AN3360
Application note

3.2 W LED power supply based on HVLED805

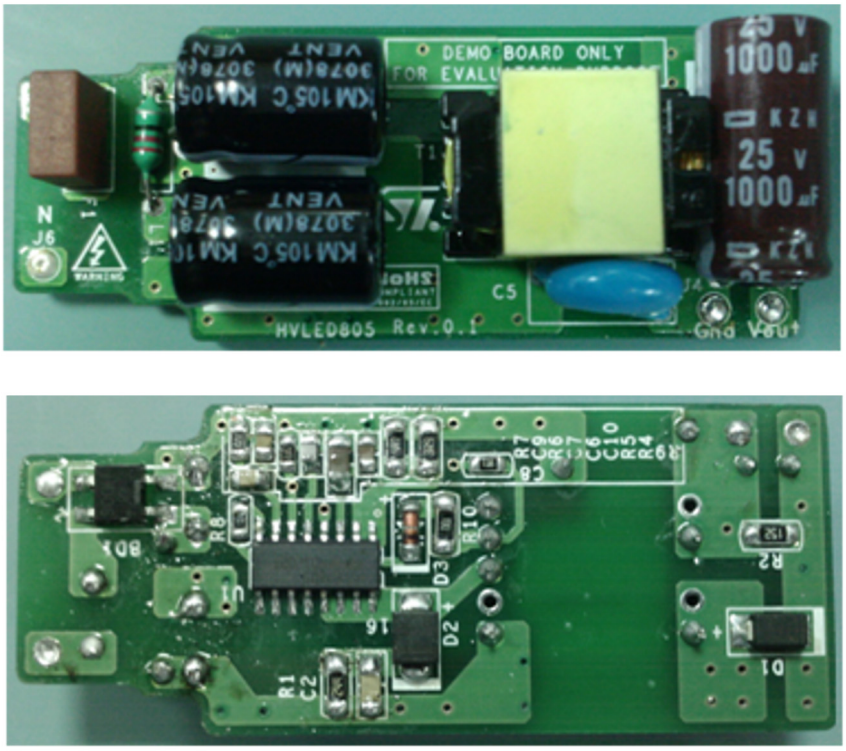
Introduction

This application note describes the demonstration board of the all-primary sensing switching regulator HVLED805 and presents the results of its bench evaluation. The board implements a 3.2 W (16 V / 0.2 A) wide range mains LED power supply with constant current.

HVLED805 combines a high-performance low-voltage PWM controller chip and an 800 V avalanche rugged power MOSFET in the same package. The PWM chip is a quasi-resonant (QR) current mode controller IC specifically designed for QR ZVS (zero voltage switching at switch turn-on) flyback converters. The device provides constant output current (CC) regulation using primary sensing feedback. This eliminates the need for the optocoupler, the secondary voltage reference, and also the current sensor, while still maintaining quite accurate regulation. The device can provide a constant output voltage regulation (CV). This makes the application able to work safely when the LED string opens due to a failure.

However, an auxiliary winding is required in the transformer to correctly perform CV/CC regulation, the chip is able to power itself directly from the rectified mains. This is useful during CC regulation, where the flyback voltage generated by the winding drops.

Figure 1. STEVAL-ILL037V1 demonstration board image



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1 Test board design and evaluation

As a reference design, a 3.2 W LED power supply based on HVLED805 is presented.

- *Table 1* summarizes the electrical specifications of the application
- *Table 2* provides the bill of material
- *Table 4* lists transformer specifications

The electrical schematic is shown in *Figure 3* and the PCB layout in *Figure 4*. and *5*.

Table 1. STEVAL-ILL037V1 demonstration board: electrical specifications

Parameter	Value
Input voltage range (V_{IN})	90 - 265 V_{AC}
Mains frequency (f_L)	50 - 60 Hz
Output power consumption	3.2 W
Output voltage	16 V_{DC} (3~5 LEDs)
Output current	200 mA
Target average efficiency	>70%

