AN4346
Application note

10 W wide range - high power factor - isolated LED driver using HVLED815PF

By Giovanni Gritti

Introduction

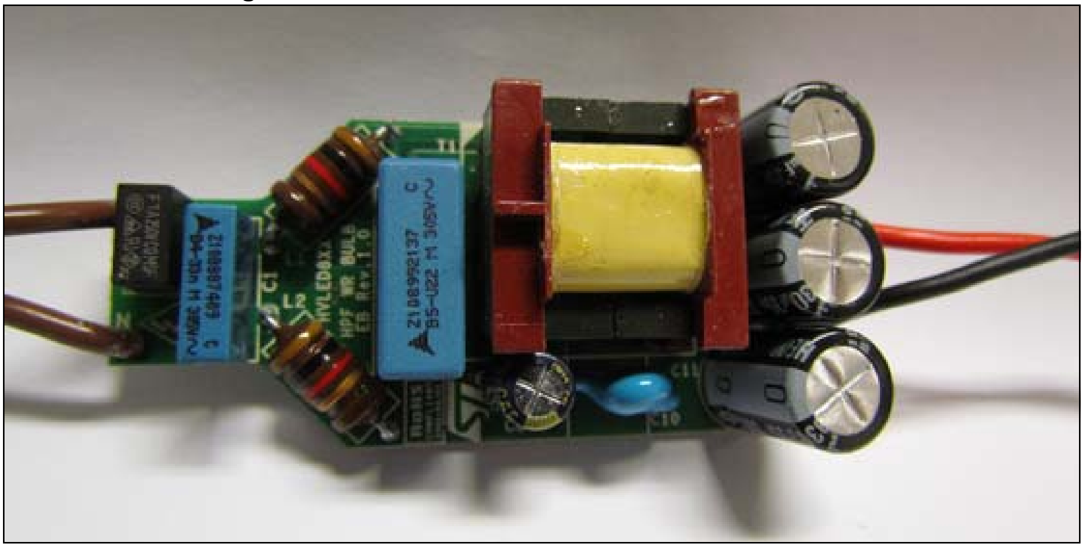
This application note describes the performances of an isolated 10 W, wide range, regulated LED driver using the HVLED815PF device, with a high power factor and a constant output current regulation. Main input specifications are:

- Input voltage: 88 - 265 Vac
- Isolated solution (flyback topology)
- Output power: 10 W
- Output LED voltage (typ.): 22 V
- Output LED current (typ.): 455 mA
- Power factor: > 0.95
- LED driver efficiency: up to 84%

The architecture is based on a single stage isolated flyback and it has been used the STMicroelectronics® HVLED815PF device with primary side control to achieve a LED current regulation within ± 5% and a high power factor.

The form factor has been designed to fit into a standard lighting case making easy the replacement of the incandescent lamp.

