15 W, 12 V output, isolated flyback converter using Viper35HD device from the VIPer™ Plus family of high voltage converters

Introduction

This document describes the STEVAL-ISA171V1 implementing a 15 W wide range SMPS based on the new VIPER35HD HV converter in the VIPer Plus quasi-resonant range of devices.

The STEVAL-ISA171V1 is designed to optimize efficiency and electrical performance, while restricting overall board dimensions.

1 Test board: Design and evaluation

Table 1. Evaluation board electrical specifications

Parameter	Min.	Typ.	Max.
AC main input voltage	90 V_{AC}		265 V_{AC}
Mains frequency (f_L)	50 Hz		60 Hz
Output voltage	11.5 V	12 V	12.5 V
Output current			1.25 A
Output ripple voltage			100 mV
Rated output power		15 W	
Input power in standby @ 230V_{AC}			30 mW
Active mode efficiency	83%		
Ambient operating temperature			50 °C

Figure 1. Electrical schematic

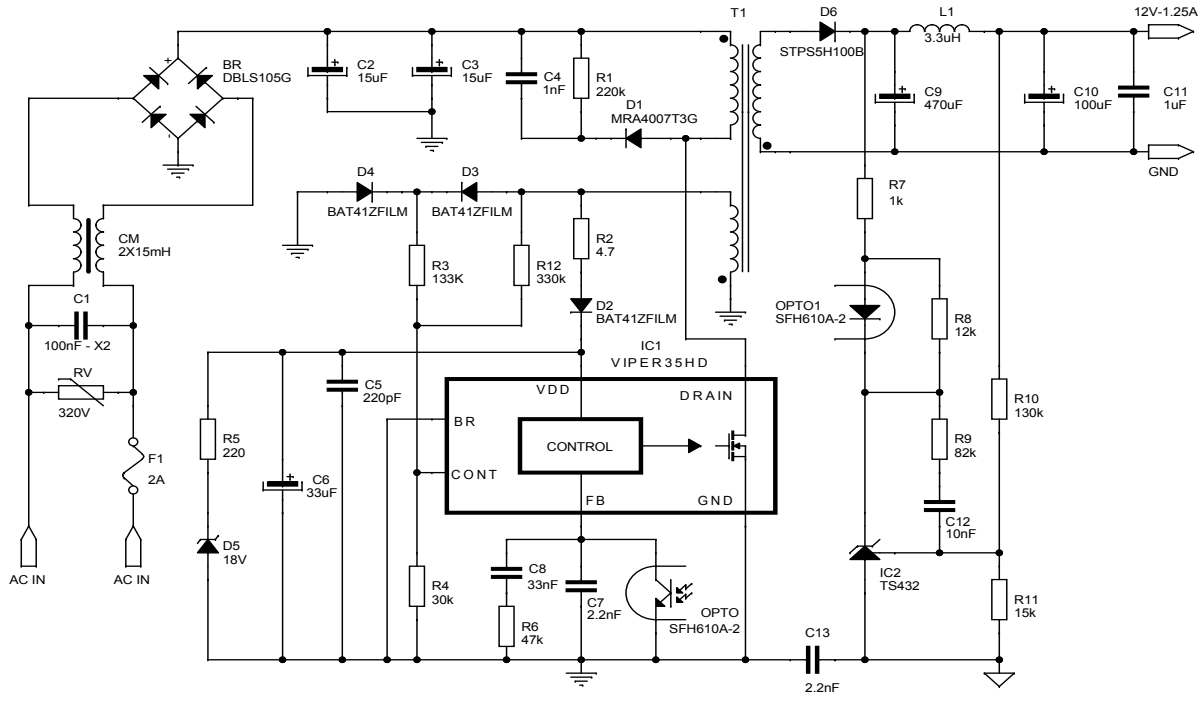


Figure 2. **Demo board picture: (30 x 72 mm.) max**

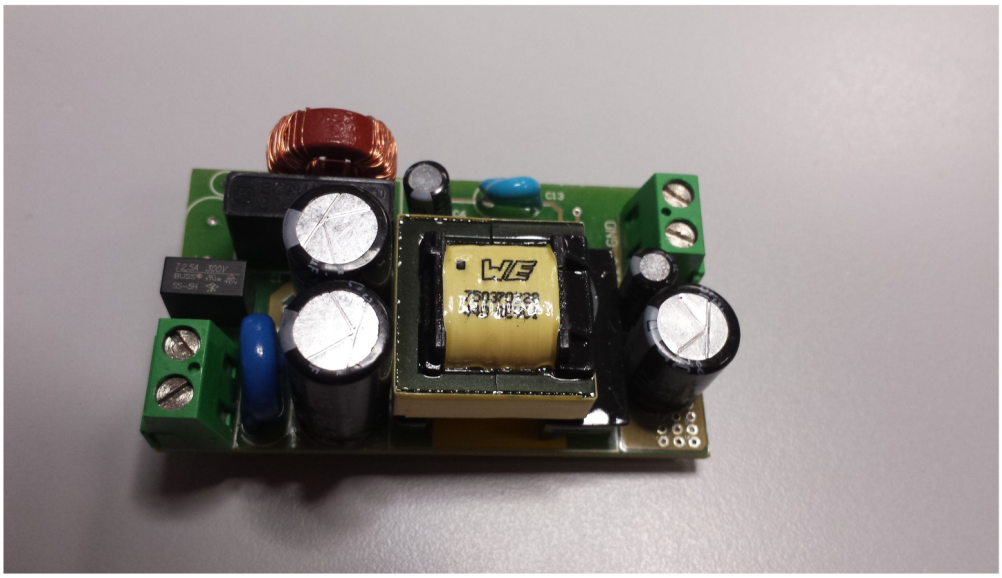


Table 2. **VIPer35H demonstration board bill of material**

