

48 W PoE-enabled smart LED driver evaluation board with IEEE 802.3bt PoE-PD interface, high power LED driver and Bluetooth module

Introduction

The **STEVAL-POEL45W1** Power over Ethernet (PoE) powered LED driver reference design delivers a power output of 45 W and dims LEDs down to 1% of the maximum brightness without any flicker. The solution supports remote dimming control via Bluetooth with the **PoE_Lighting** Android application (available on [Google Play](#)).

You can use this reference design to develop complete indoor network-powered lighting solutions with IP-based Powered Devices (PDs), without additional AC power infrastructure, and extend the functionality to include remote data management via existing LAN networks.

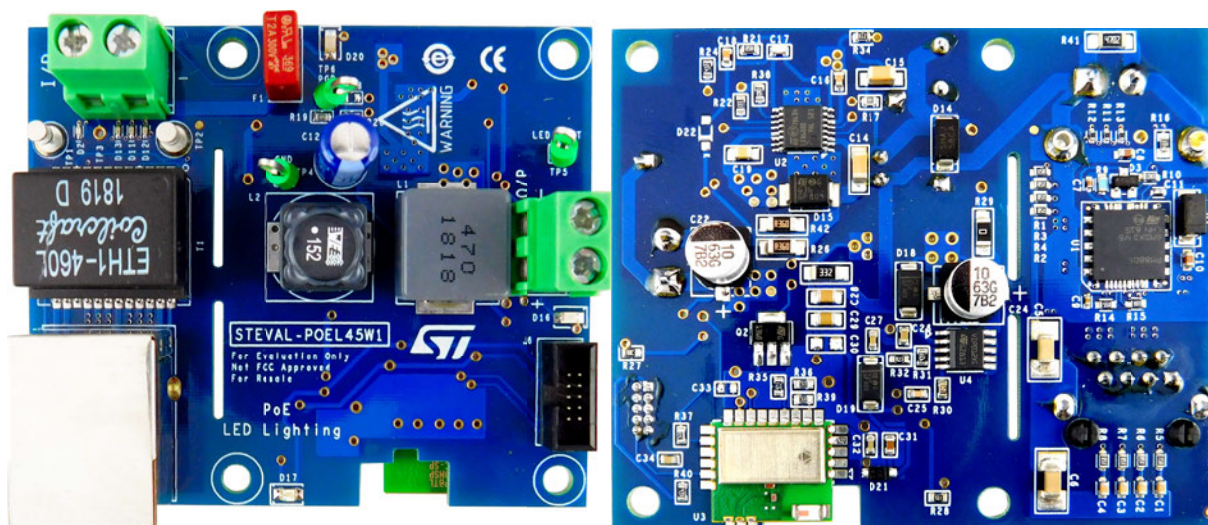
The reference design features a highly integrated **PM8805** IEEE802.3bt-compliant Powered Device (PD) PoE interface, a high efficiency **LED6000** LED driver able to source up to 3 A_{DC} current, and a certified **SPBTLE-1S** Bluetooth Low Energy module, compliant with BT specifications v4.2 and BQE qualified.

For new design, the **BLUENRG-M2SA** module for Bluetooth® low energy v5.2 is recommended.

SPBTLE-1S and **BLUENRG-M2SA** are pin to pin compatible.

The **STSW-POEL45FW** board firmware is programmed via the **STSW-BNRG1STLINK** utility.

Figure 1. STEVAL-POEL45W1 evaluation board top and bottom



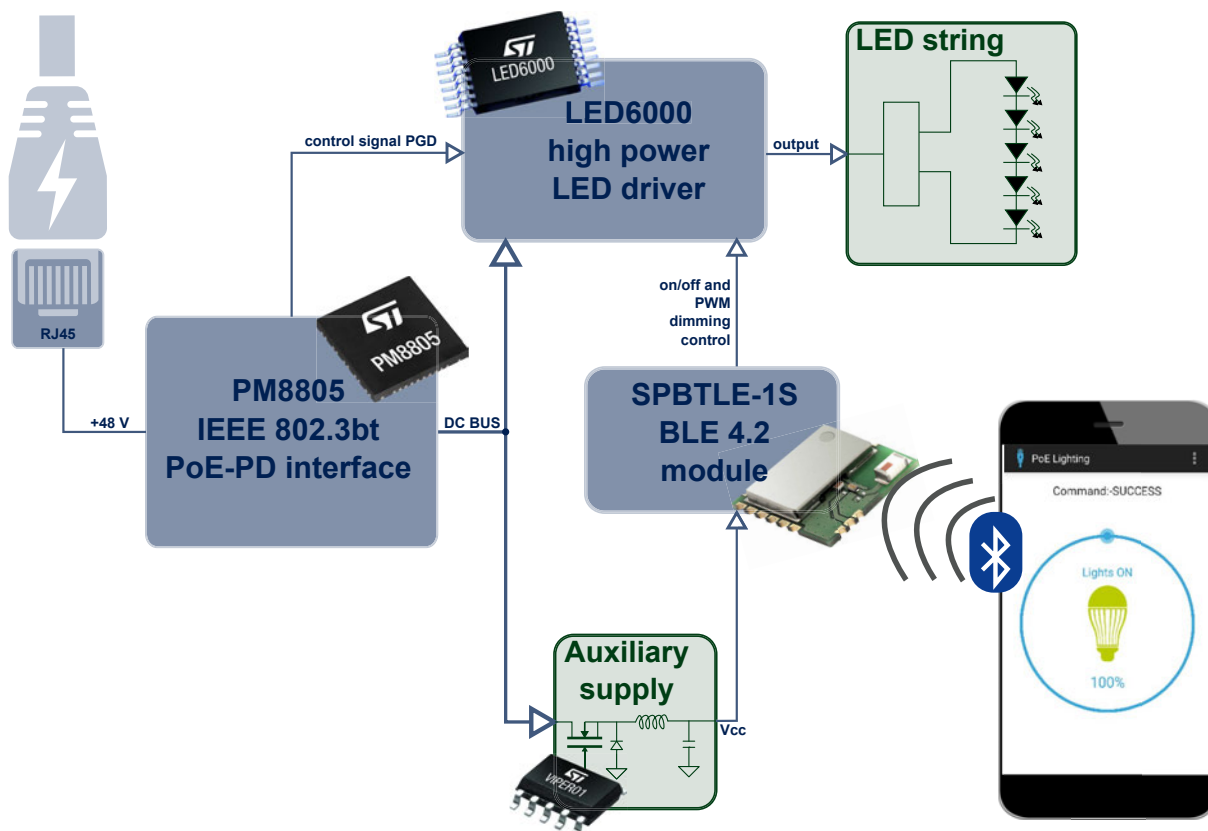
1 STEVAL-POEL45W1 evaluation board overview

1.1 Features

- PoE-PD IEEE 802.3af/at/bt compliant
- Constant current output, working in buck topology
- Output current – 1.4 A with < 0.05% current regulation
 - Number of LEDs connected at output: 6 – 11 white LEDs (3.3 V each)
- Wireless ON/OFF and dimming control with [PoE_Lighting](#) Android application
- Digital dimming with 1% resolution
- LED driver input voltage range 37 – 57 V_{DC}
- Peak efficiency at maximum load > 95%
- Low standby power consumption < 100 mW
- Comprehensive set of protections:
 - open/no-load circuit protection
 - short/overload circuit protection
- RoHS compliant
- WEEE compliant