Figure 1. EVLHVLED815W10F demonstration board



Contents

List of tables

List of figures

1 Demonstration board details

Figure 2. EVLHVLED815W10F circuit diagram

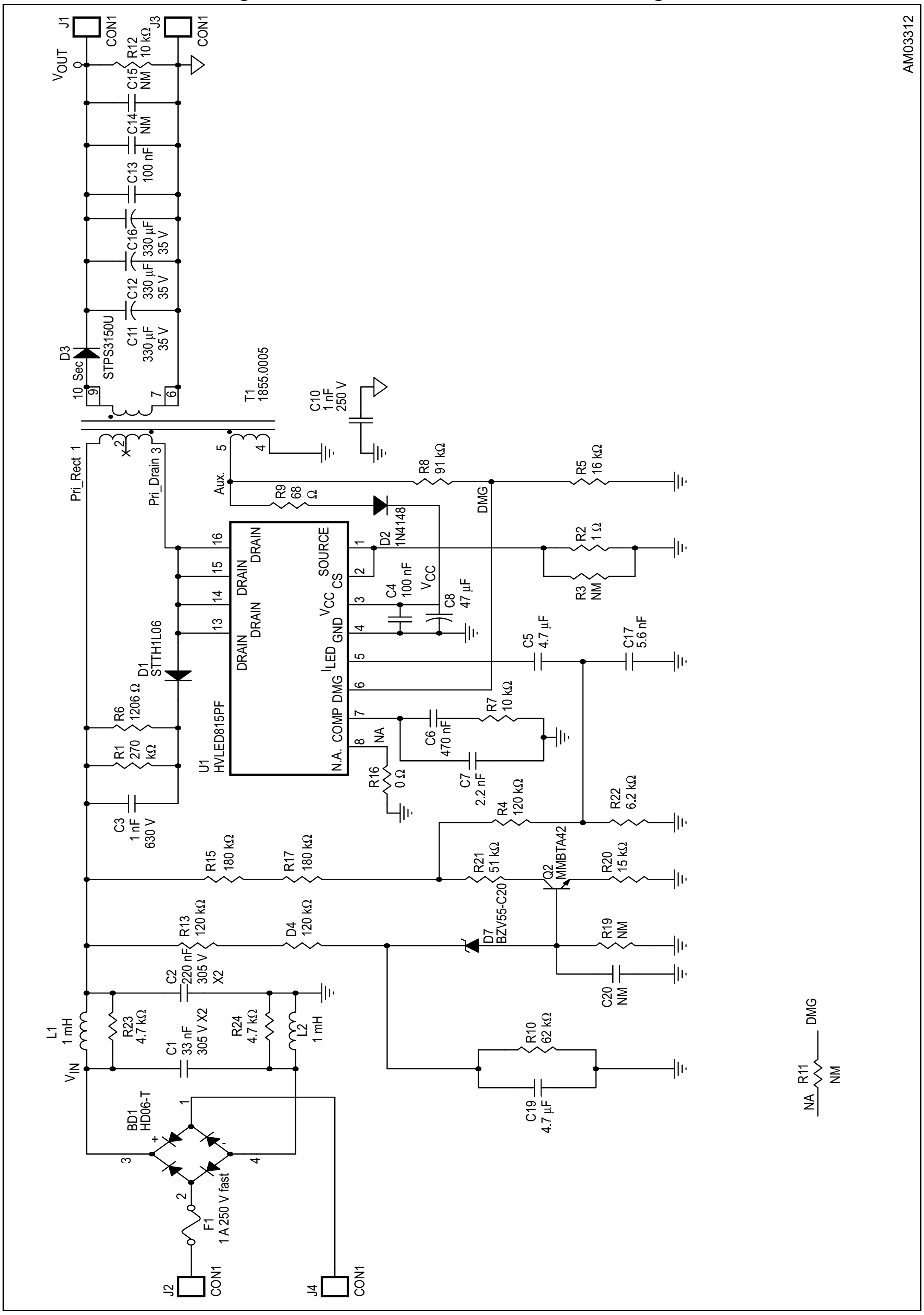


Figure 3. Component layout

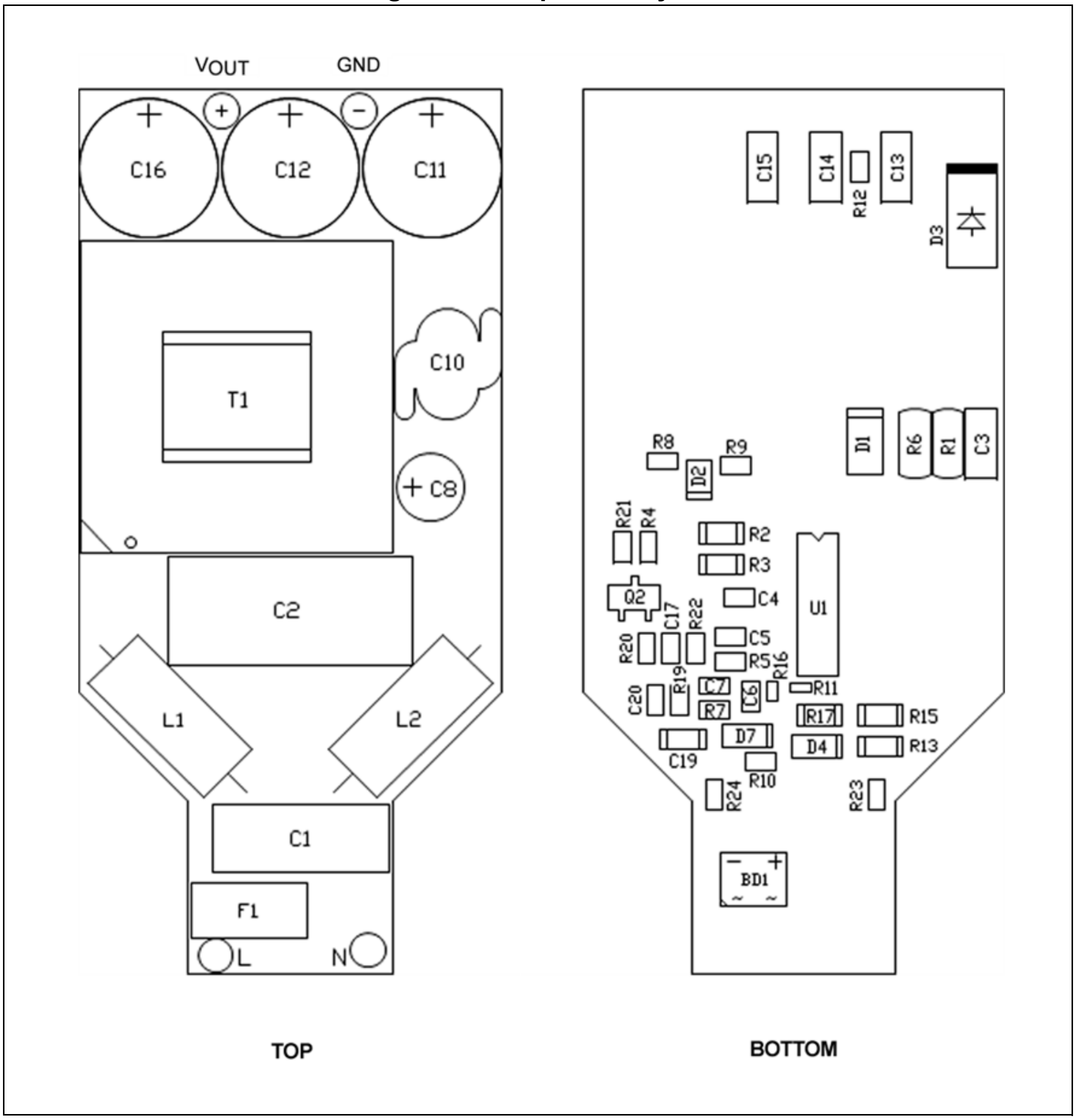


Figure 4. PCB layout

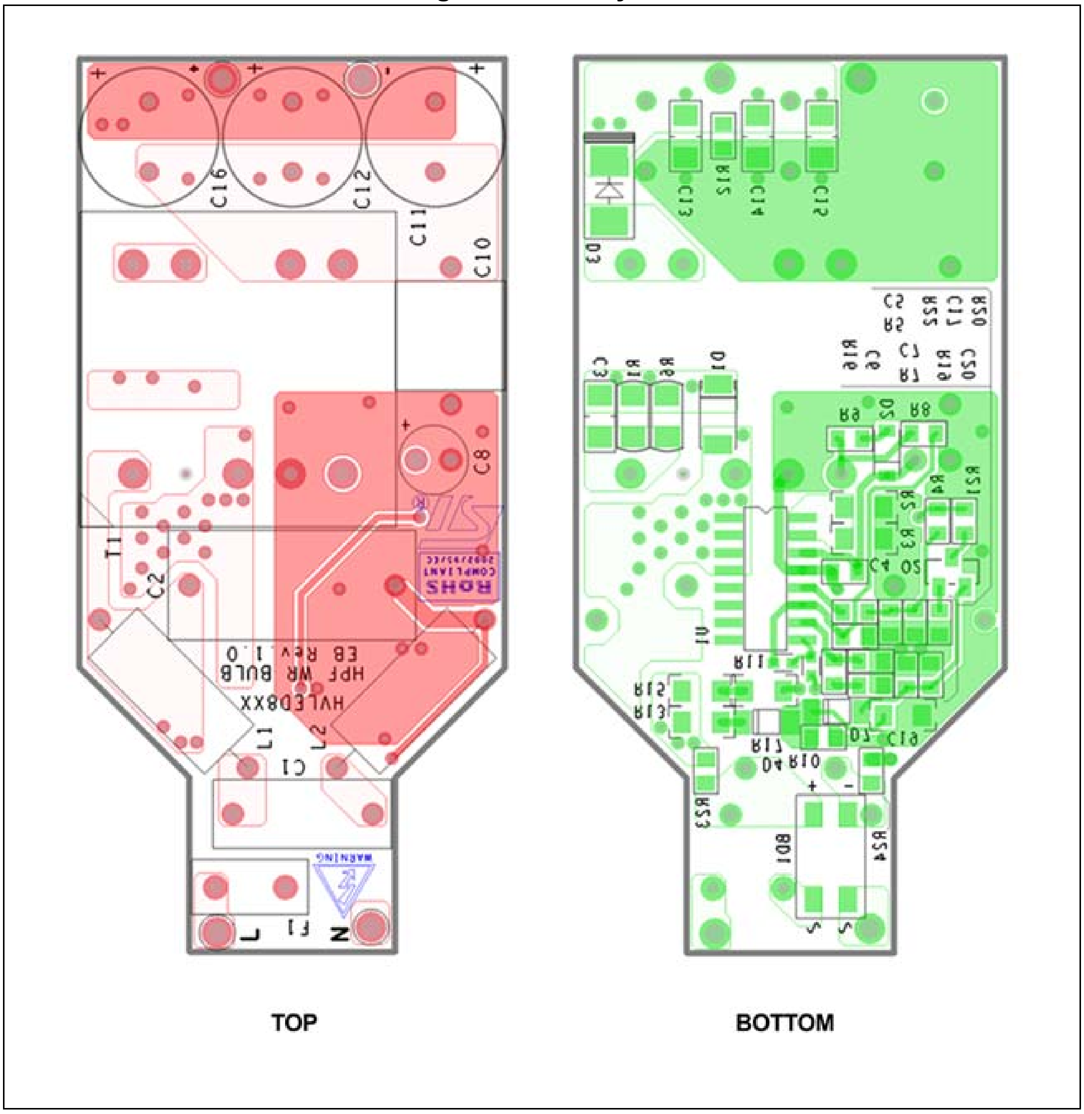


Table 1. Bill of material (BOM)

Ref.	Value	Description	Manufacturer	Manuf. part number
BD1	HD06-T	Diode bridge HD06-T 600 V 0.8 A MINIDIP	DIODES® Inc.	HD06-T
C1	33 nF	CAP 33 nF X2 305 V MKP P.10	EPCOS	B32921C3333M
C2	220 nF	CAP 220 nF X2 305 V MKP P.15	EPCOS	B32922C3224M
C3	1 nF	Cap. 1 nF ± 10% X7R 630 V 1206	TDK	C3216X7R2J102K115AA
C4	100 nF	Cap. 100 nF ± 10% X7R 50 V 0805	KEMET	C0805C104K5RACTU
C5	4.7 µF	Cap. 4.7 µF ± 10% X5R 25 V 0805	KEMET	C0805C475K3PACTU
C6	470 nF	Cap. 470 nF ± 10% X7R 25 V 0805	KEMET	C0805C474K3RACTU
C7	2.2 nF	Cap. 2.2 nF ± 5% C0G 50 V 0805	MURATA	GRM2165C1H222JA01D
C8	47 µF	Cap. 47 µF ± 20% EL. 50V 105 °C rad. D5 P 2 mm	Panasonic	EEUFR1H470
C10	1 nF	CAP 1 nF X1 Y1 250 V CERAMIC P. 10	MURATA	DE1E3KX102MN5A
C11, C12, C16	330 µF	Cap. 330 µF ± 20% EL. 35 V 105 °C LL LOW ESR rad. D10 P5mm	Nichicon	UHE1V331MPD
C13	100 nF	Cap. 100 nF ± 10% X7R 50 V 1206	KEMET	C1206C104K5RACTU
C17	5.6 nF	Cap. 5.6 nF ± 5% C0G 50 V 0805	MURATA	GRM2195C1H562JA01D
C19	4.7 µF	Cap. 4.7 µF ± 10% X5R 50 V 1206	TAIYO YUDEN	UMK316BJ475KL-T
D1	STTH1L06	Diode rect. UFAST STTH1L06U 600 V 1 A SMB	STMicroelectronics®	STTH1L06U
D2	1N4148	Diode rect. fast 1N4148 75V 150 mA SOD123	Vishay®	1N4148W-V-GS08
D3	STPS3150U	Diode Schottky STPS3150U 150 V 3 A SMB	STMicroelectronics	STPS3150U
D4	120 kΩ	Res. 100 kΩ 1/4 W 1% 100 ppm 1206 SMD		CRCW1206120KFKEA
D7	BZV55-C20	Zener 20 V ± 5% 500 mW MINIMELF	NXP	BZV55-C20
F1	1 A 250 V fast	Fuse 1 A 250 V fast radial 8.4 mm x 7.7 mm P 5 mm	Multicomp Electronic Components	MCMSF 1 A 250 V
L1, L2	1 mH	Choke RF 1 mH 370 mA axial D 6.5 L 12 mm	EPCOS	B82145A1105J000
Q2	MMBTA42	NPN SML SIG G.P. AMP SOT23	STMicroelectronics	MMBTA42
R1	270 kΩ	Res. 270 kΩ 1/4 W 1% 100 ppm 1206 SMD		CRCW1206270KFKEA
R2	1 Ω	Res. 1 Ω 1/4 W 1% 100 ppm 1206 SMD		CRCW12061R00FKEA
R4	120 kΩ	Res. 120 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW0805120KFKEA

Table 1. Bill of material (BOM)

Ref.	Value	Description	Manufacturer	Manuf. part number
R5	16 kΩ	Res. 16 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW080516K0FKEA
R7, R12	10 kΩ	Res. 10 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW080510K0FKEA
R8	91 kΩ	Res. 91 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW080591K0FKEA
R9	68 Ω	Res. 68 Ω 1/8 W 1% 100 ppm 0805 SMD		CRCW080568R0FKEA
R10	62 kΩ	Res. 62 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW080562K0FKEA
R13	120 kΩ	Res. 120 kΩ 1/4 W 1% 100 ppm 1206 SMD		CRCW1206120KFKEA
R15, R17	180 kΩ	Res. 180 kΩ 1/4 W 1% 100 ppm 1206 SMD		WCR1206-180KFI
R16	0 Ω	Res. 0 Ω 0603 SMD		CRCW06030000Z0EA
R20	15 kΩ	Res. 15 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW080515K0FKEA
R21	51 kΩ	Res. 51 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW080551K0FKEA
R22	6.2 kΩ	Res. 6.2 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW08056K20FKEA
R23, R24	4.7 kΩ	Res. 4.7 kΩ 1/8 W 1% 100 ppm 0805 SMD		CRCW08054K70FKEA
T1	1855.0005	Transformer flyback 15 W L_p = 1.5 mH N_p = 190 N_s = 42 N_{aux} = 24 core EF20	Magnetica	1855.0005
U1	HVLED815PF	Offline LED driver HVLED815PF SO16	STMicroelectronics	HVLED815PF

2 Measurement results

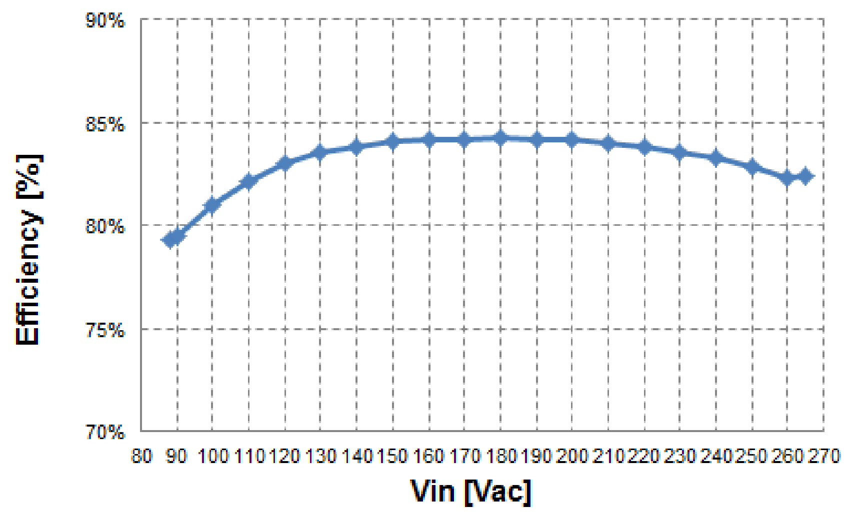
The HVLED815PF LED driver demonstration board has been tested using the following instrumentation/load:

- CHROMA® 61602 AC source
- YOGOGAWA® WT210 wattmeter
- Tektronix® DP07054 500 MHz digital oscilloscope
- Tektronix TCP0030 current probe
- LeCroy PPE4kV 100:1 400 MHz high voltage probe
- KEITHLEY 2000 digital multimeter
- Avio TVS-200 P thermal video system
- SEOUL SEMICONDUCTOR Z-POWER LED P4 LED series

2.1 Driver efficiency at nominal load

In *Figure 5* is displayed LED driver efficiency versus the AC line voltage at a nominal load.