Reference	Part	Manufacturer	Description
R1	ERJ-P08J224V	Panasonic	220kΩ±5% - 0.33W - 200V
R2	ERJ3RQF4R7V	Panasonic	4.7Ω±1% - 0.1W
R3	CRCW0603133KFKEA	Vishay	133kΩ±1% - 0.1W
R4	ERJP03F3002V	Panasonic	30kΩ±1% - 0.1W
R5	ERJT06J221V	Panasonic	220Ω±5% - 0.25W
R6	ERJ-3EKF4702V	Panasonic	47kΩ±1% - 0.1W
R7	ERJ3GEYJ102V	Panasonic	1kΩ±5% - 0.1W
R8	ERJ3GEYJ123V	Panasonic	12kΩ±5% - 0.1W
R9	ERJ3GEYJ823V	Panasonic	82kΩ±5% - 0.1W
R10	ERJP03F1203V	Panasonic	130kΩ±1% - 0.2W
R11	ERJP03F1502V	Panasonic	15kΩ±1% - 0.2W
R12	ERJ3RED3303V	Panasonic	330kΩ±1% - 0.1W
C1	ECQUAAF104M	Panasonic	100nF-275V X2 cap
C2	UVC2G150MPD	Nichicon	Elcap 15uF-400V
C3	UVC2G150MPD	Nichicon	Elcap 15uF-400V
C4	C3216C0G2J102JT	TDK	MLCC capacitor 1nF-630V
C5	GRM188R71H221KA01D	Murata	MLCC capacitor 220pF-16V
C6	35YXM33MEFC5X11	Rubycon	Elcap 33uF-35V
C7	GRM1885C1H222FA01D	Murata	MLCC capacitor 2.2nF-50V
C8	GRM188R71H333KA61D	Murata	MLCC capacitor 33nF-16V
C9	25ZLJ470M10X12.5	Rubycon	Elcap 470uF-25V
C10	25YXJ100M5X11	Rubycon	Elcap 100uF-25V
C11	GRM188C81E105KAADD	Murata	MLCC capacitor 1uF-25V