Figure 2. For E26/E27 application

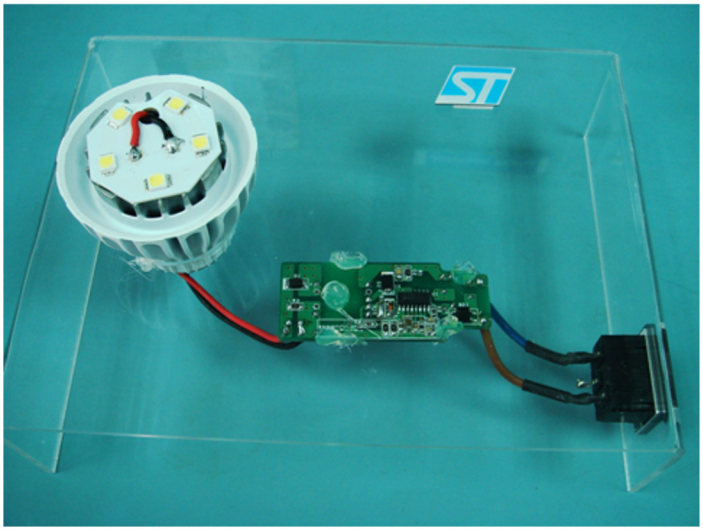

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Figure 3. Electrical schematic