Figure 5. LED driver efficiency versus AC line voltage at nominal load

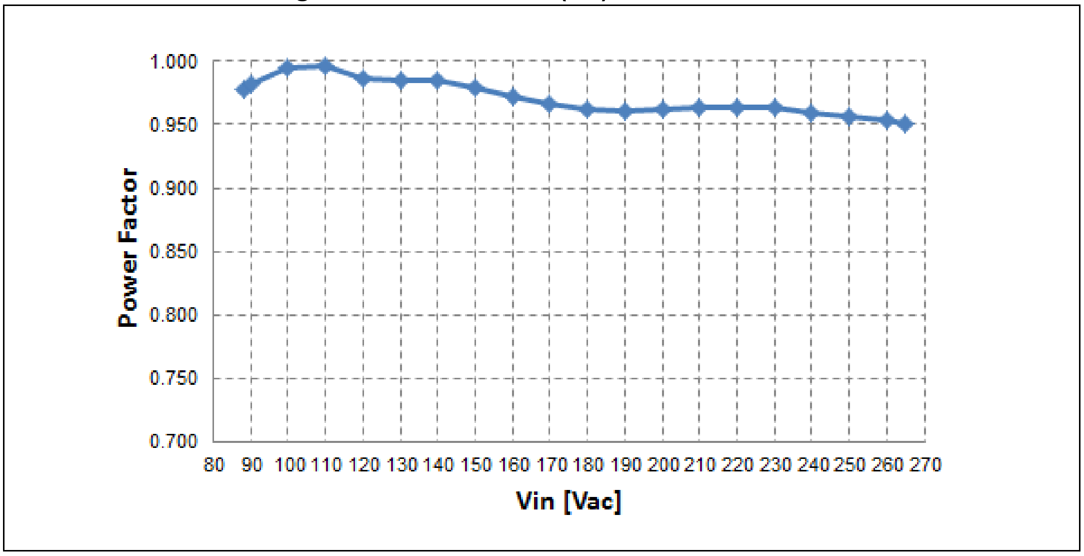


As shown in *Figure 5* LED driver efficiency is up to 84%.

2.2 Power factor at nominal load

In *Figure 6* is displayed the measured power factor (PF) at a nominal load:

Figure 6. Power factor (PF) at nominal load

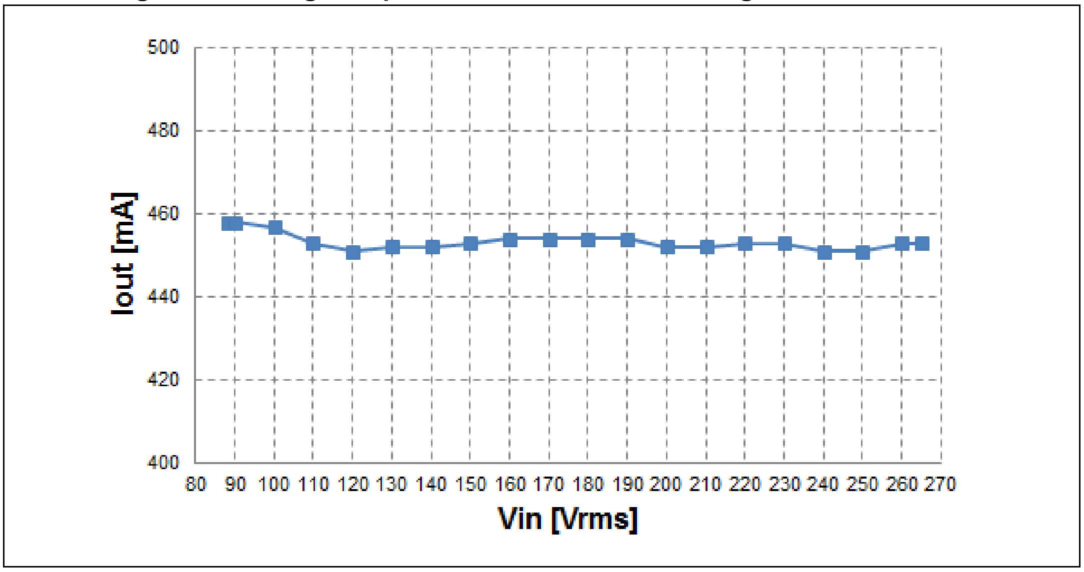


As shown in *Figure 6* the power factor (PF) is over 0.95 in all the input voltage range [88 - 265] Vac.

2.3 Line regulation at nominal load

In *Figure 7* is displayed the measured average output current versus line voltage at a nominal load.

Figure 7. Average output current versus line voltage at nominal load

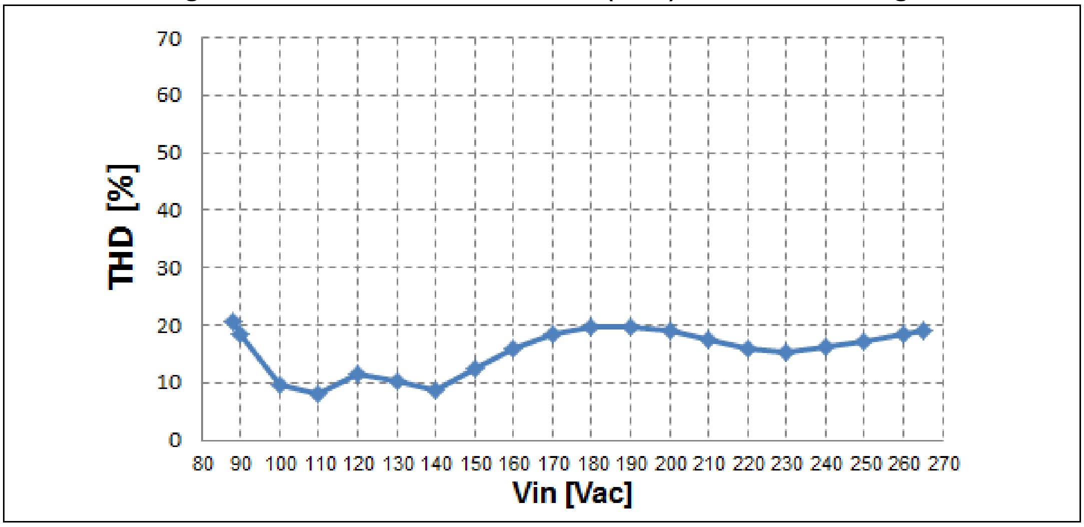


The output current is 455 mA ± 0.8% over all the input voltage range [88 - 265] Vac.

2.4 Total harmonic distortion (THD) at nominal load

In *Figure 8* is displayed the total harmonic distortion (THD) versus line voltage.

Figure 8. Total harmonic distortion (THD) versus line voltage

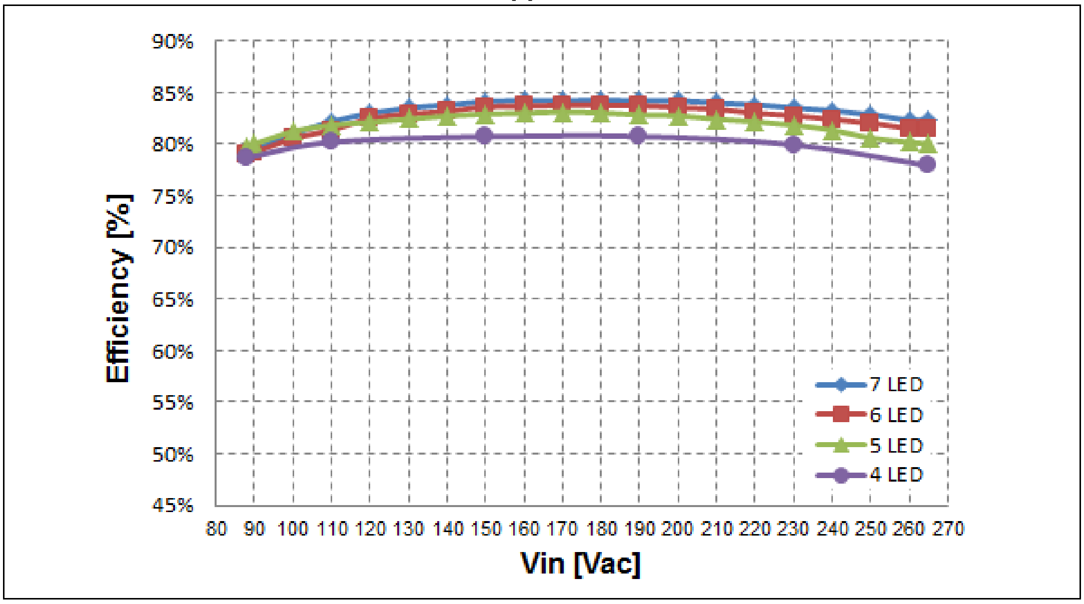


The THD at nominal input voltage is lower than 20%.

2.5 Driver efficiency at different LED load number

In *Figure 9* is displayed LED driver efficiency versus AC line voltage at different numbers of LEDs applied.

Figure 9. LED driver efficiency versus AC line voltage at different numbers of LEDs applied

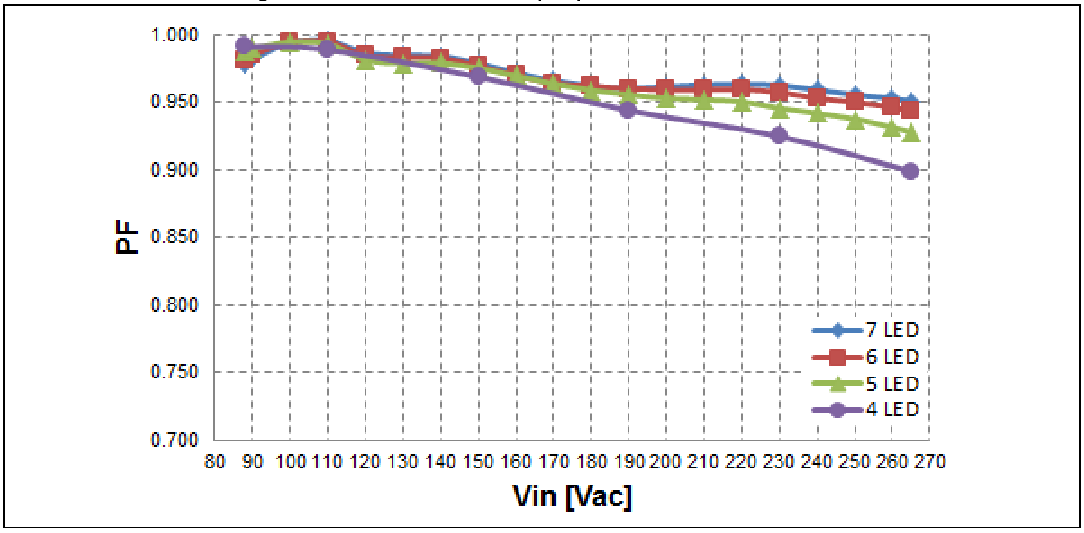


As shown in *Figure 9* LED driver efficiency is always over 80% in all the input voltage range also varying the number of LEDs.