Reference	Part	Manufacturer	Description
C12	GRM188R71H103KA01D	Murata	MLCC capacitor 10nF-50V
C13	DE2E3KY222MA2BM01	Murata	Ceramic X1/Y1 cap. 2.2nF 250Vac
D1	MRA4007T3G	ON Semiconductor	1A-1000V Power rectifier diode
D2	BAT41ZFILM	STMictroelectronics	Signal schottky 0.15A-100V
D3	BAT41ZFILM	STMictroelectronics	Signal schottky 0.15A-100V
D4	BAT41ZFILM	STMictroelectronics	Signal schottky 0.15A-100V
D5	MMSZ5248B-V-GS08	Vishay	Zener diode 18V
D6	STPS5H100B	STMictroelectronics	Power Schottky 100V-5A
L1	SD43-332ML	Coilcraft	3.3uH
CM	744821120	Wurth Elektronik	20mH CM CHOKE
IC1	VIPer35HD	STMicroelectronics	Offline HV converter
OPT	SFH6106-2T	Vishay	Optocoupler
REF	TS432ILT	STMicroelectronics	Reference
T1	750370228 Rev. 6A	Wurth Elektronik	EE20/10/6 Flyback transformer
RV	B72210S0321K101	EPCOS	MOV
RB	DBLS105G	Taiwan Semicond.	Bridge rectifier
FS	SS-5H-2-5A-BK	Cooper Bussmann	2.5A fuse

Table 3. Transformer characteristics

Type	Characteristics
Manufacturer	Wurth Elektonik
Part number	750370228 Rev. 6A
Core	EE20/10/6
Ferrite	TBD
Primary Inductance	1.5 mH ±10%
Leakage inductance	45 µH max
Primary turns (N1+N3)	168
Secondary turns (N2)	21
Auxiliary turns (N4)	21

Figure 3. **Electrical scheme**

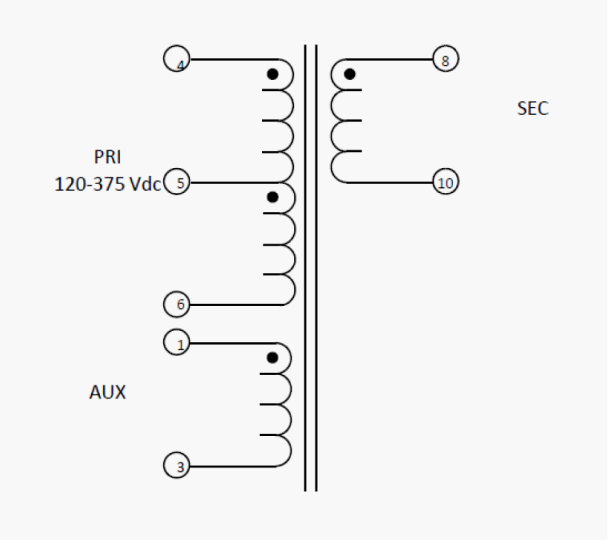


Figure 4. **Bottom view**

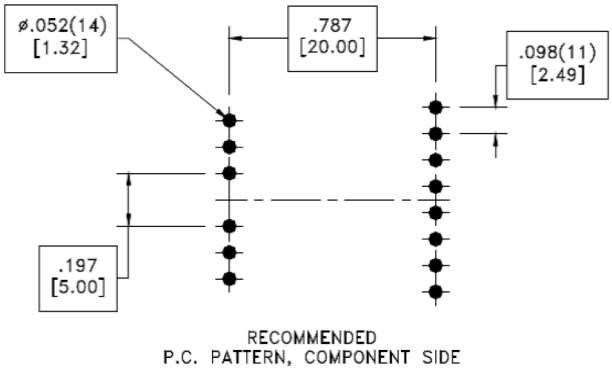
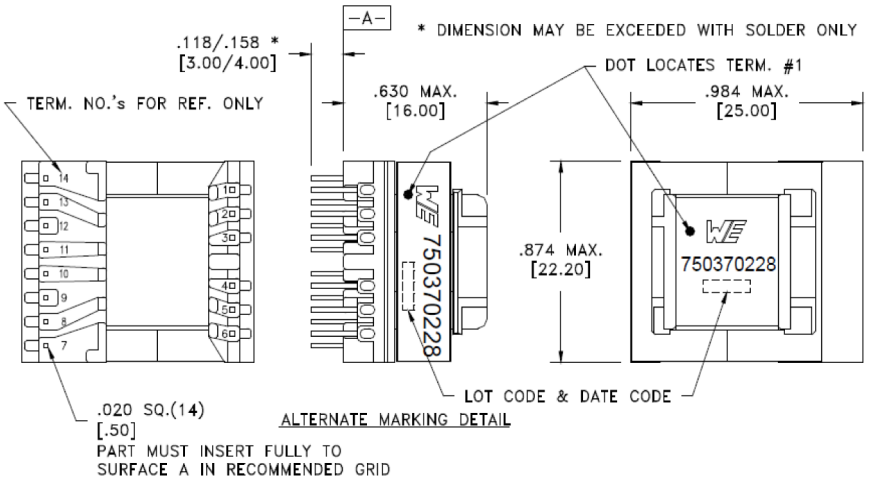