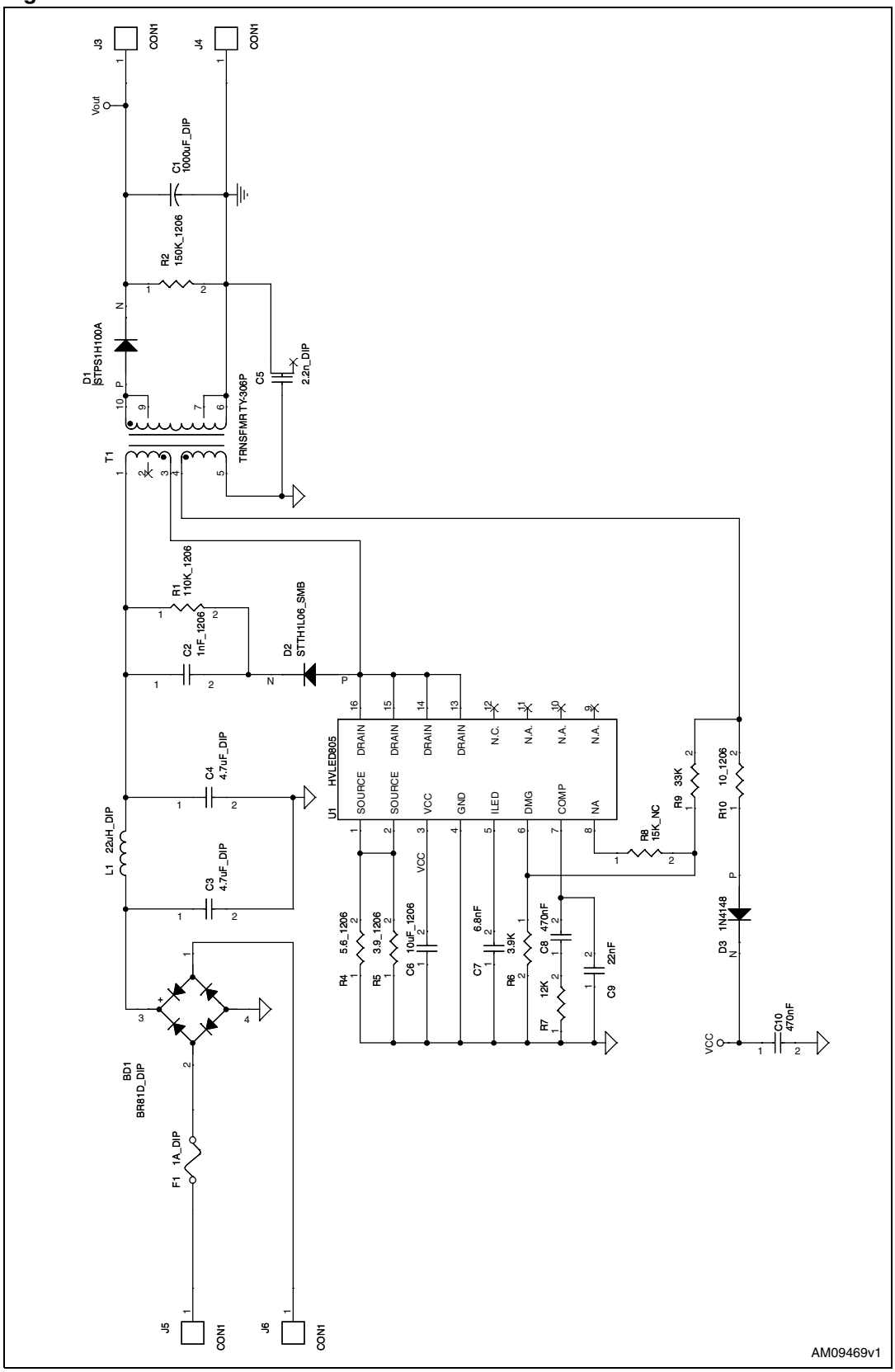


Table 2. STEVAL-ILL037V1 demonstration board bill of material

Reference	Part	Note
BD1	BR81D	
C1	1000 µF_DIP	
C2	1 nF_1206	
C3,C4	4.7 µF_DIP	
C5	2.2 nF_DIP	
C6	22 µF_1206	X5R
C7	6.8 nF	X7R
C8	470 nF	X7R
C9	22 nF	X7R
C10	470 nF	X7R
D1	STPS1H100U	STMicroelectronics
D2	STTH1L06_SMB	STMicroelectronics