2.6 Power factor at different LED load number

In *Figure 10* is displayed the measured power factor (PF) at a different LED load.

Figure 10. Power factor (PF) at different LED load

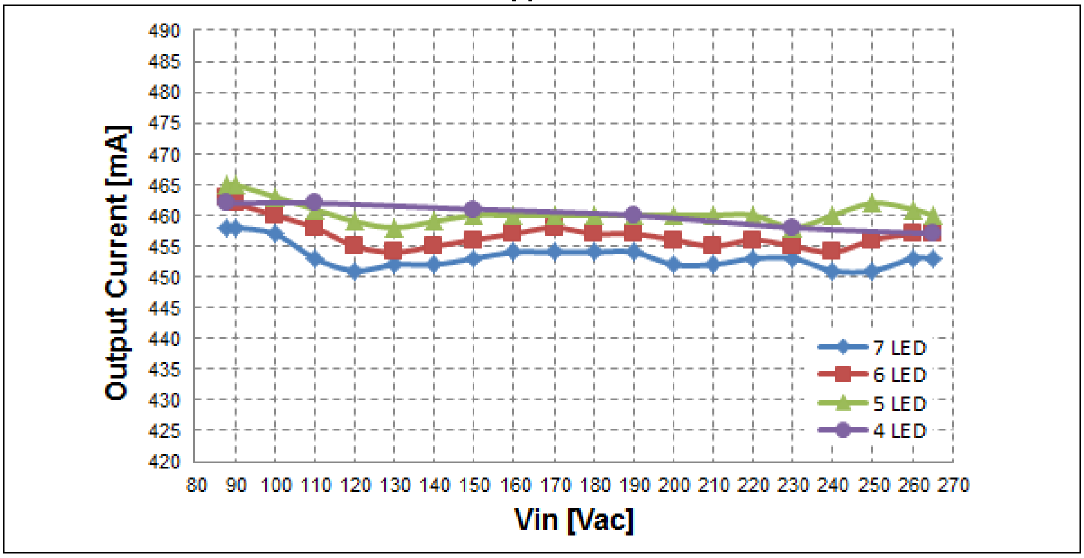


As shown in *Figure 10* the power factor (PF) is over 0.90 in all the input voltage range [88 - 265] Vac also varying the number of LEDs.

2.7 Line regulation at different LED load number

In *Figure 11* is displayed the measured average output current versus line voltage at different numbers of LEDs applied.

Figure 11. Average output current versus line voltage at different numbers of LEDs applied

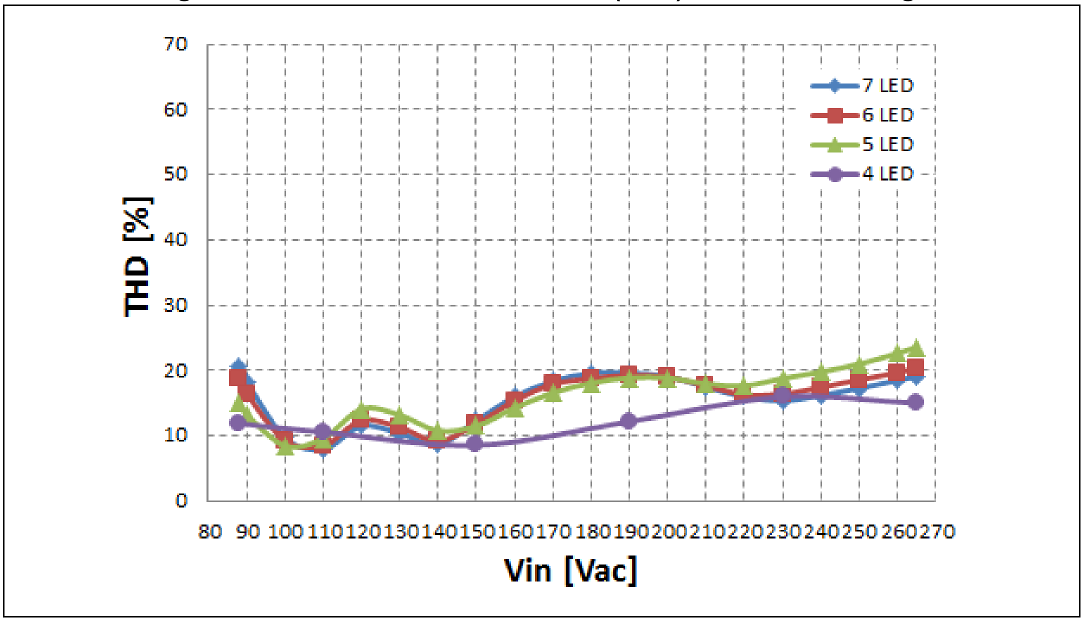


The output current is varying ± 3% changing the load over all the input voltage range [88 - 265] Vac.

2.8 Total harmonic distortion (THD) at different LED load number

In *Figure 12* is displayed the total harmonic distortion (THD) versus line voltage.

Figure 12. Total harmonic distortion (THD) versus line voltage



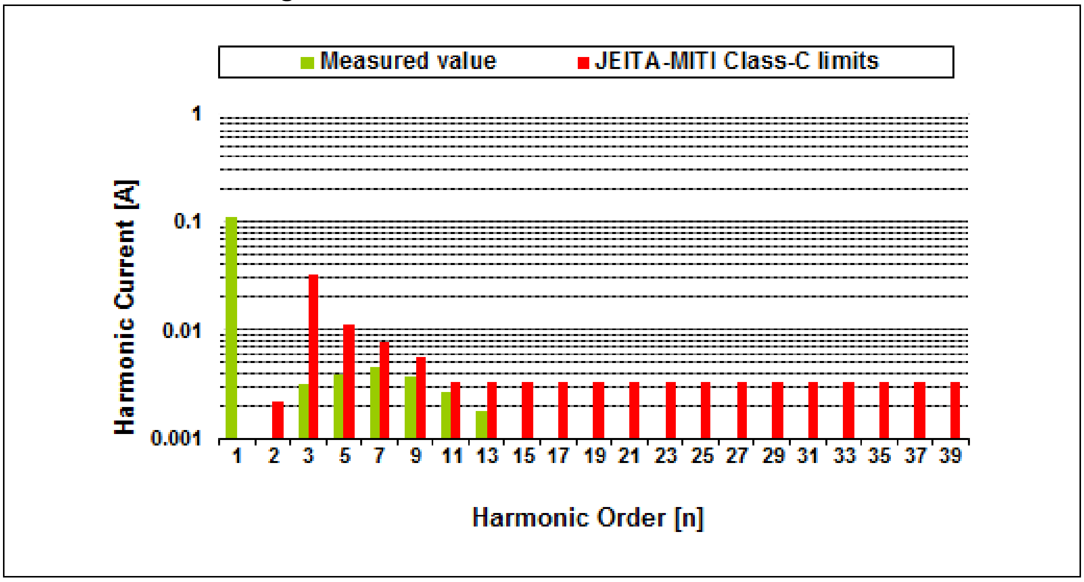
The THD at nominal input voltage is lower than 20% applying different loads.

2.9 Harmonic content at nominal mains voltage

One of the main benefits of the HVLED815PF device is the correction of input current distortion, decreasing the harmonic contents below the limits of the relevant regulations. *Figure 13* and *Figure 14* show the harmonic content at 100 Vac/50 Hz and 230 Vac/50 Hz input voltage.

The measurement at 100 Vac, 50 Hz; P_{IN} = 12.1 W; P_{OUT} = 10 W; PF = 0.994:

Figure 13. Harmonic content at 100 Vac/50 Hz



The measurement at 230 V, 50 Hz; P_{IN} = 11.8 W; P_{OUT} = 9.9 W; PF = 0.963:

Figure 14. Harmonic content at 230 Vac/50 Hz

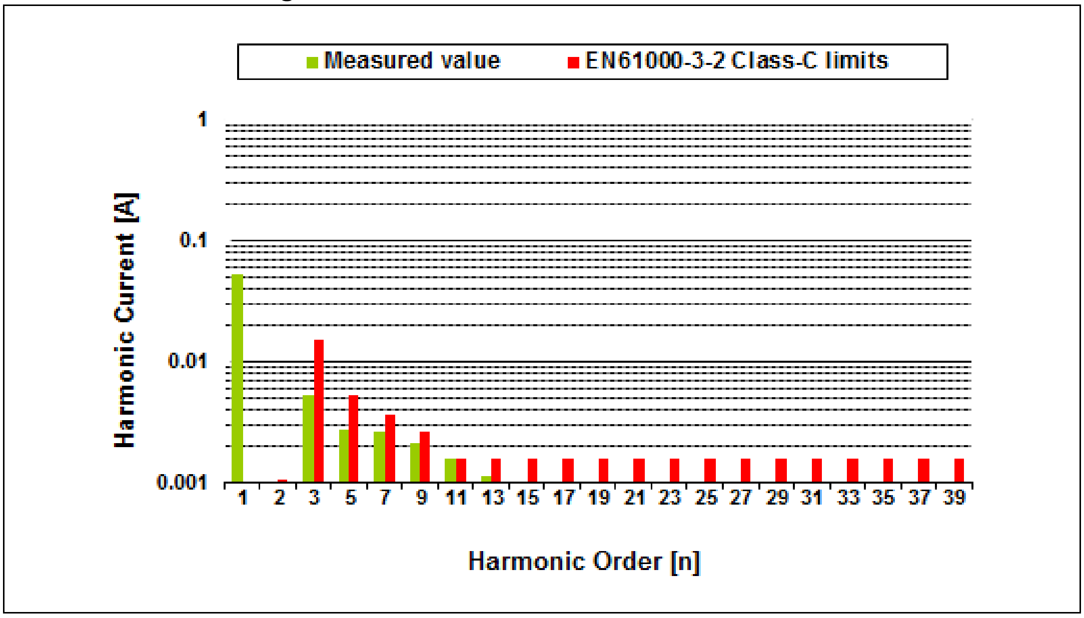


Figure 13 and *Figure 14* show as the harmonics respect the limits for Class C equipment.