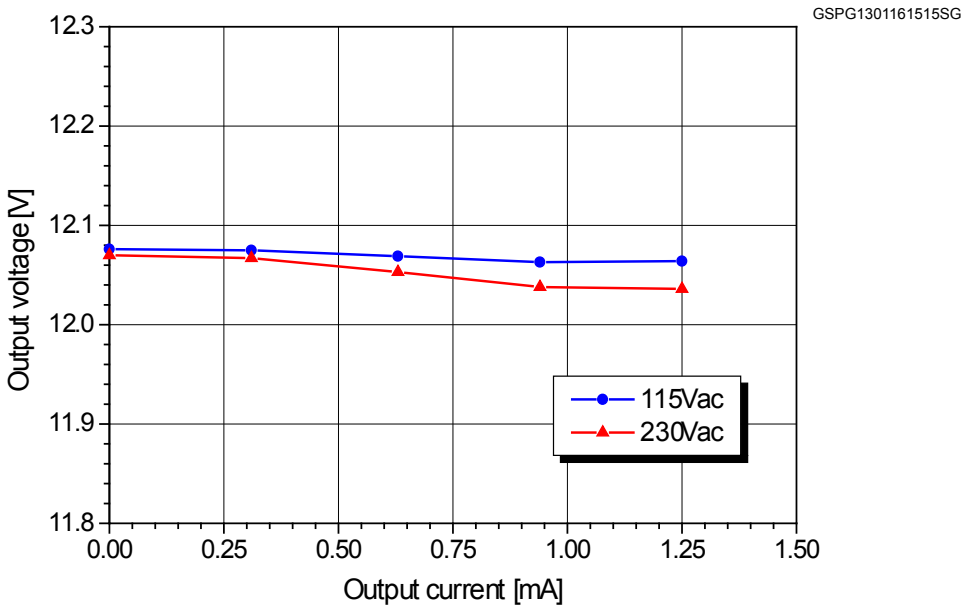
Figure 5. **Dimensions**



1.1 Output voltage characteristic

Figure 6. Line and load regulation shows the results of the board output voltage measured under different line and load conditions. The variation measured on the output connector is in the order of a few tens of millivolts across all the tested conditions.

Figure 6. Line and load regulation



1.2 Efficiency and light load measurements

Efficiency under different load conditions and 115 VAC and 230 VAC nominal input voltages is shown below, followed by the graphs for light load and no-load measurements.