D3	1N4148	CHENMKO
F1	1A_DIP	
L1	22 µH_DIP	
R1	110 kΩ_1206	5%
R2	150 kΩ_1206	5%
R4	5.6 Ω_1206	1%
R5	3.9 Ω_1206	1%
R6	3.9 kΩ	1%
R7	12 kΩ	1%
R8	NC	
R9	33 kΩ	1%
R10	10 Ω_1206	5%
T1	QEE13	Yu-Jing
U1	HVLED805	STMicroelectronics

Figure 4. PCB top side and through hole components

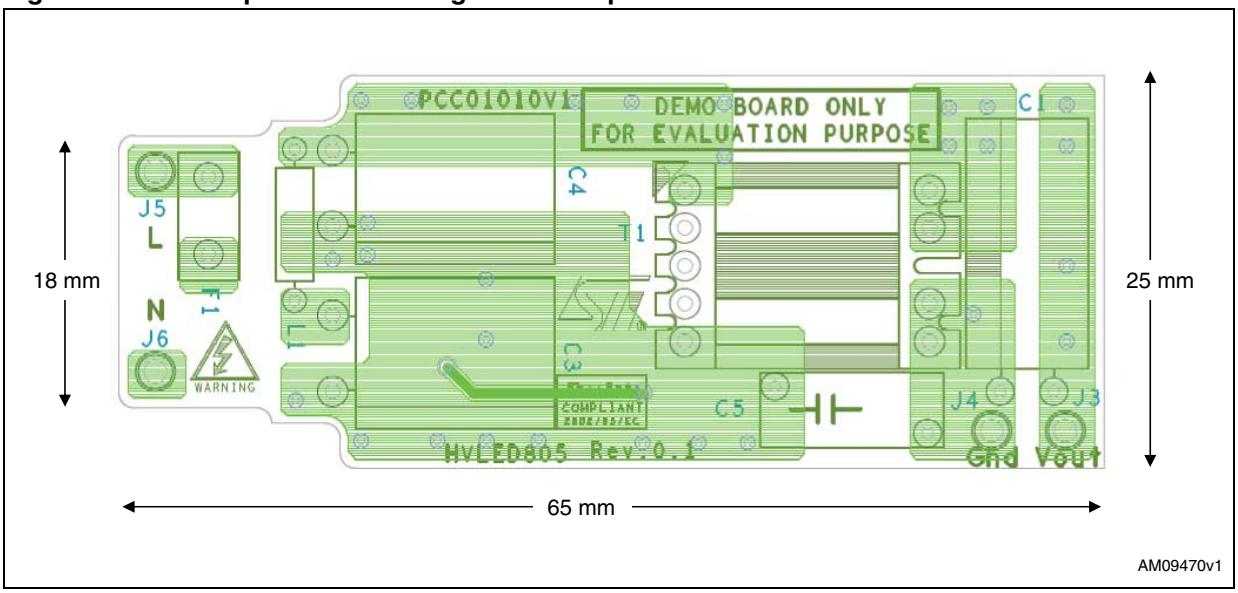
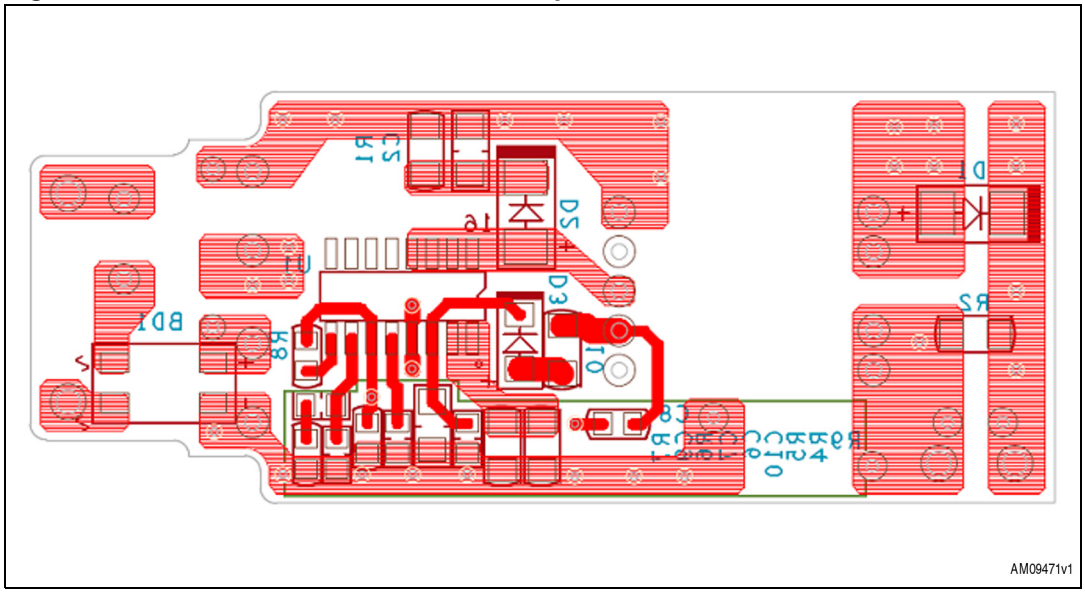