2.10 Overvoltage protection in no load condition

In the EVLHVLED815W10F demonstration board the OVP protection has been set at 30 VDC typ.

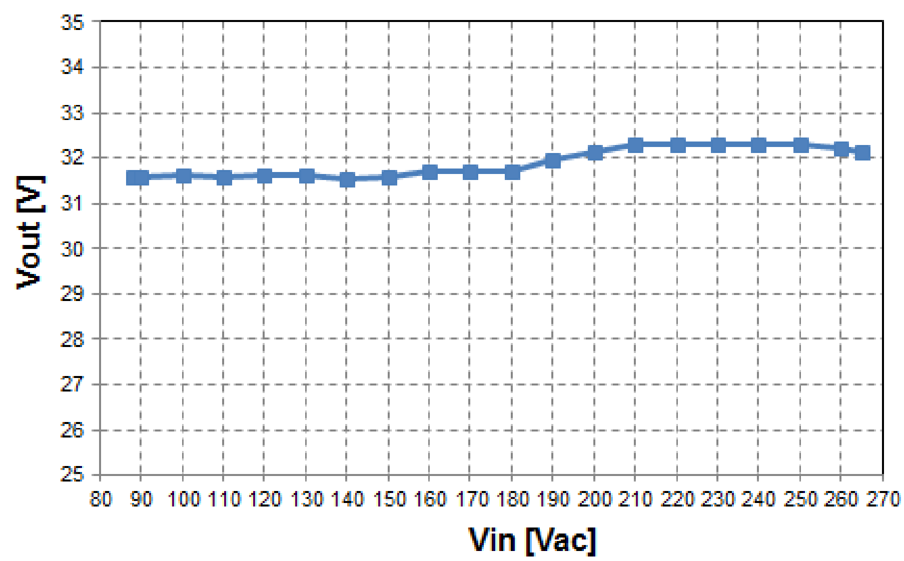
Regulated output voltage during no load condition can be fixed by selecting properly R_{DMG} and R_{FB} (see the HVLED815PF datasheet) by *Equation 1*.

Equation 1

$$V_{OUT} = \frac{N_s}{N_{aux}} \bullet \frac{R_{DMG}}{R_{FB}} \bullet V_{REF} + V_{REF} \bullet \frac{N_s}{N_{aux}} = \frac{42}{24} \bullet \frac{91k\Omega}{16k\Omega} \bullet 2.51V + 2.51V \bullet \frac{42}{24} = 30V$$

OVP voltage vs. input mains is represented in *Figure 15*.

Figure 15. OVP voltage vs. input mains



Waveforms of LED driver behavior are shown in *Section 3: Electrical waveform on page 22*.

2.11 Thermal measurements

To check reliability of design, the thermal maps have been checked with an IR camera.

The LED driver has been stressed at the nominal LED load number (P_{OUT} = 10 W) all over the input mains voltage range. Only the minimum, maximum voltage range and the two nominal mains voltage 100/50 Hz and 230/50 Hz have been reported.

Figure 16. Top side temperature P_{OUT} = 10 W - 88 V

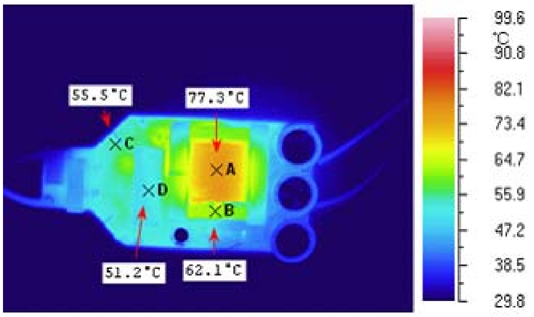


Table 2. Top side 88 V

Point	Temp.	Comment
A	77.3 °C	Winding transformer (T1)
B	62.1 °C	Magnetic transformer (T1)
C	55.5 °C	Lin (L1)

Figure 17. Top side temperature P_{OUT} = 10 W - 100 V

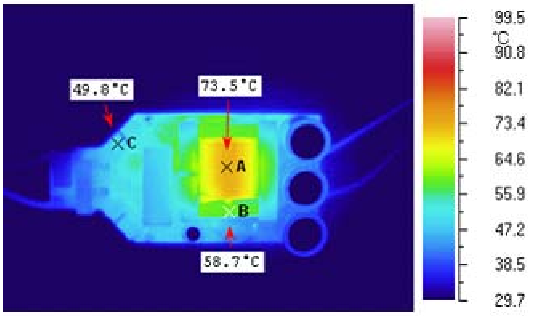


Table 3. Top side 100 V

Point	Temp.	Comment
A	73.5 °C	Winding transformer (T1)
B	58.7 °C	Magnetic transformer (T1)
C	49.8 °C	Lin (L1)

Figure 18. Top side temperature P_{OUT} = 10 W - 230 V

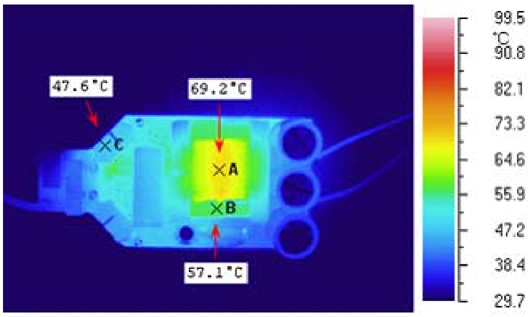


Table 4. Top side 230 V

Point	Temp.	Comment
A	69.2 °C	Winding transformer (T1)
B	57.1 °C	Magnetic transformer (T1)
C	47.6 °C	Lin (L1)

Figure 19. Top side temperature P_{OUT} = 10 W - 265 V

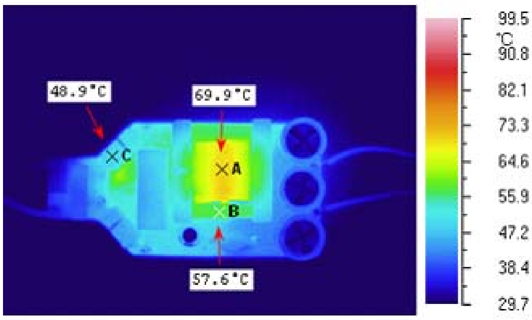


Table 5. Top side 265 V

Point	Temp.	Comment
A	69.9 °C	Winding transformer (T1)
B	57.6 °C	Magnetic transformer (T1)
C	48.9 °C	Lin (L1)

Note: Temperatures have been taken after stable thermal condition (after 60 min).

Figure 20. Bottom side temperature P_{OUT} = 10 W - 88 V

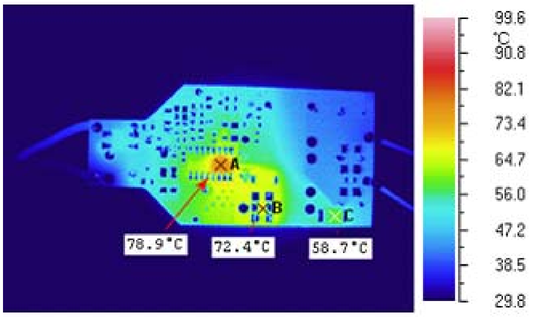


Table 6. Bottom side 88 V

Point	Temp.	Comment
A	78.9 °C	IC controller (U1)
B	72.4 °C	Snubber resistor (R1)
C	58.7 °C	Output diode (D3)

Figure 21. Bottom side temperature P_{OUT} = 10 W - 100 V

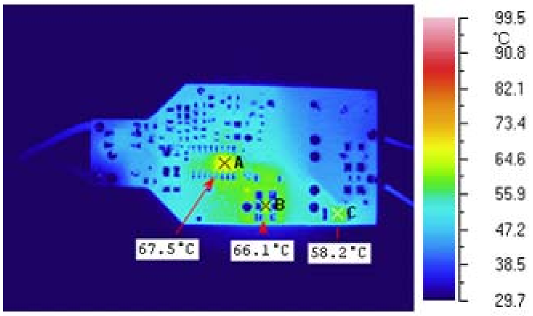


Table 7. Bottom side 100 V

Point	Temp.	Comment
A	67.5 °C	IC controller (U1)
B	66.1 °C	Snubber resistor (R1)
C	58.2 °C	Output diode (D3)

Figure 22. Bottom side temperature P_{OUT} = 10 W - 230 V

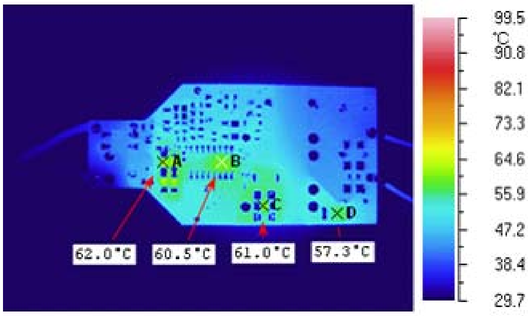


Table 8. Bottom side 230 V

Point	Temp.	Comment
A	62.0 °C	Partition resistor (D4)
B	60.5 °C	IC controller (U1)
C	61.0 °C	Snubber resistor (R1)
D	57.3 °C	Output diode (D3)

Figure 23. Bottom side temperature P_{OUT} = 10 W - 265 V

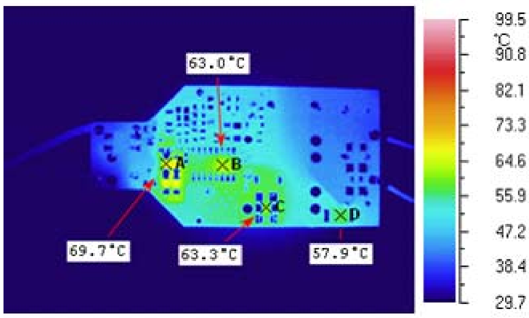


Table 9. Bottom side 265 V

Point	Temp.	Comment
A	69.7 °C	Partition resistor (D4)
B	63.0 °C	IC controller (U1)
C	63.3 °C	Snubber resistor (R1)
D	57.9 °C	Output diode (D3)

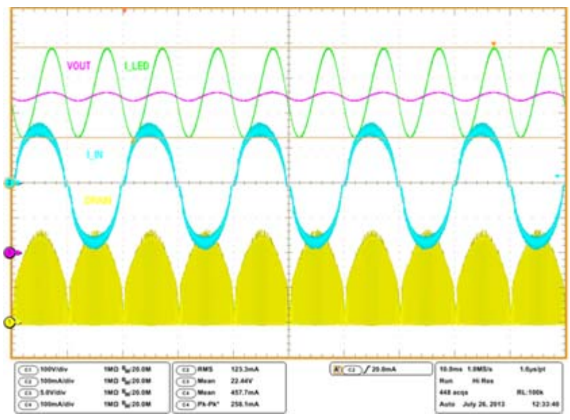
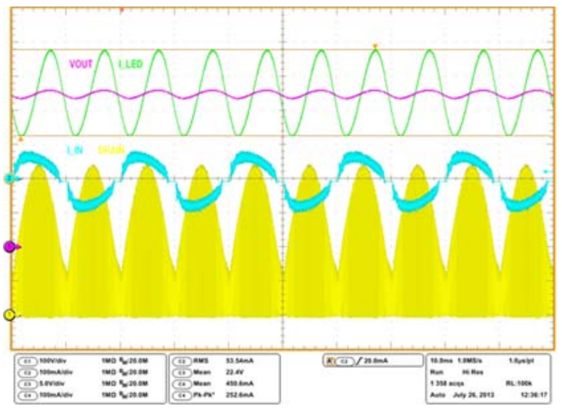
Note: Temperatures have been taken after stable thermal condition (after 60 min.).