Figure 7. Efficiency vs. output power

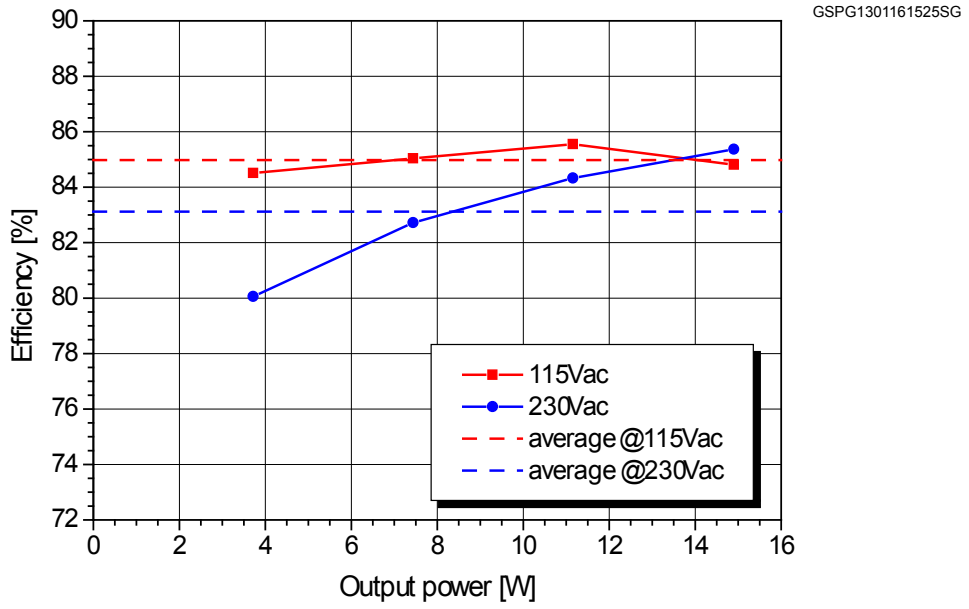


Table 4. Efficiency at 10% of the rated output load

Input voltage	Efficiency
115 V_{AC}	81.70 %
230 V_{AC}	77.16 %

Figure 8. No load consumption vs. input voltage

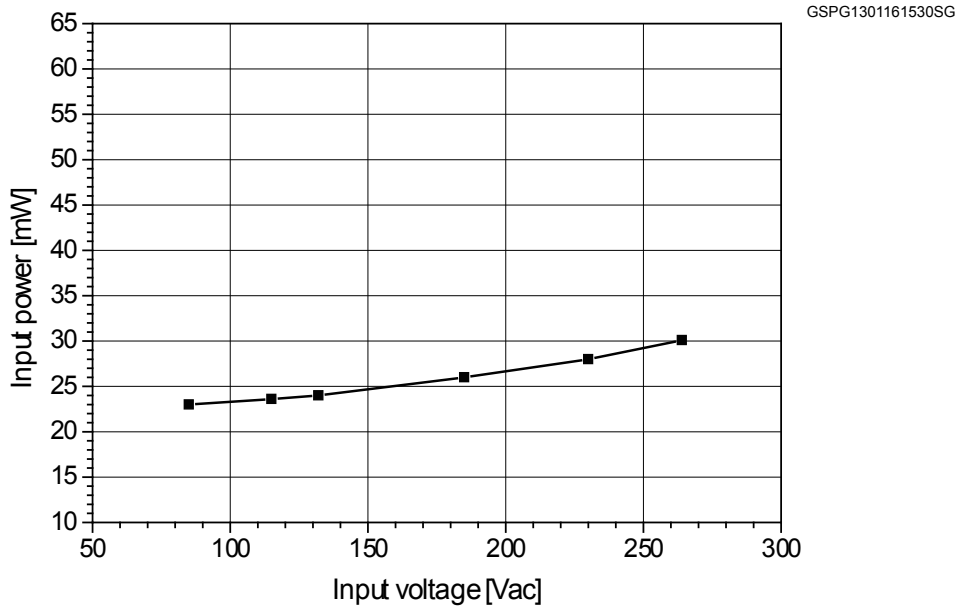
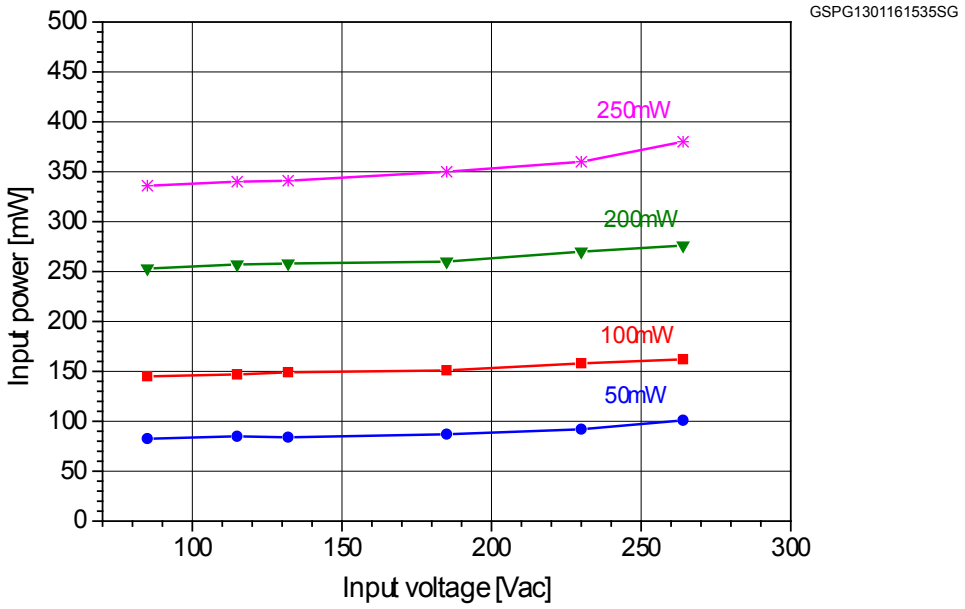


Figure 9. Light load consumptions at different output powers



1.3 Typical board waveforms

Drain voltage and current waveforms are given at nominal input voltages and full load in Figure 10. Drain current and drain voltage at full load at 115 V_{AC} .