Figure 5. PCB bottom side and SMD components



2 Transformer specification

Figure 6. EEE13-11 vertical type for under 10 W

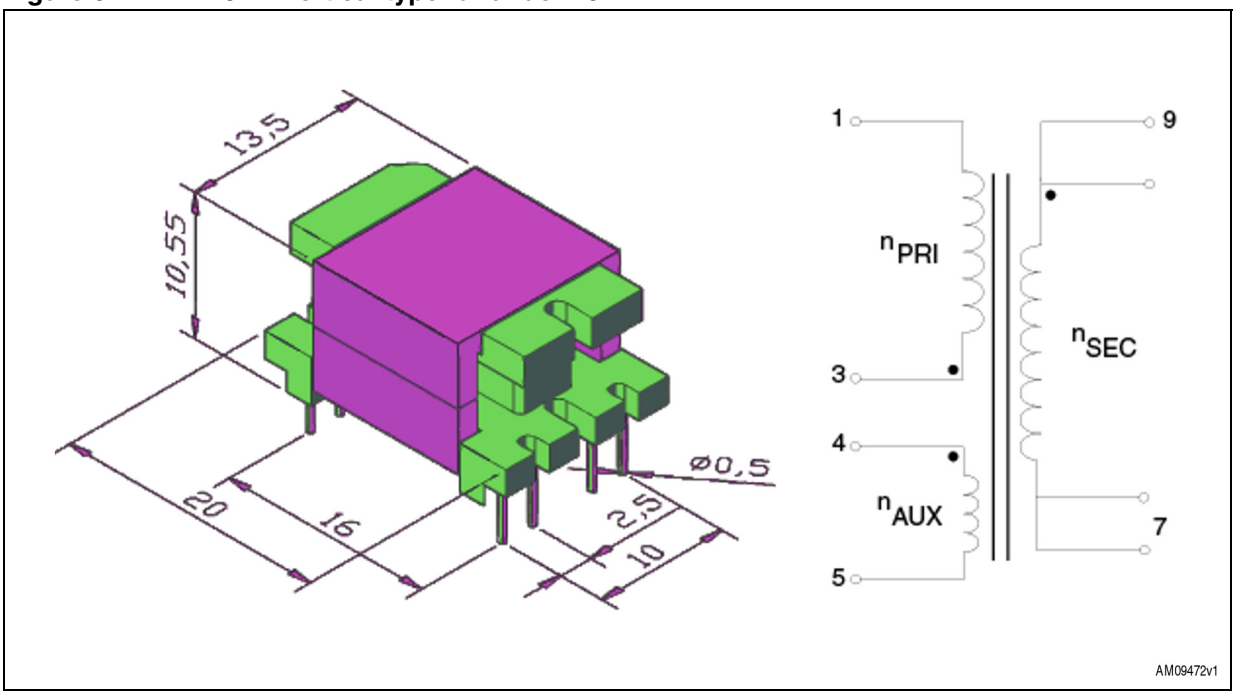


Table 3. Transformer specification

Core spec-EEE13							
Ae	36.7 mm^2		Le	27 mm	AW	2.5 mm*4.8 mm	
Wiring spec. for flyback 16 V output							
No.	Start	Finish	Wire	Winding	Turns	Inductance	LK inductance
L1	3	1	0.2 Φ*1C	Primary	72	1.9 mH±10%	31 µH ref.
L2	9	7	0.35 Φ*1C	Secondary	15	96 µH±10%	
L3	4	5	0.2 Φ*1C	AUX	20	85 µH ref.	

Note: Class B insulation system: SB14.2

- With standing voltage:
  - 1.0 kV/1 sec/AC/5 mA, primary to secondary
  - 0.5 kV/1 sec/AC/3 mA, primary to core
  - 1.0 kV/1 sec/AC/3 mA, secondary to core
- Manufacturer:
  - Yu-Jing Technology Co., LTD www.yujingtech.com.tw
  - Inductor P/N: 11999-310V600110 (EEE13-11V)

3 Efficiency measurements

The efficiency of the converter has been measured in different load and line voltage conditions.

The efficiency measurements have been done at 12 to 16 V_{DC} of the rated output power, at both 115 V_{AC} and 230 V_{AC}.

Table 4 and *5* show the results.

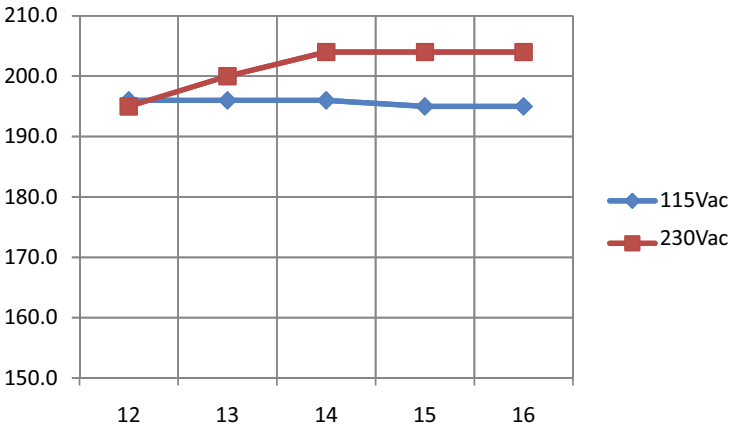
Table 4. Efficiency at 115 V_{AC}

V_{AC}	Pin (W)	Vout (V)	Iout (mA)	Eff (%)
115	2.972	12.016	196.00	79.24
	3.190	13.008	196.00	79.92
	3.420	14.016	196.00	80.33
	3.644	15.008	195.00	80.31
	3.877	16.016	195.00	80.56
Average eff. (%)				80.07

Table 5. Efficiency at 230 V_{AC}

V_{AC}	Pin (W)	Vout (V)	Iout (mA)	Eff (%)
230	3.238	12.016	195.00	72.36
	3.500	13.008	200.00	74.33
	3.792	14.016	204.00	75.40
	4.050	15.008	204.00	75.60
	4.262	16.016	204.00	76.66
Average eff. (%)				74.87

Figure 7. Output characteristics



4 Typical board waveforms

Drain voltage and current waveforms were reported for the two nominal input voltages and for the minimum and the maximum voltage of the converter input operating range. *Figure 8* and *9* show the drain current and the drain voltage waveforms at the nominal input voltages and full load.

At low load OC enters into burst mode, reducing the switching frequency down to a minimum fixed value; *Figure 10* and *11* show the typical waveforms during no load conditions at both 115 V_{AC} and 230 V_{AC} circuits at nominal input voltage.