3 Electrical waveform

3.1 Input and output LED driver waveforms

The waveforms of the input current and drain voltage at the nominal input voltage mains and nominal LED load are illustrated in this section. Drain voltage is modulated by the sinusoidal shape of the input mains voltage and the peak increase with the line.

The input current is in phase with the input voltage and a high power factor is achieved.

Figure 24. Input and output LED driver waveforms at 100 Vac - 50 Hz	Figure 25. Input and output LED driver waveforms at 230 Vac - 50 Hz
	
CH1: DRAIN pin CH2: INPUT CURRENT CH3: V_{OUT} CH4: LED CURRENT	CH1: DRAIN pin CH2: INPUT CURRENT CH3: V_{OUT} CH4: LED CURRENT

Also the LED current and output voltage have been checked.

Note that the regulated LED current remains constant all over the input mains voltage.

The LED pk-pk ripple is the ± 27% of the average current. Increasing the value of the output capacitor it is possible to decrease the LED current ripple following *Equation 2*:

Equation 2

$$I_{ripple} \approx \frac{2 \bullet I_{OUT}}{\sqrt{1 + (4\pi f_l \bullet R_{LEDtot} \bullet C_o)^2}} = \frac{2 \bullet 455mA}{\sqrt{1 + (4\pi \bullet 50Hz \bullet R_{LEDtot} \bullet (3 \bullet 330\mu F))^2}}$$

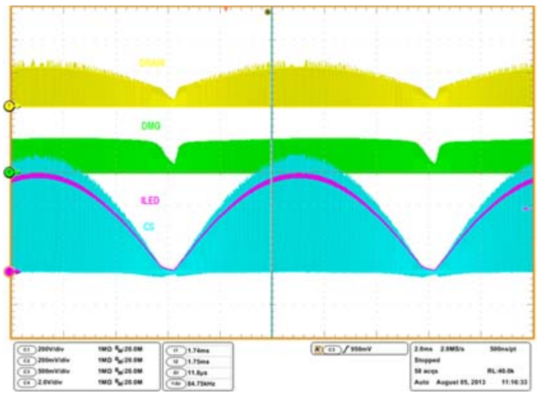
For this demonstration 3 parallel capacitors of 330 µF have been selected to have a current ripple of 250 mA pk-pk with 7 LEDs each with a dynamic resistance of 0.8 Ω.

3.2 Transition mode operation

During ON-time, the peak drain current is modulated by a signal proportional to the I_{LED} pin. This reference sets the turn-off of the MOSFET.

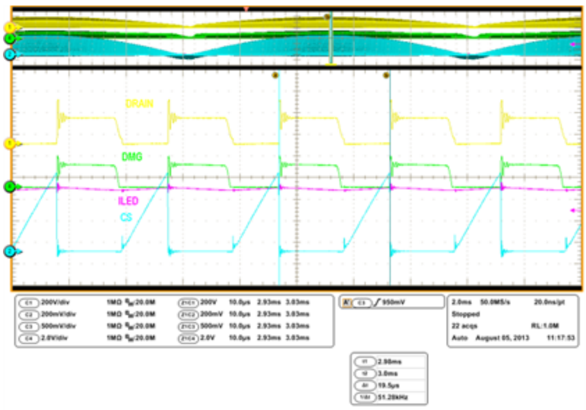
The MOSFET turn-on depends on the DMG signal that senses demagnetization of the drain current realizing a transition mode operation.

Figure 26. I_{LED} pin operation at 100 Vac - 50 Hz



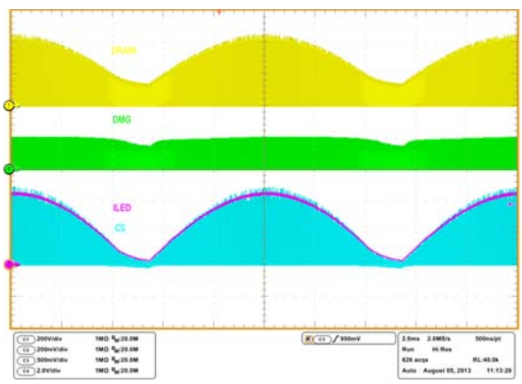
CH1: DRAIN pin
CH2: CS pin
CH3: I_{LED} pin
CH4: DMG pin

Figure 27. Transition mode operation at 100 Vac - 50 Hz - zoom on the peak - f_{sw} = 51 kHz



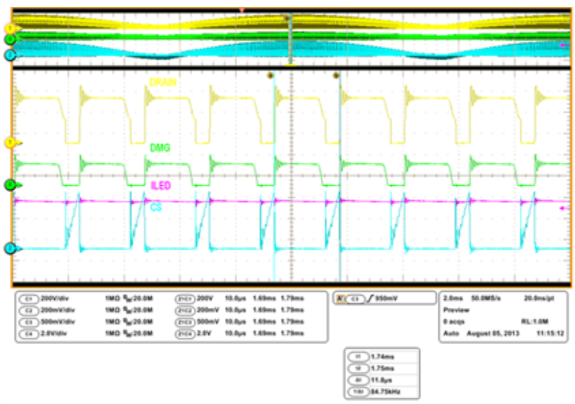
CH1: DRAIN pin
CH2: CS pin
CH3: I_{LED} pin
CH4: DMG pin

Figure 28. I_{LED} pin operation at 230 Vac - 50 Hz



CH1: DRAIN pin
CH2: CS pin
CH3: I_{LED} pin
CH4: DMG pin

Figure 29. Transition mode operation at 230 Vac - 50 Hz - zoom on the peak - f_{sw} = 83 kHz



CH1: DRAIN pin
CH2: CS pin
CH3: I_{LED} pin
CH4: DMG pin

A primary inductance of 1.5 mH has been selected in order to obtain the converter switching frequency into the interval [45 - 90] kHz.

3.3 I_{LED} pin modulation with the input mains voltage

Referring to *Figure 30*, a voltage V_X proportional to the input rectified mains is summed on the average voltage present on the I_{LED} pin trough the C_{LED} capacitor generating a voltage reference proportional to the input voltage (AC coupling).

Equation 3

$$V_X = V_{IN\_pk-pk} \bullet \frac{R_{AC\_L}}{R_{AC\_H} + R_{AC\_L}}$$

The I_{LED} pin voltage is internally divided (Gi) and then compared with the CS pin voltage, generating a primary current proportional to the input voltage reaching the high power factor condition.

The average value of I_{LED} pin is not depending from the V_{IN} input voltage (AC coupling), as a consequence the desiderated output current can be programed trough the current sense resistor R_{sense} in according to the following relationship (see the HVLED815PF datasheet for more details).

Equation 4

$$I_{LED} = \frac{n}{2} \bullet \frac{V_{CLED}}{R_{sense}} = \frac{\frac{190}{42}}{2} \bullet \frac{0.2V}{1.0\Omega} = 0.453A$$

where n is the primary-to-secondary transformer ratio ($n = N_p/N_s = 190/42$), V_{CLED} the equivalent internal voltage ($V_{CLED(typ)} = 0.2$ V) that include R, I_{ref} parameters.

Figure 30. I_{LED} pin modulation with the input mains voltage

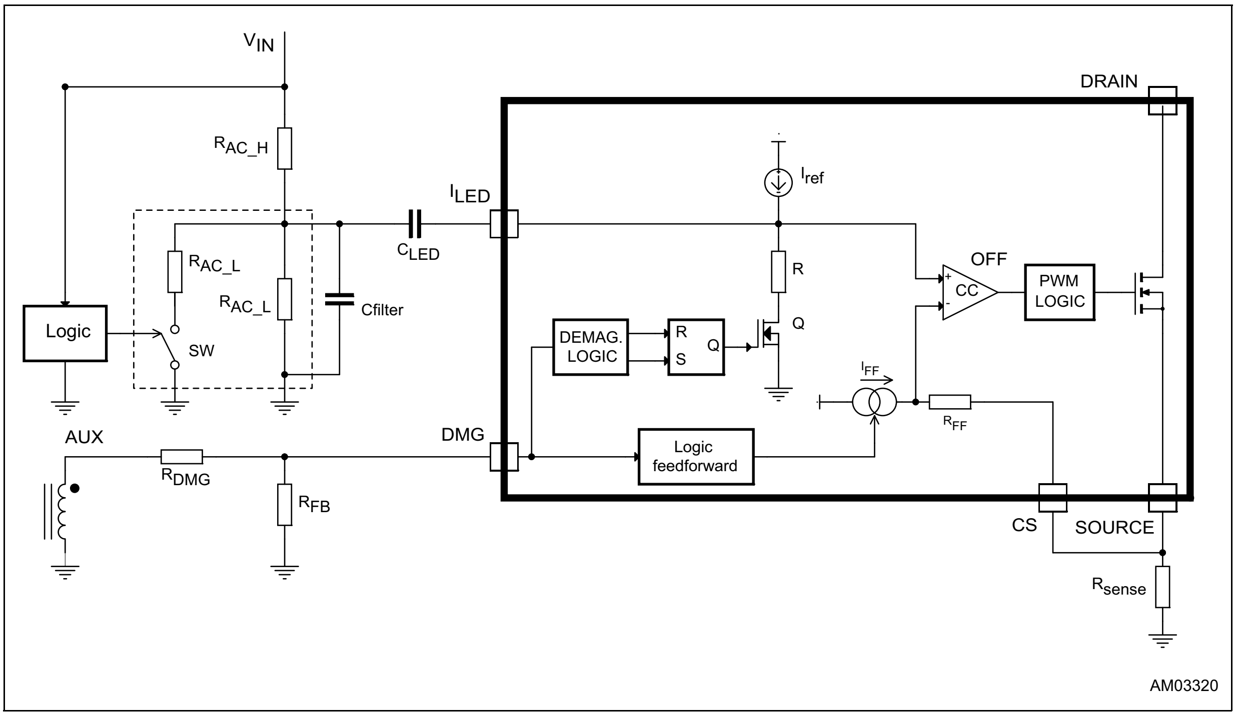
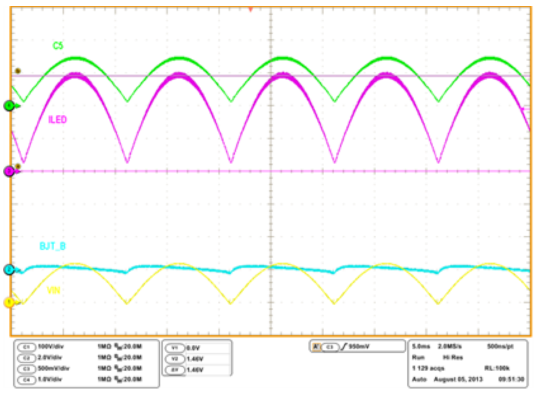