The startup phase is shown in Figure 9. Light load consumptions at different output powers, where the IC starts with a very clean waveforms and no overshoots or undershoots appear on the output.

The output voltage under dynamic load variation is also measured to test stability and to ensure no overvoltage or undervoltage occurs. Figure 14. Step load from no load to full load at 115 V_{AC} to Figure 17. Step load from half load to full load at 230 V_{AC} give the outputs for the board when subjected to variations from 0% to 100% nominal load and from 50% to 100% nominal load. No abnormal oscillations were noticed on the output and overshoot and undershoot phenomena were well within acceptable limits. Figure 11. Drain current and drain voltage at full load at 230 V_{AC} shows that the ripple at full load and light load is also within the specification range.

Figure 10. Drain current and drain voltage at full load at 115 V_{AC}

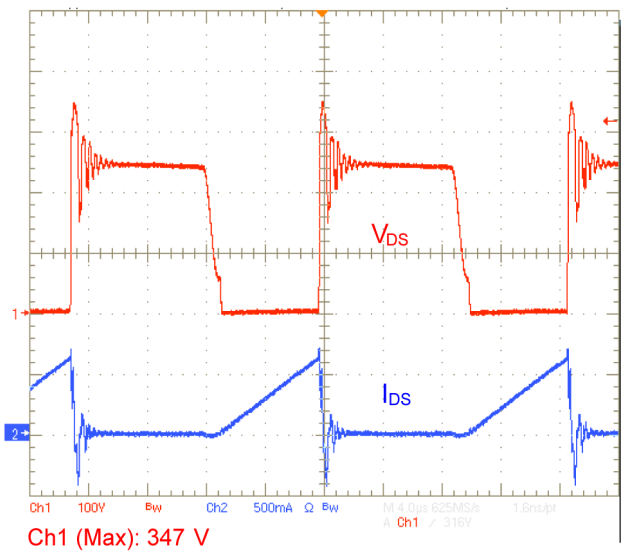


Figure 11. Drain current and drain voltage at full load at 230 V_{AC}

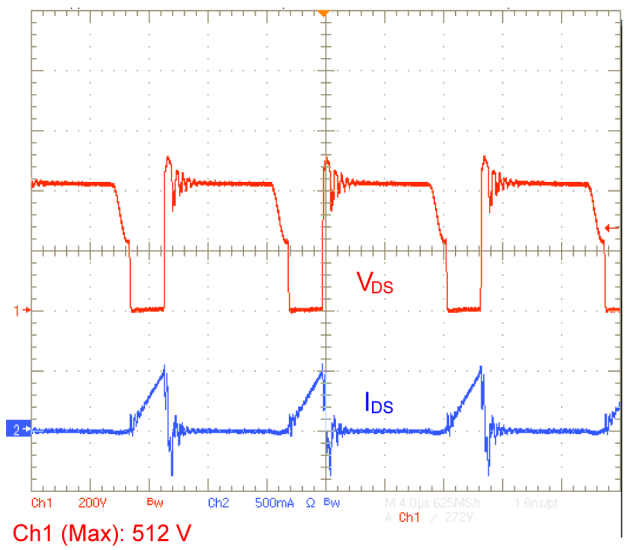
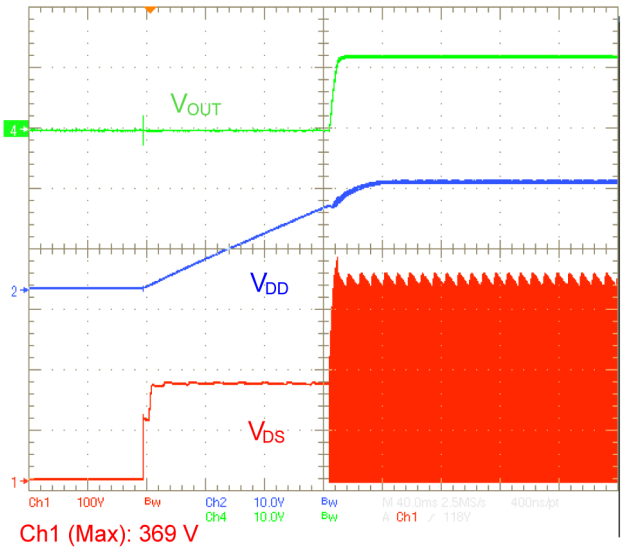