1.2 Block diagram

Figure 2. STEVAL-POEL45W1 block diagram



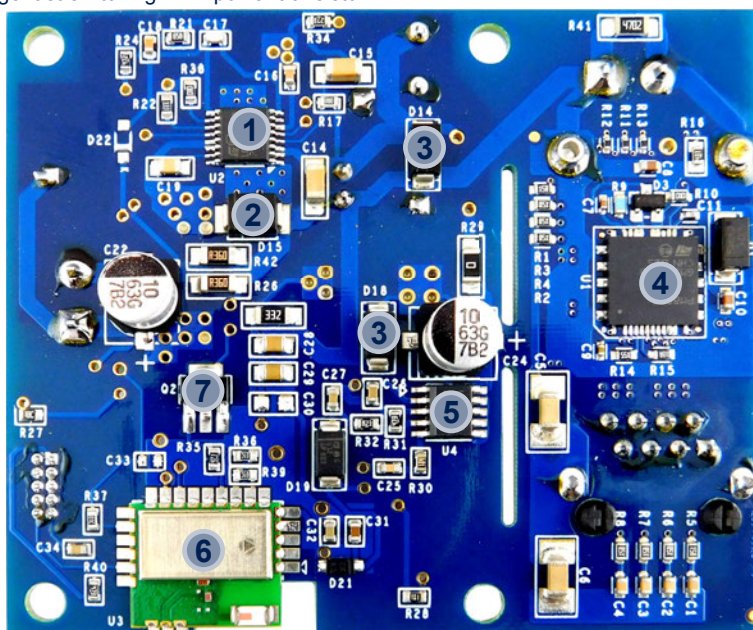
1.3 Key devices

Figure 3. STEVAL- POEL45W1 bottom view with key devices

1. **LED6000**: step-down monolithic switching regulator designed for high power LED driving. Includes overheating, overcurrent and output short-circuit protection and controls the brightness of the LED.
2. **STPS3L60U**: Power Schottky rectifier suitable for switch mode power supplies and high frequency DC to DC converters.
3. **STTH102A**: high efficiency ultrafast diode suitable for power supplies and other power switching applications.
4. **PM8805**: IEEE 802.3bt PoE-PD interface with embedded dual active bridge. The device performs IEEE802.3bt physical layer classification for PSE type indication and stabilizes the differential voltage into a stable DC voltage.
5. **VIPER012XS**: intelligent high voltage converter used to regulate the supply voltage of the SPBTLE-1S BLE module.
6. **SPBTLE-1S** is a Bluetooth® Low Energy SoC application processor certified module, compliant with BT specifications v4.2 and BQE qualified.

Note: For new design **BLUENRG-M2SA** is recommended.

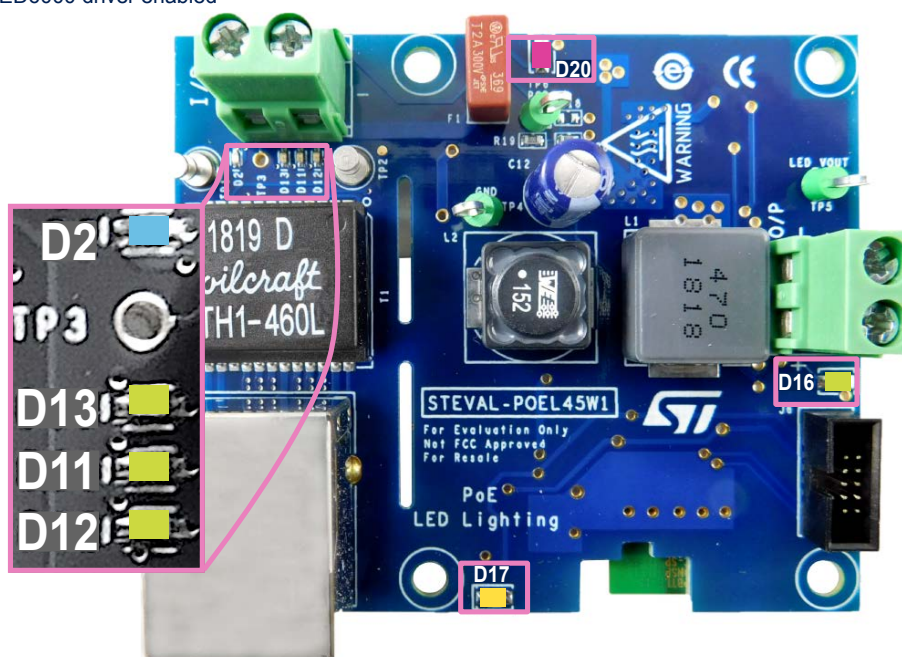
7. **2STF1360**: low voltage fast-switching NPN power transistor.



1.4 Status LEDs

Figure 4. STEVAL-POEL45W1 top view with status LEDs

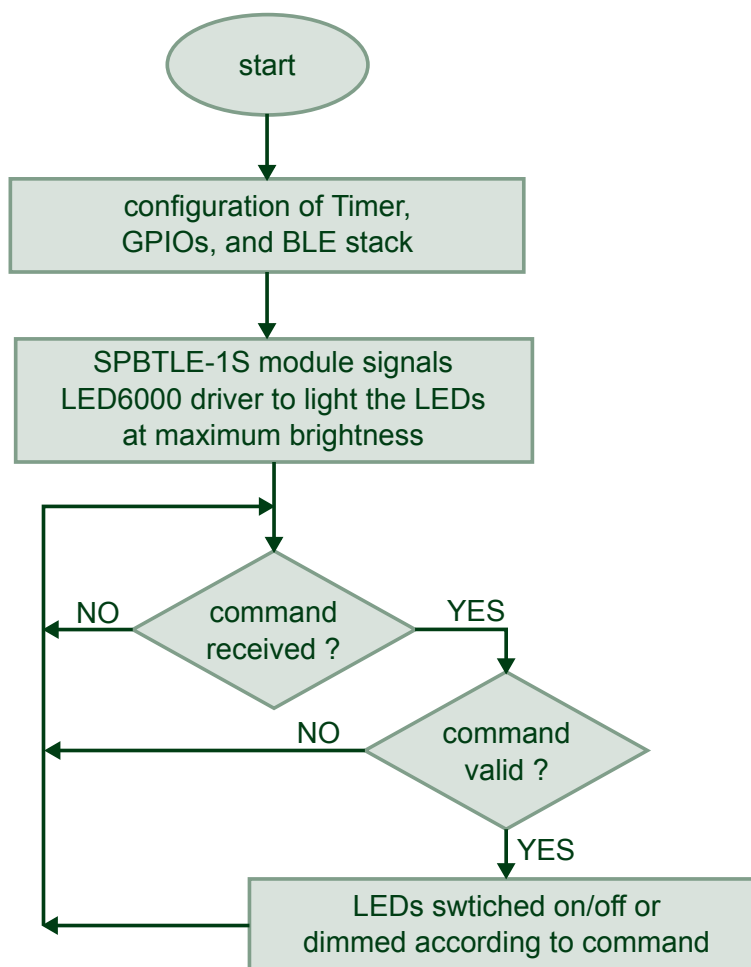
- D2 (Blue): stable DC voltage generated by PM8805
- D11, D12, D13 (Green): Power Sourcing Equipment (PSE) type
- D17 (Yellow): V_{CC} for SPBTLE-1S
- D20 (Red): Input voltage to LED6000
- D16 (Green): LED6000 driver enabled



1.5 Firmware implementation

The SPBTLE-1S Bluetooth® Low Energy module includes a microcontroller which allows the BLE module to assume smart master and slave device roles simultaneously.