Figure 31 to *Figure 36* show the behavior of the I_{LED} pin depending on the action of the switch represented by the BJT Q2 (SW in *Figure 30*, Q2 in *Figure 2 on page 6*). At low line the switch is off (BJT base is low) and the pin is modulated by the divider composed by R_{AC_H} and R_{AC_L1}. When, at high line, the BJT is ON the pin I_{LED} is modulated by a different ratio of the divider (R_{AC_H} and the parallel of R_{AC_L1} with R_{AC_L2}) in order to keep the same dynamic on the I_{LED} pin.

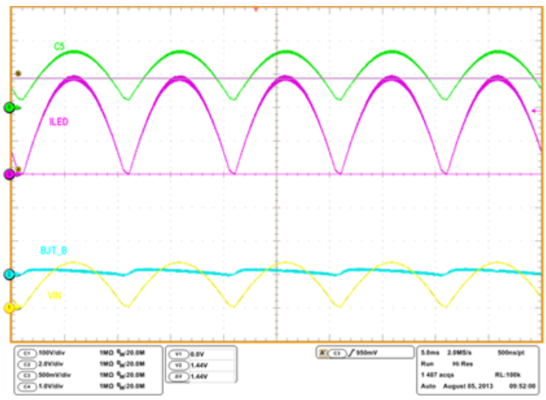
The effect is a very sinusoidal shape at nominal mains voltage 100 Vac and 230 Vac with high performance in terms of PF and THD.

Figure 31. I_{LED} pin operation at 88 Vac



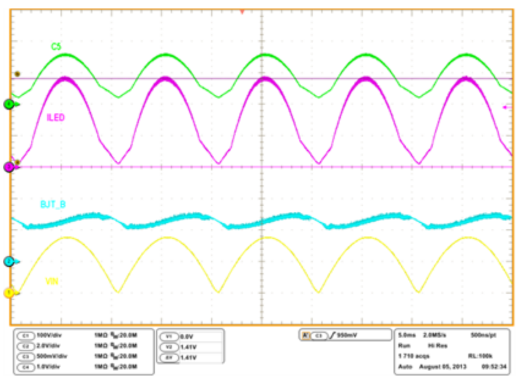
CH1: V_{IN}
CH2: BJT base
CH3: I_{LED} pin
CH4: C5 capacitor (see schematic)

Figure 32. I_{LED} pin operation at 100 Vac



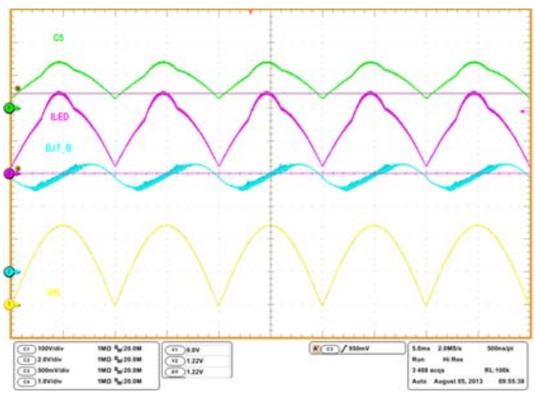
CH1: V_{IN}
CH2: BJT base
CH3: I_{LED} pin
CH4: C5 capacitor

Figure 33. I_{LED} pin operation at 130 Vac



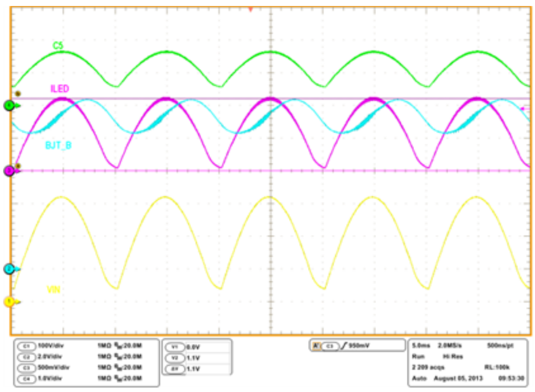
CH1: V_{IN}
CH2: BJT base
CH3: I_{LED} pin
CH4: C5 capacitor

Figure 34. I_{LED} pin operation at 175 Vac



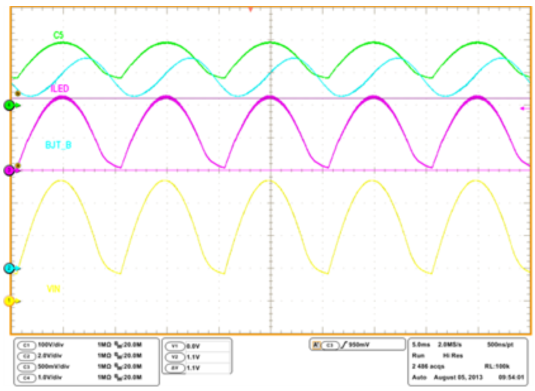
CH1: V_{IN}
CH2: BJT base
CH3: I_{LED} pin
CH4: C5 capacitor

Figure 35. I_{LED} pin operation at 230 Vac



CH1: V_{IN}
CH2: BJT base
CH3: I_{LED} pin
CH4: C5 capacitor

Figure 36. I_{LED} pin operation at 265 Vac



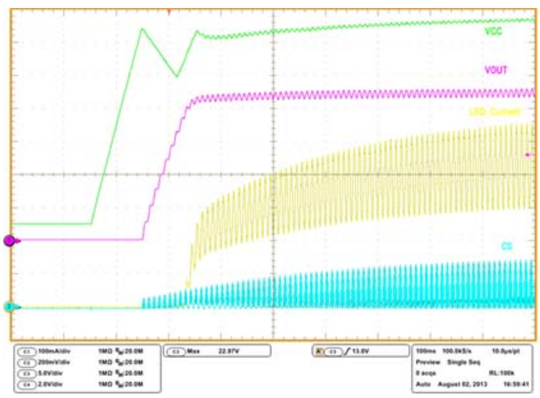
CH1: V_{IN}
CH2: BJT base
CH3: I_{LED} pin
CH4: C5 capacitor

3.4 Startup

With a V_{CC} capacitor of 47 µF, the HVLED815PF device turns-on in 100 ms (see *Figure 37* and *Figure 38*). Light appears hundreds milliseconds later.

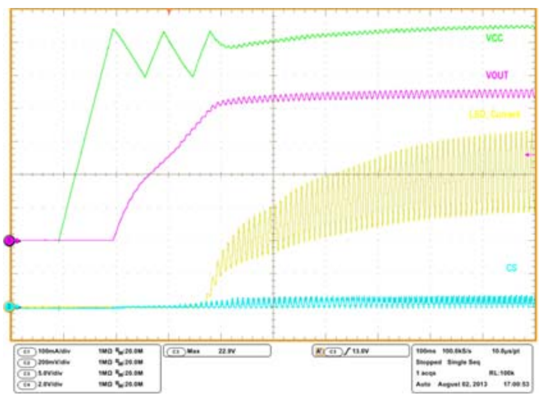
A capacitor C5 (4.7 µF) on the I_{LED} pin is charging during the start-up phase and it is responsible of the LED current soft-start time.

Figure 37. Startup at 100 Vac - 50 Hz



CH1: LED current
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

Figure 38. Startup at 230 Vac - 50 Hz



CH1: LED current
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

Acting on this C5 capacitor, it is possible to modify the soft-start time. In detail, to speed up the loop it is enough to reduce the C5 capacitor reducing the soft-start time.

3.5 Startup at no load

If the converter wakes-up during no load condition, the OVP protection is triggered and the output voltage is regulated at 32 V, protecting the output electrolytic capacitors from high voltage.