The CC mode technique eliminates the need for overload protection; in fact, the maximum output power is achieved on the corner point between CV mode and CC mode and coincides with the full load condition. *Figure 12* and *13* show the typical waveforms during short-circuit at nominal input voltage.

Figure 14 and *15* show the startup in full load conditions and nominal input voltage; the maximum drain-source voltage is well below the BVDSS of the IC.

Figure 8. Normal operation at full load - at 115 V_{AC}

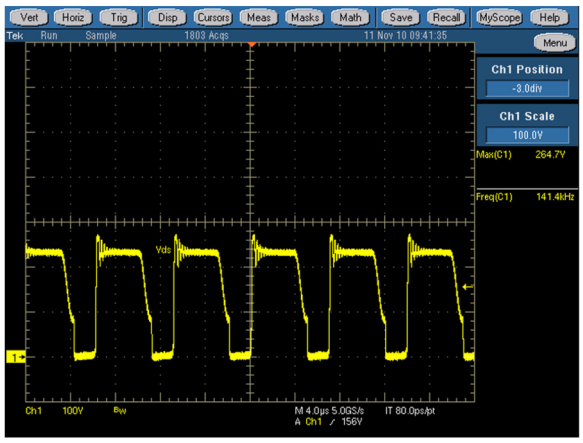


Figure 9. Normal operation at full load - at 230 V_{AC}

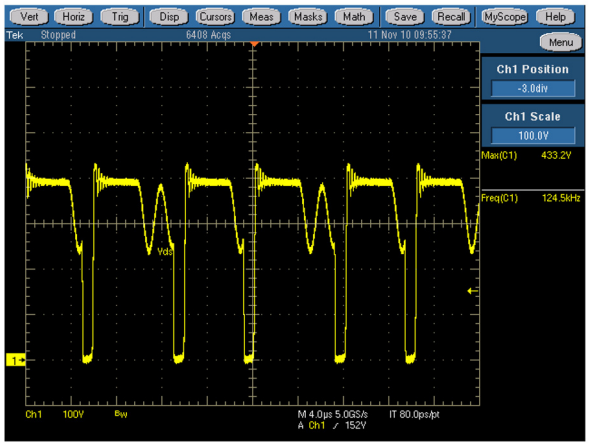


Figure 10. Normal operation at no load - at 115 V_{AC}

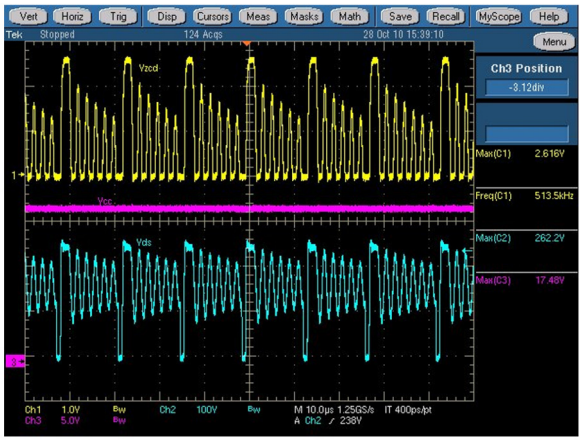


Figure 11. Normal operation at no load - at 230 V_{AC}

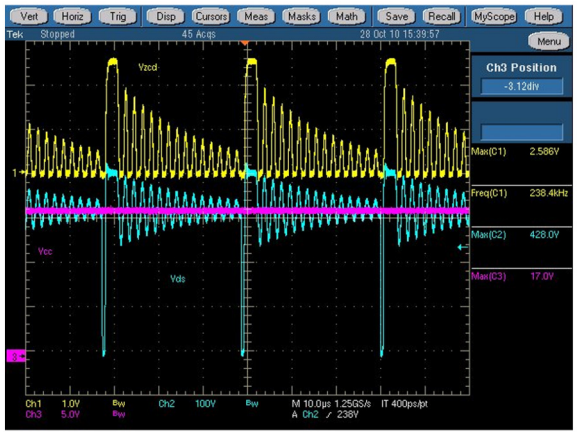


Figure 12. Short-circuit at 115 V_{AC}

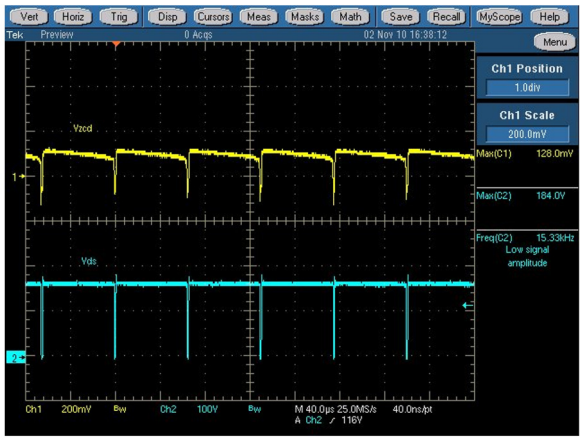


Figure 13. Short-circuit at 230 V_{AC}

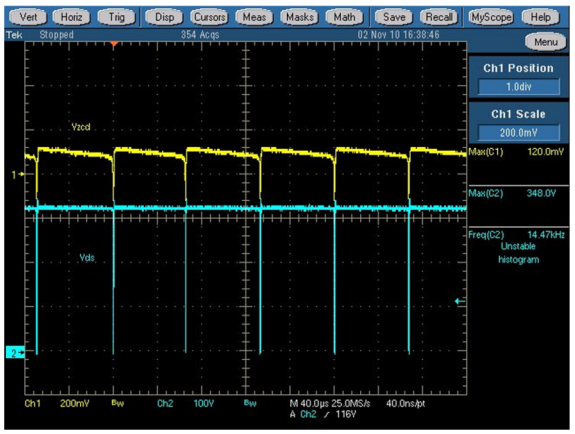


Figure 14. Startup at full load at 115 V_{AC}

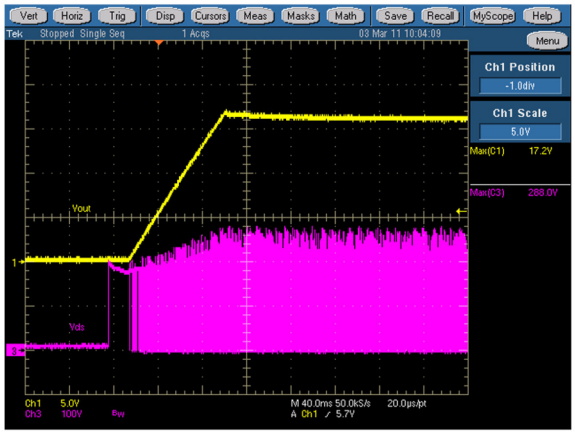