Figure 5. STEVAL-POEL45W1 firmware flow chart



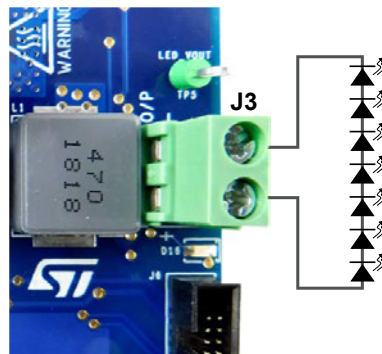
2 Setup and operation

2.1 How to connect your LED string and power the board

Follow the procedure below to connect your LED string and Ethernet power supply.

- Step 1.** Connect your LED string to the 2-terminal connector J3 on the board.
You can connect between 6 and 11 white LEDs (3.3 V each)

Figure 6. J3 connector for LED load



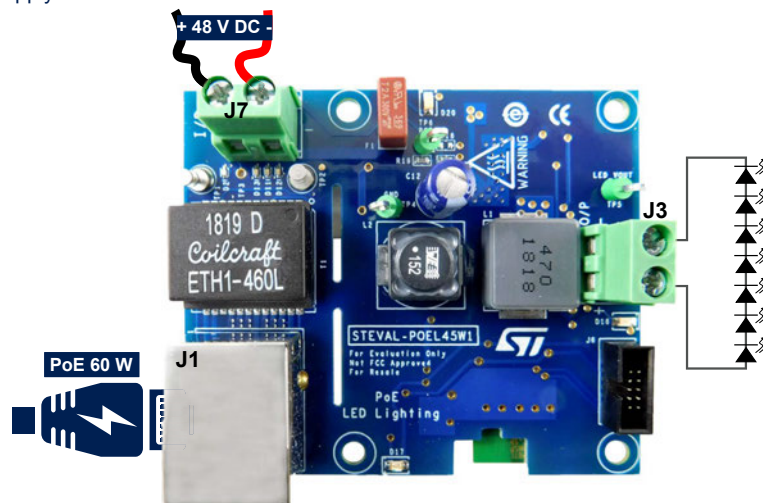
- Step 2.** Supply power to the board in one of the following ways:
- If you have a PoE-enabled cable in a network that can supply 60 W of power, connect the Ethernet cable to the RJ45 8-pin connector J1.

Note: *If the Ethernet cable is not PoE-enabled or the LAN cannot supply adequate power: you can introduce a PSE (Power Sourcing Equipment) with adequate power rating (e.g. Microsemi PD-9501GR, or equivalent) between a non-PoE Ethernet switch and the PD (Powered Device).*

- If you cannot or do not wish to supply power via Ethernet, connect a 48 V DC source to connector J7 on the board.

Figure 7. Power supply options at J1 or J7

PoE power supply providing 60 W at J1
OR
48 V DC power supply at J7



Once the board is appropriately powered and the load is connected, the LED driver delivers 100% brightness.

You can then establish a Bluetooth connection with the board and use an Android application to remotely control LED dimming and on and off switching.

2.2 How to use the PoE Lighting Android application

Your mobile device must have Android version 6.0 or above to use the app.

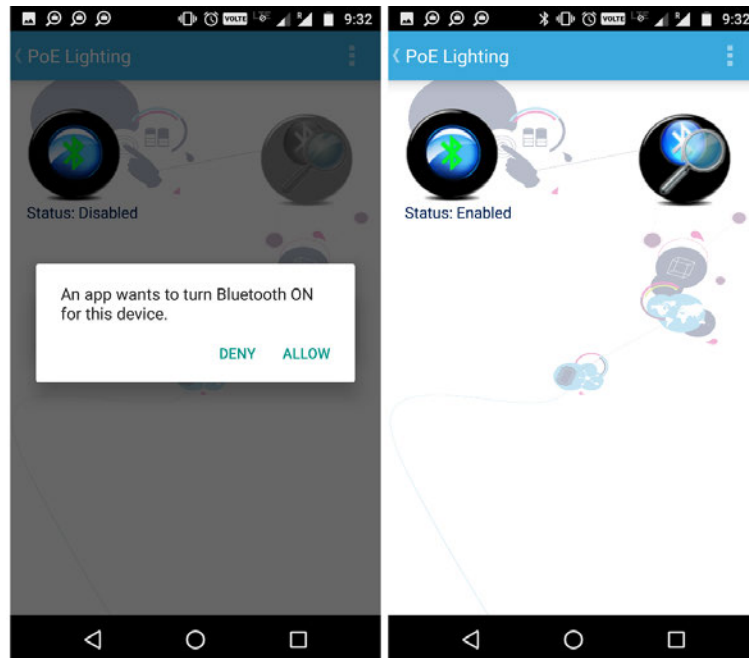
- Step 1.** Download and install the [PoE Lighting](#) app from the Google Play store.
The app allows you to remotely control the following LED functions on the board:
- ON and OFF
 - brightness level with 1% resolution
- Step 2.** Open the app on your mobile device.

Figure 8. PoE Lighting Android app first page



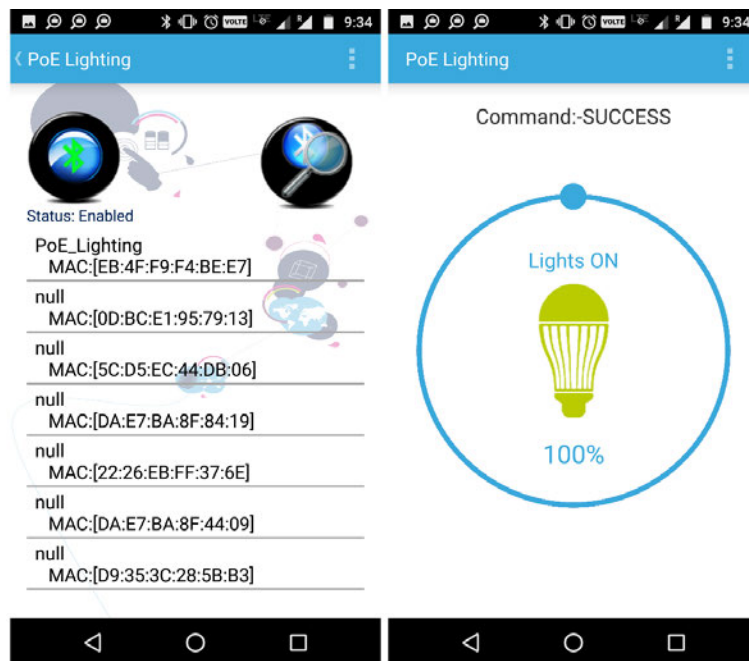
- Step 3.** Click on the Bluetooth icon and then click **[ALLOW]**
This enables Bluetooth on your device if it isn't already on.

Figure 9. Enable Bluetooth on your mobile device



- Step 4.** Click the search icon and select PoE_Lighting device from the list.

Figure 10. Select the PoE Lighting device to establish connection



- Step 5.** Use the following functions to control the LEDs attached to the board:
- Click on the bulb icon to turn the LEDs on and off
 - Drag the blue dot around the circular slider to adjust the brightness level

- Step 6.** Click [**Disconnect**] from the overflow menu.
You need to disconnect to end a session or if you wish to connect to a different LED driver board.