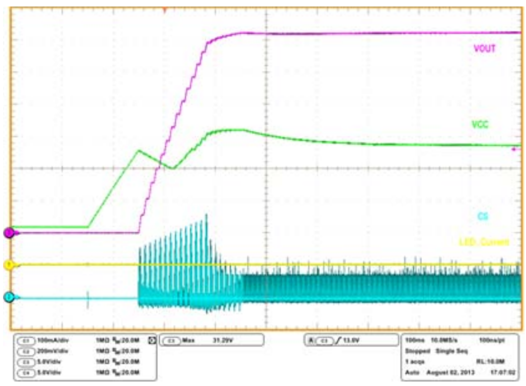


Figure 39. Startup at 100 Vac - 50 Hz - no load

CH1: LED current
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

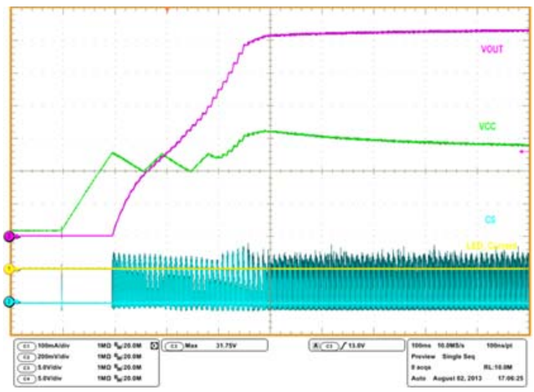


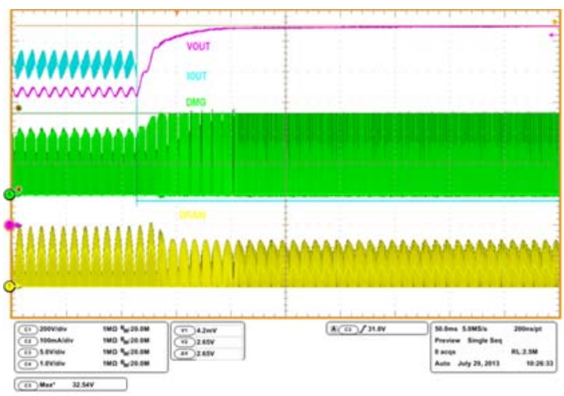
Figure 40. Startup at 230 Vac - 50 Hz - no load

CH1: LED current
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

3.6 OVP protection to a load disconnection

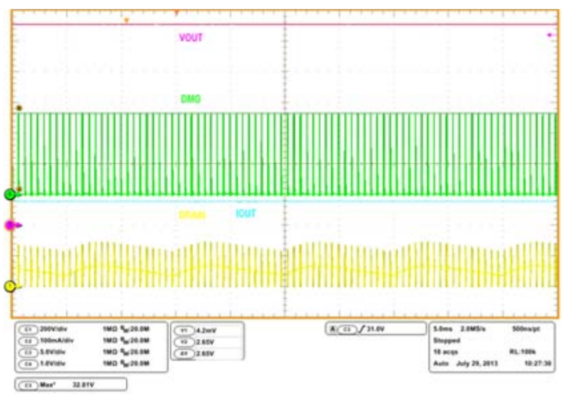
During a load disconnection the HVLED815PF device senses the output voltage through the DMG pin and controls the voltage loop in order to regulate the output capacitor voltage to a level below its maximum rating.

Figure 41. Load disconnection at 100 Vac - 50 Hz



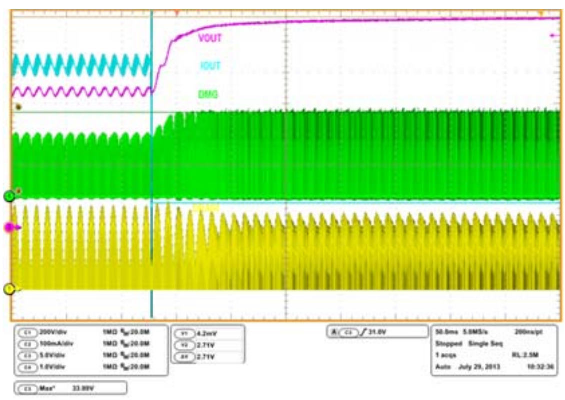
CH1: DRAIN pin
CH2: I_{OUT}
CH3: V_{OUT}
CH4: DMG pin

Figure 42. No load behavior at 100 Vac - 50 Hz



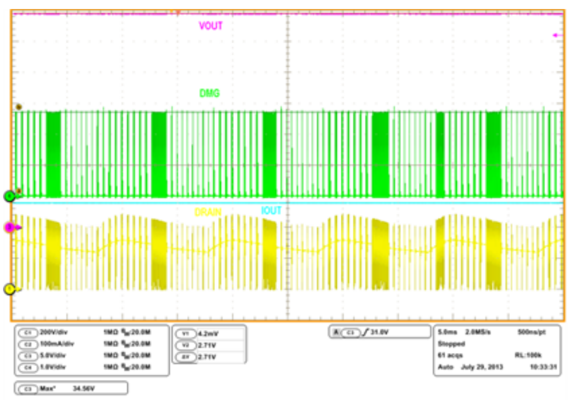
CH1: DRAIN pin
CH2: I_{OUT}
CH3: V_{OUT}
CH4: DMG pin

Figure 43. Load disconnection at 230 Vac - 50 Hz



CH1: DRAIN pin
CH2: I_{OUT}
CH3: V_{OUT}
CH4: DMG pin

Figure 44. No load behavior at 230 Vac - 50 Hz



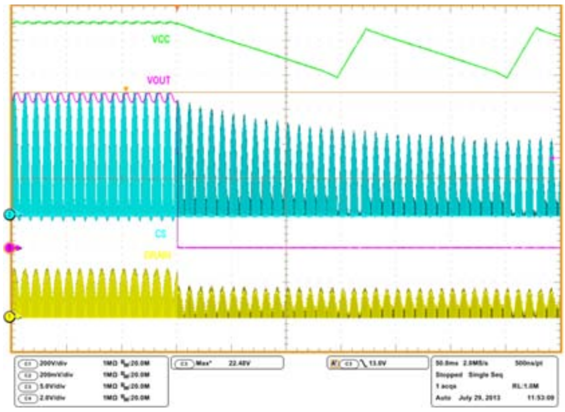
CH1: DRAIN pin
CH2: I_{OUT}
CH3: V_{OUT}
CH4: DMG pin

As shown in *Figure* and *Figure 44* the converter works in burst mode during no load condition.

3.7 Output short-circuit

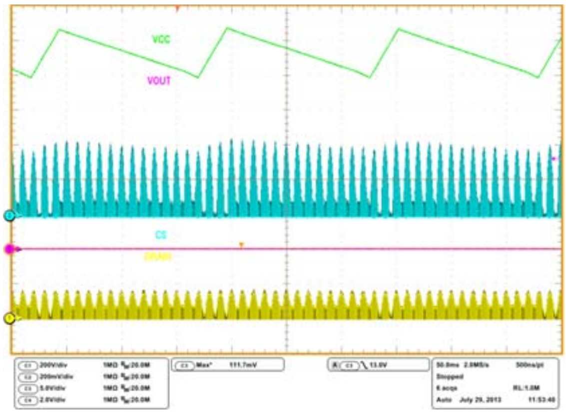
During a short of the output connector, all the energy stored in the output electrolytic capacitor is discharged into the output side loop and no current will flow into the external LED preventing their failure.

Figure 45. Short-circuit behavior at 100 Vac - 50 Hz



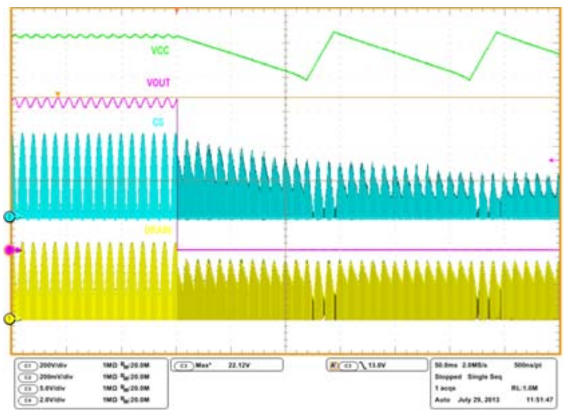
CH1: DRAIN pin
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

Figure 46. After short-circuit at 100 Vac - 50 Hz



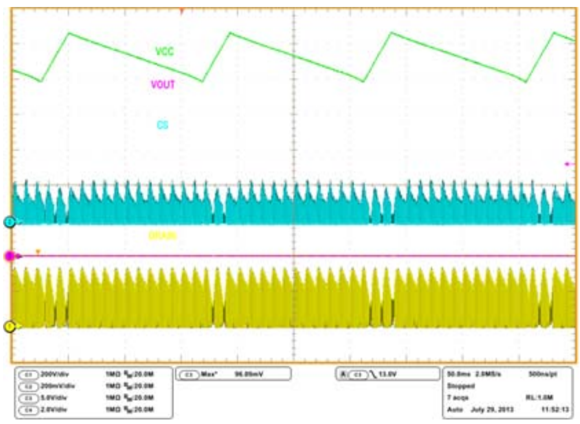
CH1: DRAIN pin
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

Figure 47. Short-circuit behavior at 30 Vac - 50 Hz



CH1: DRAIN pin
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

Figure 48. After short-circuit at 230 Vac - 50 Hz



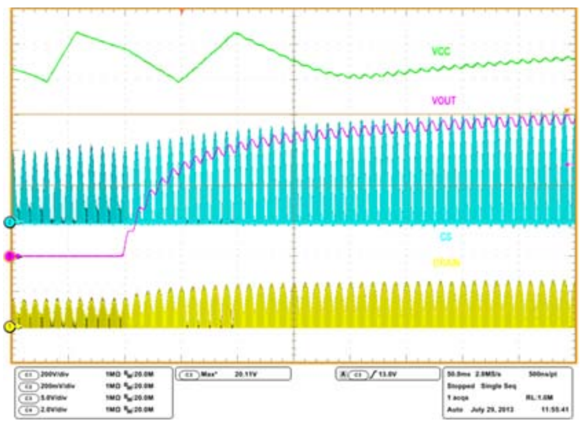
CH1: DRAIN pin
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

The converter is able to regulate the output current to a minimum level reducing the input power during this fail.

Converter is internally self supplying through the HVs generator.

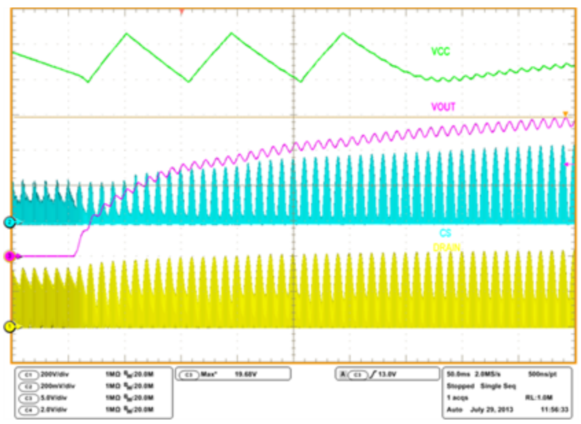
If the short is removed, the output voltage comes back to its nominal value, the external charging pump supplies the IC and the output current is regulated at its nominal value.

Figure 49. Short-circuit removal at 100 Vac - 50 Hz



CH1: DRAIN pin
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

Figure 50. Short-circuit removal at 230 Vac - 50 Hz



CH1: DRAIN pin
CH2: CS pin
CH3: V_{OUT}
CH4: V_{CC} pin

4 Support material

Documentation

HVLED815PF datasheet: “Offline LED driver with primary-sensing and high power factor up to 15 W”.

5 Revision history

Table 10. Document revision history

Date	Revision	Changes
29-Oct-2013	1	Initial release.