Figure 12. Startup at full load at 115 V_{AC}

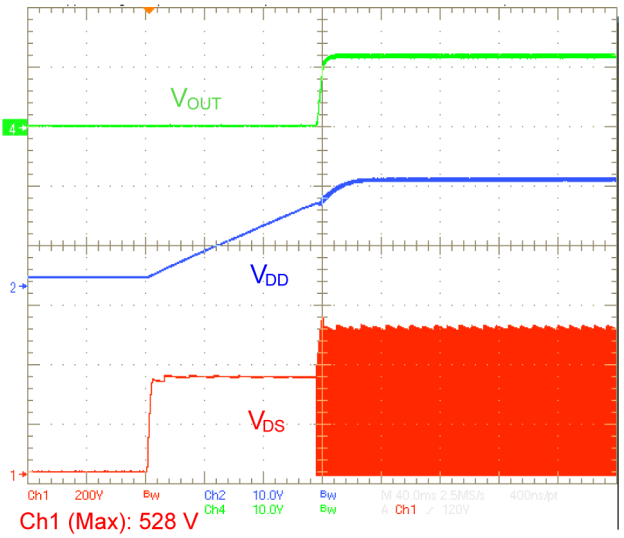
GSPG1301161600SG



Ch1 (Max): 369 V
Ch2 (Max): 18.19 mA
Ch4 (Max): 12.22V
M: 40.0 µs/div

Figure 13. Startup at full load at 230 V_{AC}

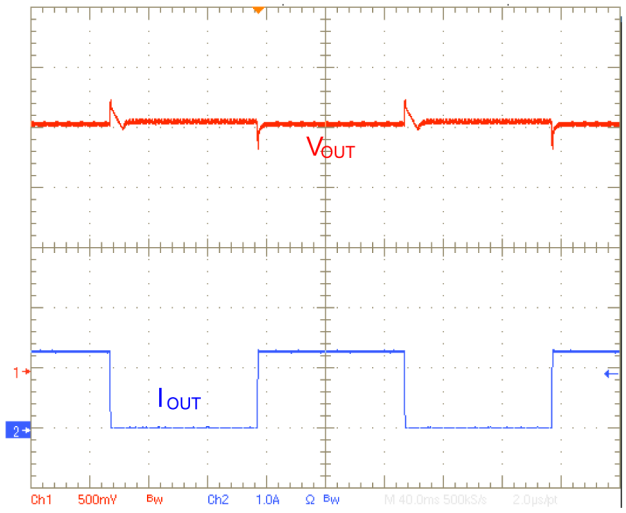
GSPG1301161610SG



Ch1 (Max): 528 V
Ch2 (Max): 18.19 mA
Ch4 (Max): 12.28V
M: 40.0 µs/div

Figure 14. Step load from no load to full load at 115 V_{AC}

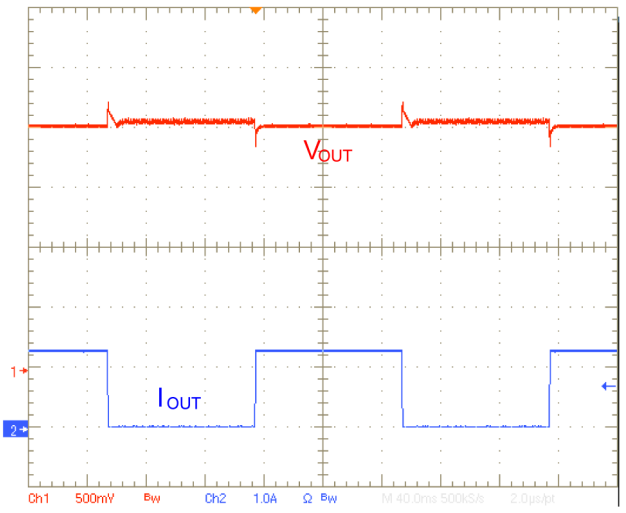
GSPG1301161615SG



Ch1 (Max): 12.25 V
Ch1 (Max): 11.9 V
Ch2 (Max): 0 A
Ch2 (Max): 1.25 A
M: 40.0 µs/div