Figure 11. PoE Lighting Android app first page



3

Schematic diagrams

Figure 12. STEVAL-POEL45W1 board schematic (1 of 2)

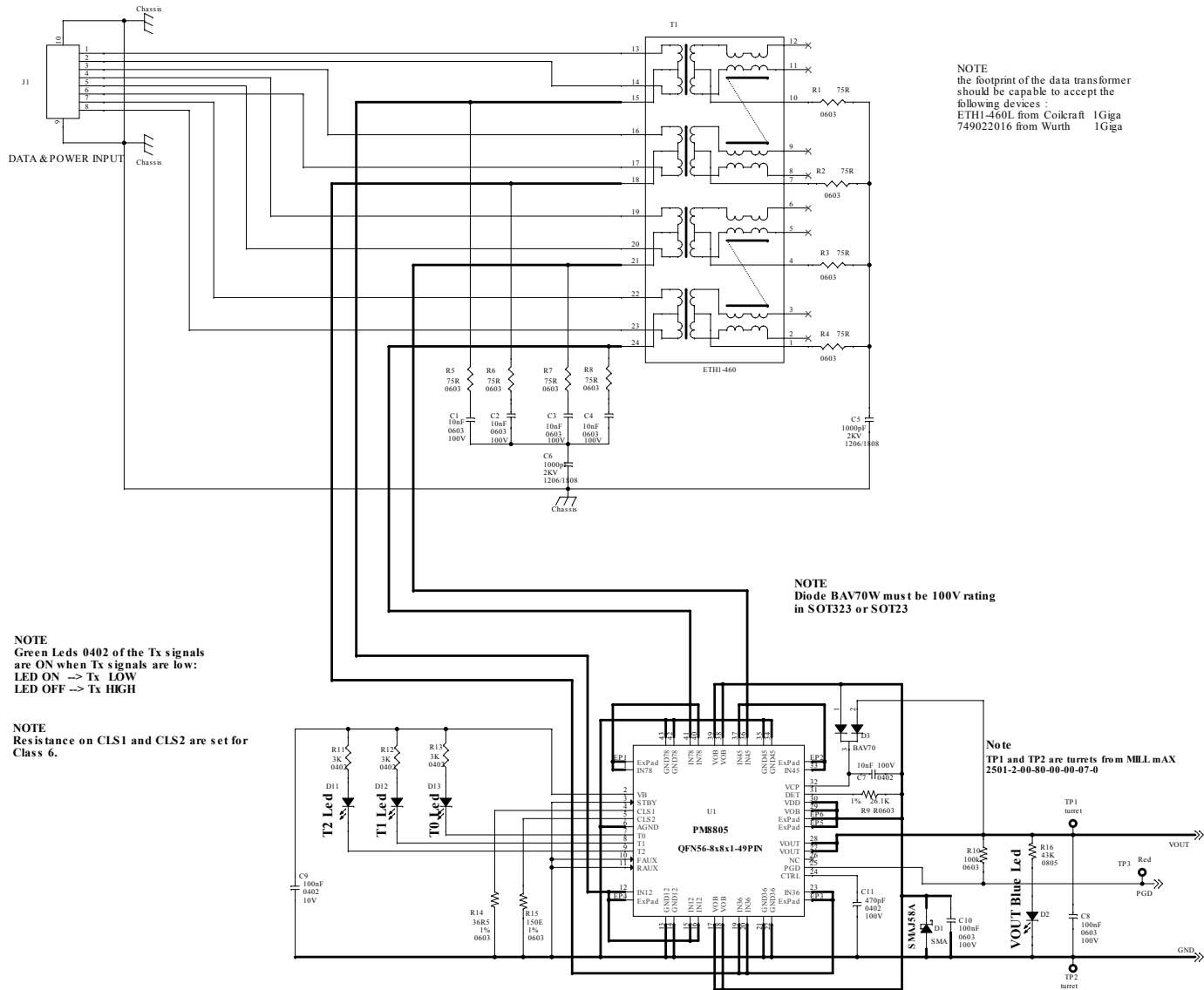
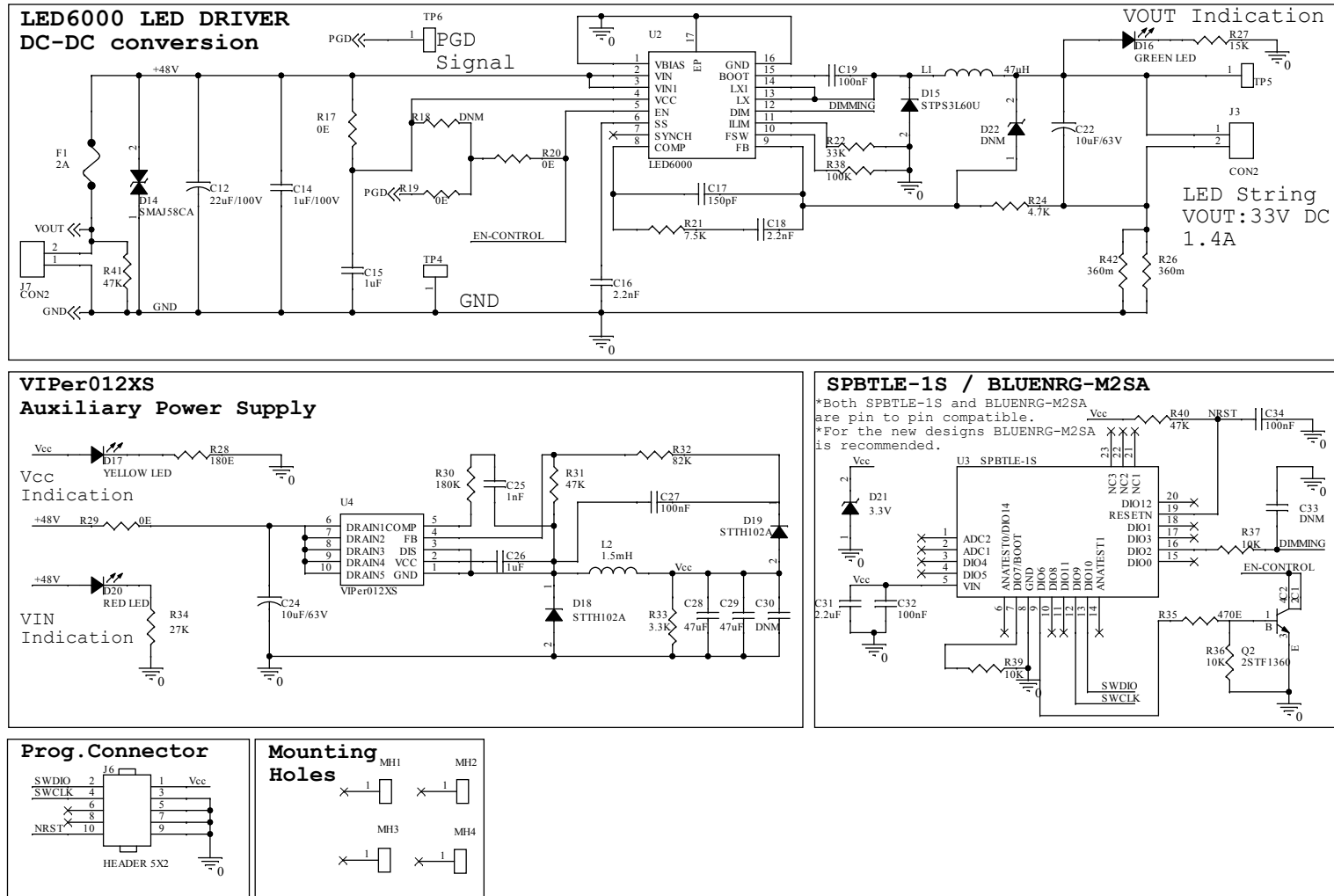


Figure 13. STEVAL-POEL45W1 board schematic (2 of 2)