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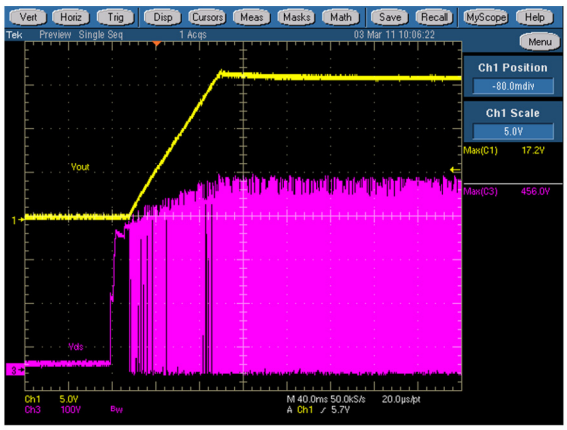
Figure 15. Startup at full load at 230 V_{AC}



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5 Conclusion

The LED power supply demonstration board using the HVLED805 device was presented and the results show that good performances can be obtained using this new device.

Auxiliary winding is required in the transformer to correctly perform CV/CC regulation, and the chip is able to power itself directly from the rectified mains. This is particularly useful during CC regulation, where the flyback voltage generated by the winding drops.

The HVLED805 is able to meet the most restrictive worldwide standards regarding efficiency. The embedded onboard protections and the 800 V power section considerably increase the end-product safety and reliability.

6 References

1. HVLED805 datasheet
2. AN3093 application note

7 Revision history

Table 6. Document revision history

Date	Revision	Changes
30-Mar-2011	1	Initial release.
21-Jul-2011	2	– Updated *Figure 3*. – Updated component D1 in *Table 2*.