
R6	3K3	MULTICOMP	MC01W080513K3	SMD 0805	Thick film resistor
R7, R11	0 R	VISHAY DRALORIC	CRCW08050000Z0EA	SMD 0805	Standard thick film resistor
R8	31K6	VISHAY DRALORIC	CRCW080531K6FKEA	SMD 0805	Standard thick film resistor
R9	100 R	MULTICOMP	MCSR08X1000FTL	SMD 0805	Anti-sulfuration resistor

Designator	Value	Manufacturer	Part Number	Package	Description
R10	10 R	Vishay Dale	CRCW080510R0FKEB	SMD 0805	Standard thick film resistor
R12	1R00 1%/0.5 W	Vishay / Dale	CRCW12061R00FKEAHP	SMD 1206	High power thick film resistor
R13	1R2 1%/0.5 W	Susumu	RL1632R-1R20-F	SMD 1206	High power thick film resistor
R15	680 R/125 mW	MULTICOMP	MCSR08X6800FTL	SMD 0805	Anti-sulfuration resistor
R18	4K7	VISHAY DRALORIC	CRCW08054K70FKEA	SMD 0805	Standard thick film resistor
U1	SFH617A-3	VISHAY SEMICONDUCTOR	SFH617A-3	DIP4	Optocoupler
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14	Test point	MULTICOMP	TEST-3		Test pin
CPJ					Wire JUMPER
C12, R14	Not mounted				
SW1	SW-SPDT	WURTH ELEKTRONIK	450301014042	Through hole	Switch SPST-CO

Table 9 BOM for ILD2111 Evaluation Board – Alphabetical Order

Designator	Value	Manufacturer	Part Number	Package	Description
C1	10 uF/100 V	MULTICOMP	NP100V106M8X11.5	Radial Leaded D8 mm LS3.5 mm	Non-polarized radial capacitor
C3	100 nF/100 V	Xicon	140-100V9-104Z-RC	RM 9.5 mm	Ceramic disc capacitor
C4	220 nF/100 V	KEMET	C330C224K1R5TA	RM 5.08 mm	Multilayer ceramic capacitor
C5	100 nF	AVX	08055C104KAT2A	SMD 0805	X7R capacitance

Designator	Value	Manufacturer	Part Number	Package	Description
C6	1 uF/50 V	TDK	C3216X7R1H105K160A B	SMD 1206	Multilayer ceramic capacitor
C7	100 nF/100 V	Xicon	140-100V9-104Z-RC	RM 9.5 mm	Ceramic disc capacitor
C9	100 nF	AVX	08055C104KAT2A	SMD 0805	X7R capacitance
C10	10 nF	MULTICOMP	MC0805B103J500CT	SMD 0805	X7R capacitance
C11	100 pF	MULTICOMP	MC0805N101J500CT	SMD 0805	X7R capacitance
C12	Not mounted				
C13	100 nF	AVX	08055C104KAT2A	SMD 0805	X7R capacitance
C14	100 nF	AVX	08055C104KAT2A	SMD 0805	X7R capacitance
C15	100 nF	AVX	08055C104KAT2A	SMD 0805	X7R capacitance
CON1	WURTH 6P	WURTH ELEKTRONIK	691412120006MB	3.5 mm, 45° Entry – 2.1 mm^2 wires	Screwless connector
CON2	NSL254M-3G	MPE Garry	428-1-003-0-T-KS0	3 way, 1 row, Pitch 2.54 mm	PCB Connector Header
CON3	BOX HDR RA 20 positions	WURTH ELEKTRONIK	61202021721	2.54 mm, R/A, 20 way	Header
CON4	BOX HDR RA 6 positions	WURTH ELEKTRONIK	61200621721	2.54 mm, R/A, 6 way	Header
CON5	WURTH 2P	WURTH ELEKTRONIK	691412120002MB	3.5 mm, 45° Entry – 2.1 mm^2 wires	Screwless connector
CON6	WURTH 3P	WURTH ELEKTRONIK	691412120003MB	3.5 mm, 45° Entry – 2.1 mm^2 wires	Screwless connector
CON8	WURTH 2P	WURTH ELEKTRONIK	691412120002MB	3.5 mm, 45° Entry – 2.1 mm^2 wires	Screwless connector
CPJ					Wire JUMPER