4 Bill of materials

Table 1. STEVAL-POEL45W1 bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	U1	QFN56-8x8 x1-49PIN	IEEE802.3bt PoE- PD interface with integrated dual-active-bridge	ST	PM8805TR
2	1	U2	HTSSOP16	3 A, 61 V monolithic current source with dimming capability	ST	LED6000PHR
3	1	U3	SMD	Very low power application module for Bluetooth® Smart v4.2	ST	SPBTLE-1S and BLUENRG-M2SA are pin to pin compatible. For new designs BLUENRG-M2SA is recommended.
4	1	U4	SSOP10	Low voltage energy saving fixed frequency high voltage converter	ST	VIPER012XSTR
5	1	D1	58 V SMA	400 W TVS in SMA	ST	SMAJ58A-TR
6	1	Q2	SOT-89	Low voltage fast- switching NPN power transistors	ST	2STF1360
7	2	D18,D19	1 A/200 V SMA	200 V ultrafast recovery diode	ST	STTH102A
8	1	D15	3 A/60 V SMB	Low drop power Schottky rectifier	ST	STPS3L60U
9	1	D14	58 V SMA	400 W TVS in SMA	ST	SMAJ58CA-TR
10	4	C1, C2, C3, C4	10 nF 100 V ±10% SMD-0603 X7R	Ceramic capacitor	Kemet	C0603C103K1RACTU
11	1	C7	10 nF 100 V ±10% SMD-0402	Ceramic capacitor	TDK	C1005X7S2A103K050BB
12	2	C5, C6	1000 pF 2 KV ±10% SMD1206-1 808	Ceramic capacitor	TDK	C4520X7R3D102K130KA
13	3	C27, C32, C34	100 nF 25 V ±10% SMD-0603	Ceramic capacitor	Any	
14	1	C19	100 nF 50 V ±10% SMD-0805	Ceramic capacitor	Any	
15	1	C9	100 nF 16 V ±10% SMD-0402	Ceramic capacitor	Murata	GRM155R71C104KA88D
16	2	C8, C10	100 nF 100 V ±10% SMD-0603	Ceramic capacitor	Murata	GRM188R72A104KA35D

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
17	1	C11	470 pF 100 V $\pm 10\%$ SMD-0402	Ceramic capacitor	Murata	GRM155R72A471KA01D
18	1	C12	22 μ F 100 V $\pm 20\%$ through hole	Electrolytic capacitor	Nichicon	UVR2A220MED
19	2	C14, C15	1 μ F 100 V $\pm 10\%$ SMD-1206	Ceramic capacitor	Any	
20	1	C26	1 μ F 25 V $\pm 10\%$ SMD-0603	Ceramic capacitor	Any	
21	2	C16, C18	2.2 nF 25 V $\pm 10\%$ SMD-0603	Ceramic capacitor	Any	
22	1	C17	150 pF 25 V $\pm 10\%$ SMD-0603	Ceramic capacitor	Any	
23	2	C22, C24	10 μ F 63 V $\pm 20\%$ SMD	Electrolytic capacitor	Kemet	EDK106M063A9GAA
24	1	C25	1 nF 2 KV $\pm 10\%$ SMD-0603	Ceramic capacitor	Any	
25	2	C28, C29	47 μ F 10V $\pm 20\%$ SMD-0805	Ceramic capacitor	Any	
26	1	C31	2.2 μ F 16V $\pm 10\%$ SMD-0603	Ceramic capacitor	Any	
27	2	C30, C33	DNM			
28	1	D22	DNM			
29	1	D2	VOUT SMD-0402	Blue LED	Kingbright	KPHHS-1005QBC-D-V
30	1	D3	100 V SOT23	Dual switching diode common cathode	OnSemiconductors	BAV70LT3G
31	1	D11	2.1 V/20 mA SMD-0402	Low power green LED	Kingbright	KPHHS-1005MGCK
32	1	D12	2.1 V/20 mA SMD-0402	Low power green LED	Kingbright	KPHHS-1005MGCK
33	1	D13	2.1 V/20 mA SMD-0402	Low power green LED	Kingbright	KPHHS-1005MGCK
34	1	D16	2.2 V/20 mA SMD-0805	Green LED	Osram opto semiconductors Inc.	LG R971-KN-1
35	1	D17	2.2 V/20 mA SMD-0805	Yellow LED	Lite-on Inc.	LTST-C171YKT
36	1	D20	1.8 V/20 mA SMD-0805	Red LED	Osram opto semiconductors Inc.	LH R974-LP-1
37	1	D21	3.3 V 0.5 W $\pm 5\%$ SOD-123	Zener diode	Vishay Semiconductors	MMSZ4684-E3-08

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
38	1	F1	2 A 300 V	Fuse	Littlefuse	36912000000
39	1	J1	RJ45-8 pins	Conn MOD jack 8P8C R/A shielded	Stewart connector	SS-7188S-A-NF
40	2	J3, J7	CON2 10 A/300 V	Fixed terminal blocks 2P 5.08 mm	Phoenix Contact	651-1888687
41	1	J6	5x2 through hole	Box header	CNC Tech	3220-10-0100-00
42	1	L1	47 μ H 6.5 A $\pm$ 20% SMD	Fixed inductors	Bourns Inc.	SRP1265A-470MCT-ND
43	1	L2	1.5 mH 0.32 A SMD	Fixed inductors	Würth Electronics	710-7687714152
44	4	MH1, MH2, MH3, MH4		Mounting holes	Any	
45	1	R18	SMD-0603	Thick film resistors (DNM)		
46	1	R38	100 K SMD-0603	Thick film resistors	Any	
47	8	R1, R2, R3, R4, R5, R6, R7, R8	75 R 63 mW $\pm$ 1% SMD-0603	Thick film resistors	Multicomp	MC0063W0603175R
48	1	R9	26.1 K 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	Panasonic	ERJ3EKF2612V
49	1	R10	100 K 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	TE Connectivity	CRG0603F100K
50	3	R11, R12, R13	3 K 63 mW $\pm$ 1% SMD-0402	Thick film resistors	Yageo	RC0402FR-073KL
51	1	R14	36R5 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	Panasonic	ERJ3EKF36R5V
52	1	R15	150E 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	Any	
53	1	R16	43 K 0.1 W $\pm$ 1% SMD-0805	Thick film resistors	Multicomp	MC01W0805143K
54	3	R17, R19, R20	0E 0.1 W $\pm$ 5% SMD-0603	Thick film resistors	Any	
55	1	R29	0E 0.25 W $\pm$ 5% SMD-1206	Thick film resistors	Any	
56	1	R21	7.5 K 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	Any	
57	1	R22	33 K 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	Any	
58	1	R24	4.7 K 0.1 W $\pm$ 1% SMD-0603	Thick film resistors	Any	

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
59	1	R26, R42	360m 0.25 W $\pm 1\%$ SMD-1206	Thick film resistors	Yageo	RL1206FR-070R36L
60	1	R27	15 K 0.1 W $\pm 5\%$ SMD-0603	Thick film resistors	Any	
61	1	R28	180E 0.1 W $\pm 5\%$ SMD-0603	Thick film resistors	Any	
62	1	R30	180 K 0.1 W $\pm 1\%$ SMD-0603	Thick film resistors	Any	
63	1	R31	47 K 0.1 W $\pm 1\%$ SMD-0603	Thick film resistors	Any	
64	1	R32	82 K 0.1 W $\pm 1\%$ SMD-0603	Thick film resistors	Any	
65	1	R33	3.3 K 0.25 W $\pm 5\%$ SMD-1206	Thick film resistors	Any	
66	1	R34	27 K 0.1 W $\pm 5\%$ SMD-0603	Thick film resistors	Any	
67	1	R35	470E 0.1 W $\pm 5\%$ SMD-0603	Thick film resistors	Any	
68	3	R36, R37, R39	10 K 0.1 W $\pm 5\%$ SMD-0603	Thick film resistors	Any	
69	1	R41	47 K 0.25 W $\pm 5\%$ SMD-1206	Thick film resistors	Any	
70	1	R40	47 K 0.1 W $\pm 5\%$ SMD-0603	Thick film resistors	Any	
71	2	TP1, TP2	PIN-2501-2	Turret	MILL-MAX	2501-2-00-80-00-00-07-0
72	4	TP3, TP4, TP5, TP6	Through hole	Test points	Keystone Electronics	36-5126-ND
73	1	T1		Transformer	Coilcraft	ETH1-460

5 Test results for STEVAL-POEL45W1 evaluation board

5.1 Test setup

The following results are based on input DC power supply with R18 mounted as zero ohm and R19 not mounted. The frequency of operation is 375 KHz. All the input and output readings were taken with the YOKOGAWA WT310 Power Analyzer.

The input DC power is supplied through connector J7 on the board and the LED load is connected through connector J7.

5.2 Performance results

Figure 14. Input voltage vs efficiency at different loads

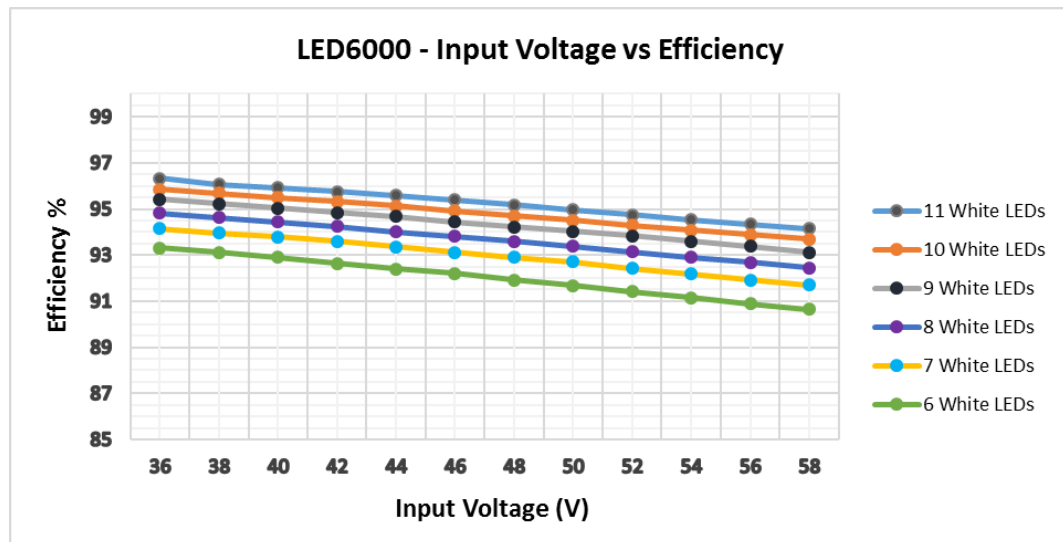


Figure 15. Input voltage vs output current at different loads

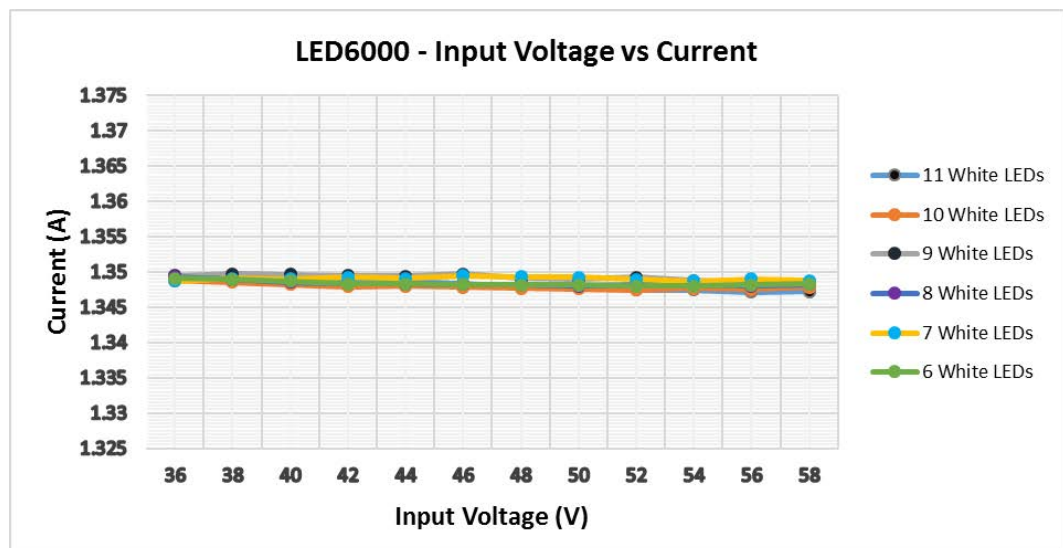
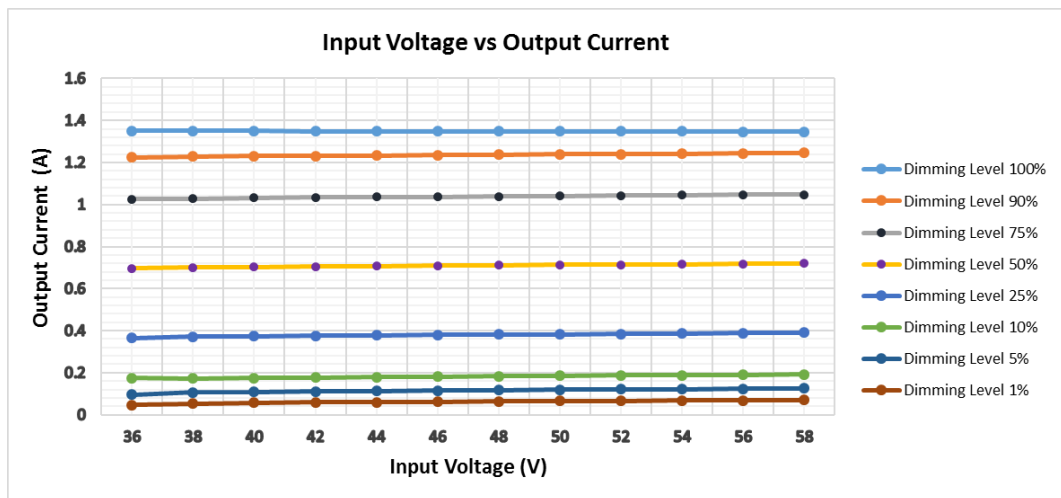


Figure 16. Input voltage vs output current at different brightness levels



5.3 Circuit protection tests

Figure 17. Short-circuit protection behavior

Pink waveform is the output voltage
Green waveform is the inductor current



Figure 18. Open circuit protection behavior

Pink waveform is the output voltage
Green waveform is the inductor current



5.4 Typical waveforms

The STEVAL-POEL45W1 evaluation board waveforms of the Output Voltage and the Inductor current are shown below:

Figure 19. Output voltage vs inductor current at 40 V DC

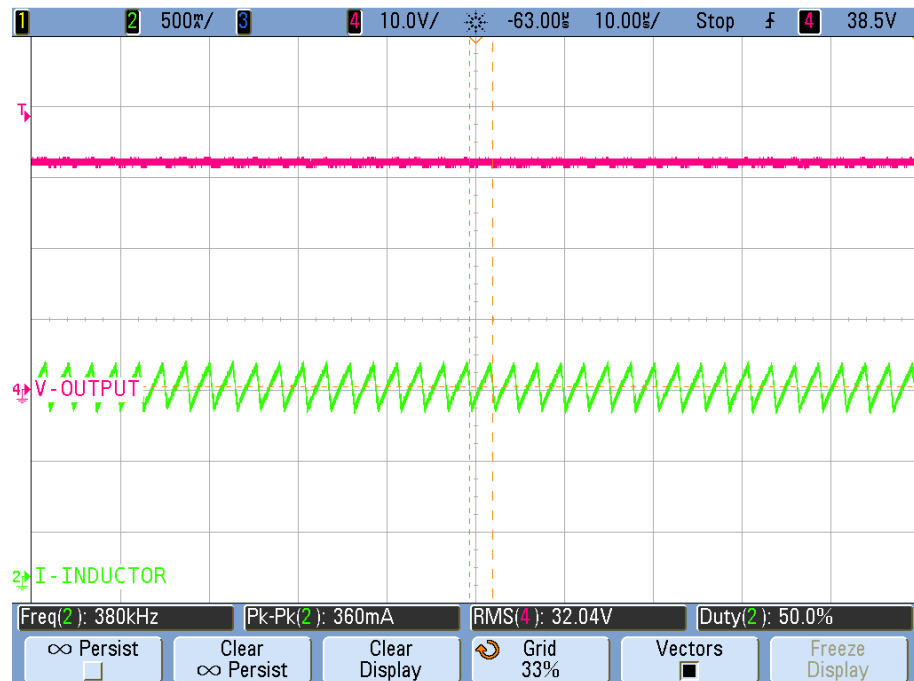


Figure 20. Output voltage vs inductor current at 48 V DC

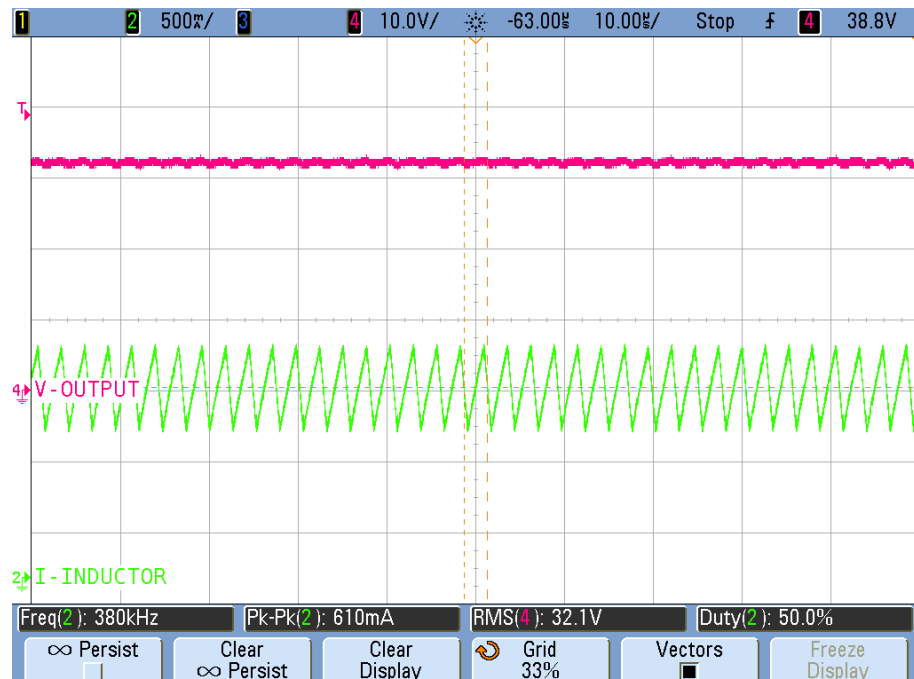
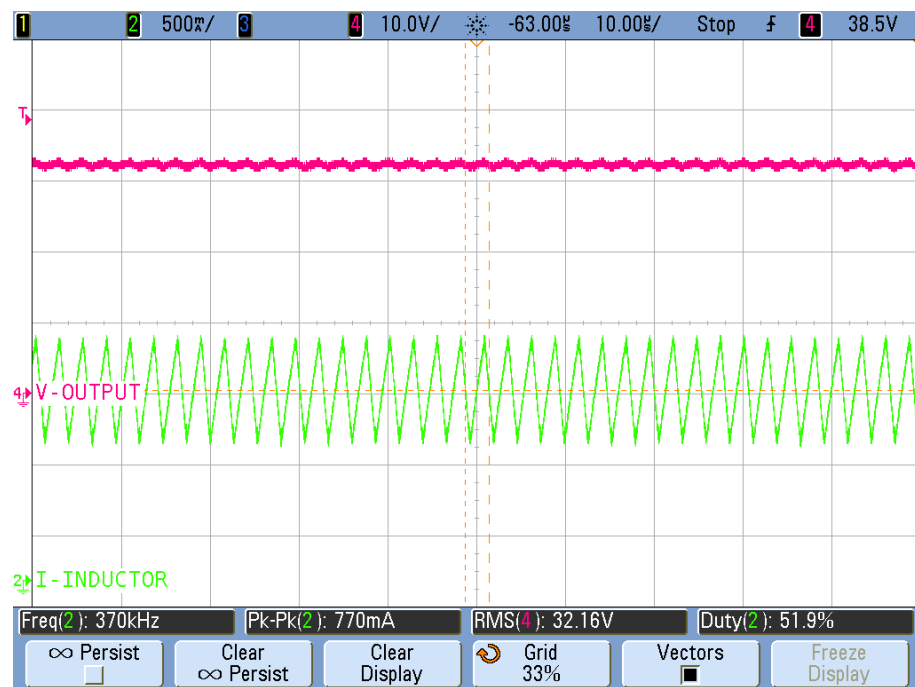


Figure 21. Output voltage vs inductor current at 54 V DC



6 STEVAL-POEL45W1 layouts

Figure 22. STEVAL-POEL45W1 layout top layer

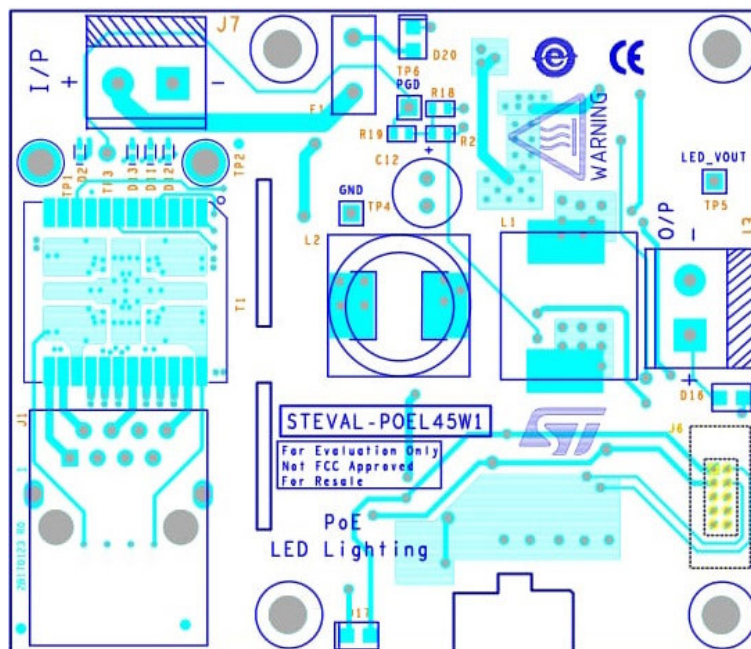
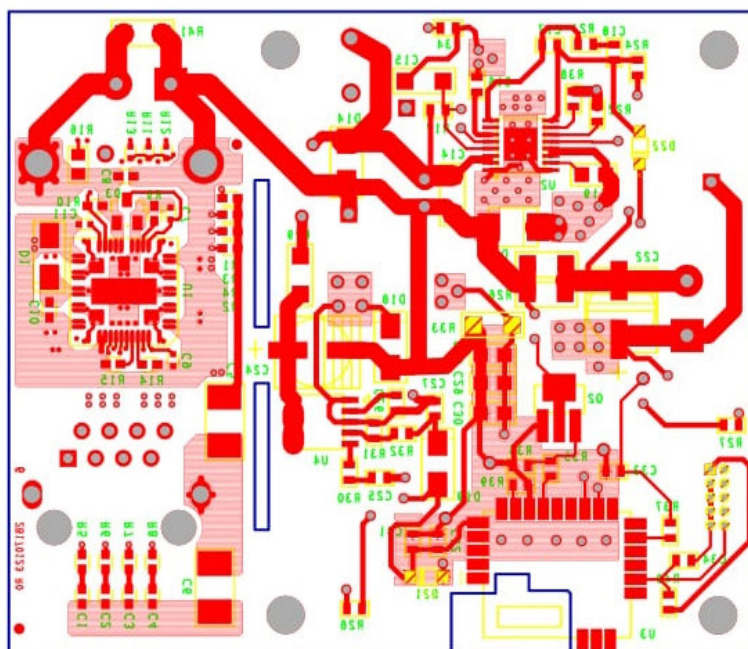