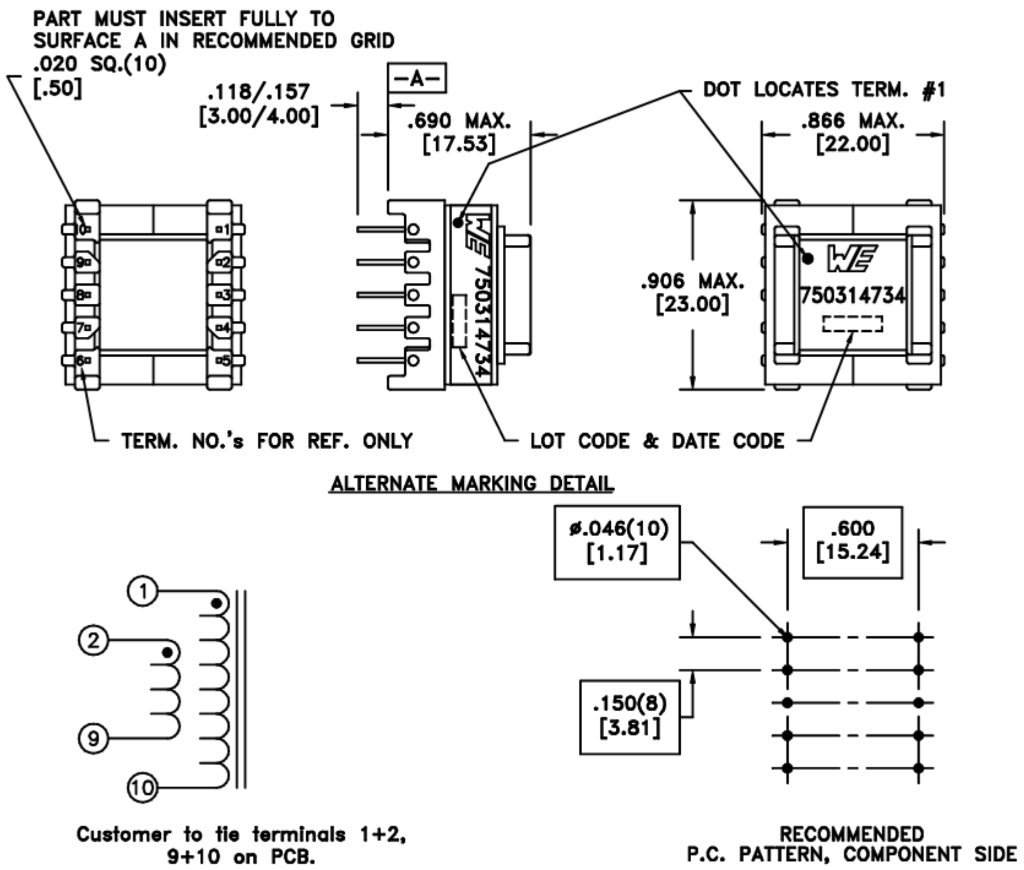
Designator	Value	Manufacturer	Part Number	Package	Description
D1	ES3B-E3/57T, 3 A/100 V	VISHAY GENERAL SEMICONDUCTOR	ES3B-E3/57T	SMC	Ultrafast rectifier diode
D2	EGF1D 1 A/200 V	Fairchild Semiconductor	EGF1D	SMA	Fast rectifier diode
D3	BZT52C3V3-7-F	DIODES INC.	BZT52C3V3-7-F	SOD-123	Zener diode, 3.3 V/0.5 W
D4	0 R	VISHAY DRALORIC	CRCW12060000Z0EA	SMD 1206	Standard thick film resistor
D5	BZT52C3V3-7-F	DIODES INC.	BZT52C3V3-7-F	SOD-123	Zener diode, 3.3 V/0.5 W
D6	PESD12VS2UQ	NXP	PESD12VS2UQ	SOT-663	Double ESD protection diode
IC1	ILD2111	Infineon Technologies	ILD2111	PG-DSO-8-58	
L1	600 µH	WURTH ELEKTRONIK	750314734rev00		Inductor, See section **10.2**
L2	2x100 µH	WURTH ELEKTRONIK	744841210		Common-Mode Power Line Choke
Q1	BSP716N	Infineon Technologies	BSP716N	SMD PG-SOT	
R1	47 K/500 mW	VISHAY DRALORIC	CRCW120647K0FKEAHP	SMD 1206	High power thick film resistor
R2	27 K/500 mW	TE CONNECTIVITY	CRGH1206F27K	SMD 1206	High power thick film resistor
R3	47 K/500 mW	VISHAY DRALORIC	CRCW120647K0FKEAHP	SMD 1206	High power thick film resistor
R4	27 K/500 mW	TE CONNECTIVITY	CRGH1206F27K	SMD 1206	High power thick film resistor
R5	0 R	VISHAY DRALORIC	CRCW12060000Z0EA	SMD 1206	Standard thick film resistor
R6	3K3	MULTICOMP	MC01W080513K3	SMD 0805	Thick film resistor