Figure 23. STEVAL-POEL45W1 layout bottom layer



7 Thermal behavior

The LED6000 in the HTSSOP16 package features 40°C/W thermal resistance and the maximum current flowing through the driver is approximately 1.4 A.

Thermal analysis of the board was performed using an IR camera at 54 V DC input, under full load condition with an ambient temperature of 25°C.

Figure 24. STEVAL-POEL45W1 heat map for top at 54 V DC input

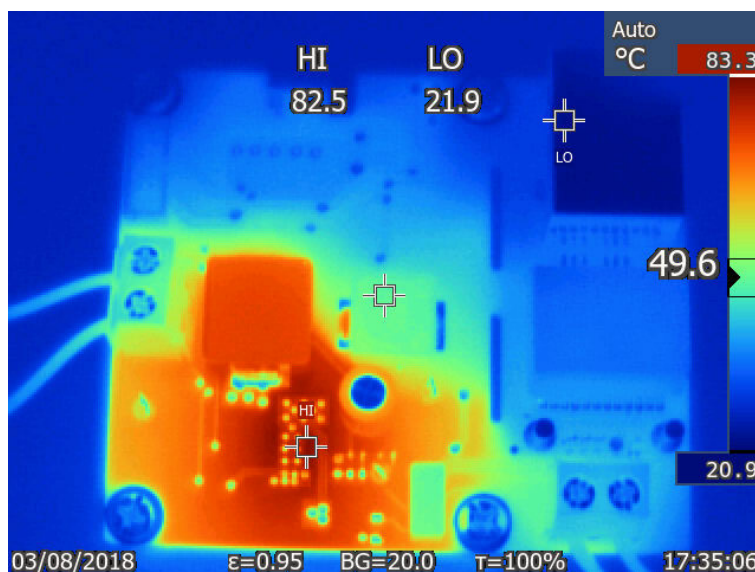
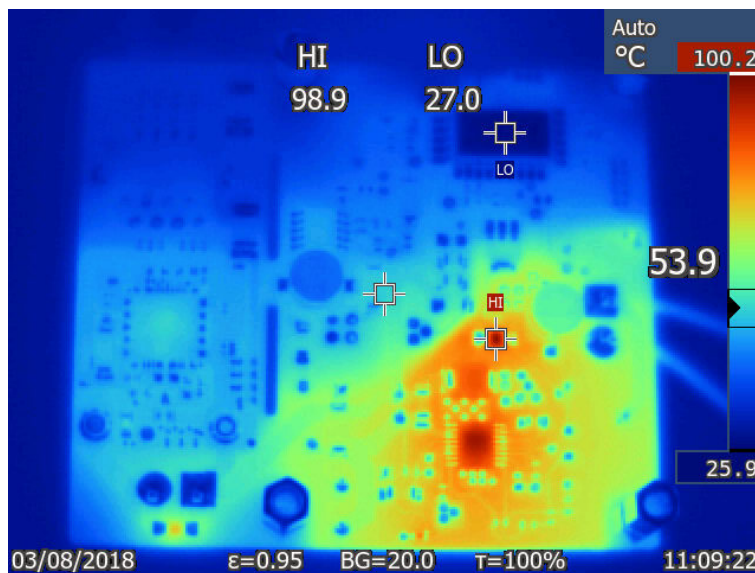


Figure 25. STEVAL- POEL45W1 heat map for bottom at 54 V DC input



Revision history

Table 2. Document revision history

Date	Version	Changes
07-Feb-2019	1	Initial release.
17-Mar-2021	2	Added BLUENRG-M2SA compability information. Updated Section 3 STEVAL-POEL45W1 schematic diagrams and Section 4 Bill of materials

Contents

1	STEVAL-POEL45W1 evaluation board overview	2
1.1	Features	2
1.2	Block diagram	2
1.3	Key devices	3
1.4	Status LEDs	4
1.5	Firmware implementation	5
2	Setup and operation	6
2.1	How to connect your LED string and power the board	6
2.2	How to use the PoE Lighting Android application	7
3	Schematic diagrams	10
4	Bill of materials	12
5	Test results for STEVAL-POEL45W1 evaluation board	16
5.1	Test setup	16
5.2	Performance results	16
5.3	Circuit protection tests	18
5.4	Typical waveforms	19
6	STEVAL-POEL45W1 layouts	21
7	Thermal behavior	22
	Revision history	23

List of figures

Figure 1.	STEVAL-POEL45W1 evaluation board top and bottom	1
Figure 2.	STEVAL-POEL45W1 block diagram	2
Figure 3.	STEVAL- POEL45W1 bottom view with key devices	3
Figure 4.	STEVAL-POEL45W1 top view with status LEDs	4
Figure 5.	STEVAL-POEL45W1 firmware flow chart	5
Figure 6.	J3 connector for LED load	6
Figure 7.	Power supply options at J1 or J7.	6
Figure 8.	PoE Lighting Android app first page	7
Figure 9.	Enable Bluetooth on your mobile device.	8
Figure 10.	Select the PoE Lighting device to establish connection	8
Figure 11.	PoE Lighting Android app first page	9
Figure 12.	STEVAL-POEL45W1 board schematic (1 of 2)	10
Figure 13.	STEVAL-POEL45W1 board schematic (2 of 2)	11
Figure 14.	Input voltage vs efficiency at different loads	16
Figure 15.	Input voltage vs output current at different loads	16
Figure 16.	Input voltage vs output current at different brightness levels	17
Figure 17.	Short-circuit protection behavior	18
Figure 18.	Open circuit protection behavior	18
Figure 19.	Output voltage vs inductor current at 40 V DC	19
Figure 20.	Output voltage vs inductor current at 48 V DC	19
Figure 21.	Output voltage vs inductor current at 54 V DC	20
Figure 22.	STEVAL-POEL45W1 layout top layer	21
Figure 23.	STEVAL-POEL45W1 layout bottom layer	21
Figure 24.	STEVAL-POEL45W1 heat map for top at 54 V DC input.	22
Figure 25.	STEVAL- POEL45W1 heat map for bottom at 54 V DC input	22

List of tables

Table 1.	STEVAL-POEL45W1 bill of materials	12
Table 2.	Document revision history	23

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2021 STMicroelectronics – All rights reserved