Designator	Value	Manufacturer	Part Number	Package	Description
R7	0 R	VISHAY DRALORIC	CRCW08050000Z0EA	SMD 0805	Standard thick film resistor
R8	31K6	VISHAY DRALORIC	CRCW080531K6FKEA	SMD 0805	Standard thick film resistor
R9	100 R	MULTICOMP	MCSR08X1000FTL	SMD 0805	Anti-sulfuration resistor
R10	10 R	Vishay Dale	CRCW080510R0FKEB	SMD 0805	Standard thick film resistor
R11	0 R	VISHAY DRALORIC	CRCW08050000Z0EA	SMD 0805	Standard thick film resistor
R12	1R00 1%/0.5 W	Vishay / Dale	CRCW12061R00FKEAHP	SMD 1206	High power thick film resistor
R13	1R2 1%/0.5 W	Susumu	RL1632R-1R20-F	SMD 1206	High power thick film resistor
R14	Not mounted				
R15	680 R/125 mW	MULTICOMP	MCSR08X6800FTL	SMD 0805	Anti-sulfuration resistor
R16	0 R	VISHAY DRALORIC	CRCW12060000Z0EA	SMD 1206	Standard thick film resistor
R17	0 R	VISHAY DRALORIC	CRCW12060000Z0EA	SMD 1206	Standard thick film resistor
R18	4K7	VISHAY DRALORIC	CRCW08054K70FKEA	SMD 0805	Standard thick film resistor
SW1	SW-SPDT	WURTH ELEKTRONIK	450301014042	Through hole	Switch SPST-CO
TP1	Test point	MULTICOMP	TEST-3		Test pin
TP2	Test point	MULTICOMP	TEST-3		Test pin
TP3	Test point	MULTICOMP	TEST-3		Test pin
TP4	Test point	MULTICOMP	TEST-3		Test pin
TP5	Test point	MULTICOMP	TEST-3		Test pin
TP6	Test point	MULTICOMP	TEST-3		Test pin

Designator	Value	Manufacturer	Part Number	Package	Description
TP7	Test point	MULTICOMP	TEST-3		Test pin
TP8	Test point	MULTICOMP	TEST-3		Test pin
TP9	Test point	MULTICOMP	TEST-3		Test pin
TP10	Test point	MULTICOMP	TEST-3		Test pin
TP11	Test point	MULTICOMP	TEST-3		Test pin
TP12	Test point	MULTICOMP	TEST-3		Test pin
TP13	Test point	MULTICOMP	TEST-3		Test pin
TP14	Test point	MULTICOMP	TEST-3		Test pin
U1	SFH617A-3	VISHAY SEMICONDUCTOR	SFH617A-3	DIP4	Optocoupler

10.2 Inductor Specification

CUSTOMER TERMINAL	RoHS	LEAD(Pb)–FREE
Sn96%, Ag4%	Yes	Yes



ELECTRICAL SPECIFICATIONS @ 25°C unless otherwise noted:

PARAMETER		TEST CONDITIONS	VALUE
D.C. RESISTANCE	1–10	@20°C Tie(1+2, 9+10)	0.24 ohms ±10%
INDUCTANCE	1–10	10kHz, 100mVAC, Ls Tie(1+2, 9+10)	600uH ±5%
SATURATION CURRENT		20% rolloff from initial	1.1A min.
DIELECTRIC	1–Core	500VAC, 1 second Tie(1+2, 9+10)	–

GENERAL SPECIFICATIONS:
OPERATING TEMPERATURE RANGE: −40°C to +125°C including temp rise.

CURRENT RATING: 1.1A

Figure 46 Inductor Specification

11 References

[1] ILD2111 Data Sheet
[2] ILD2111 Design Guide
[3] .dp vision User Manual
[4] ILD2111 Evaluation System Test Report
[5] ILD2111 Evaluation System Getting Started

Revision History

Major changes since the last revision

Page or Reference	Description of change
	Initial version

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