Figure 15. Step load from no load to full load at 230 V_{AC}

GSPG1301161620SG



Ch1 (Max): 12.22 V
Ch1 (Max): 11.92 V
Ch2 (Max): 0 A
Ch2 (Max): 1.25 A
M: 20.0 µs/div

Figure 16. Step load from half load to full load at 115 V_{AC}

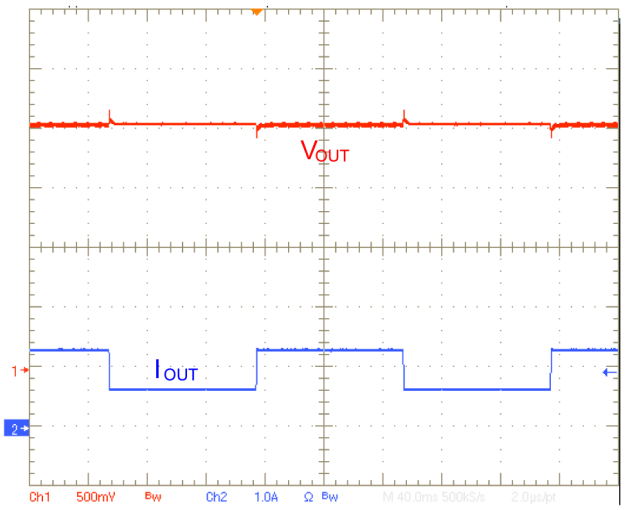


Figure 17. Step load from half load to full load at 230 V_{AC}

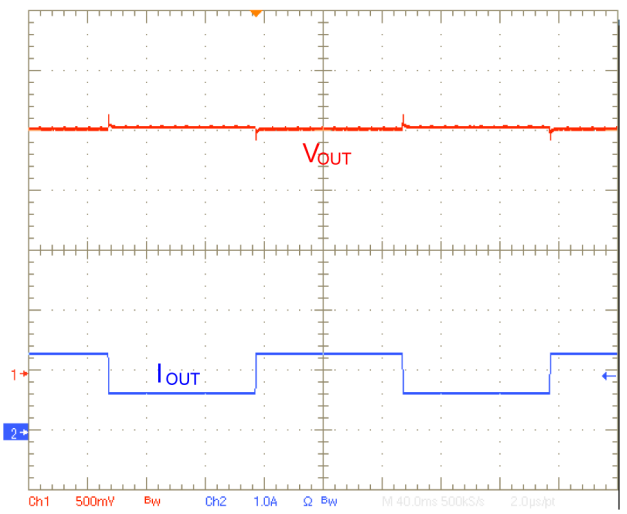
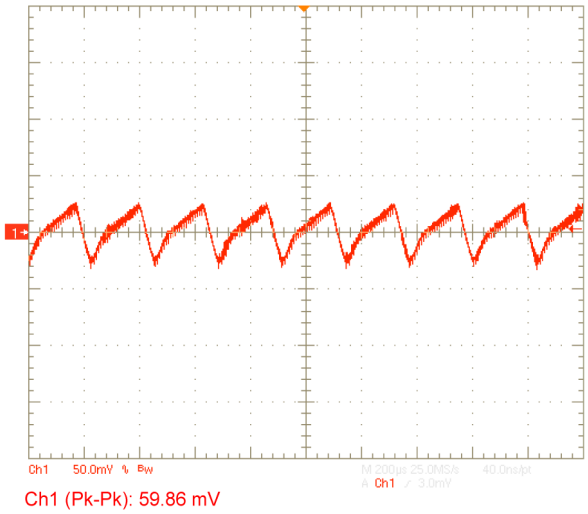


Figure 18. Output voltage ripple at no load

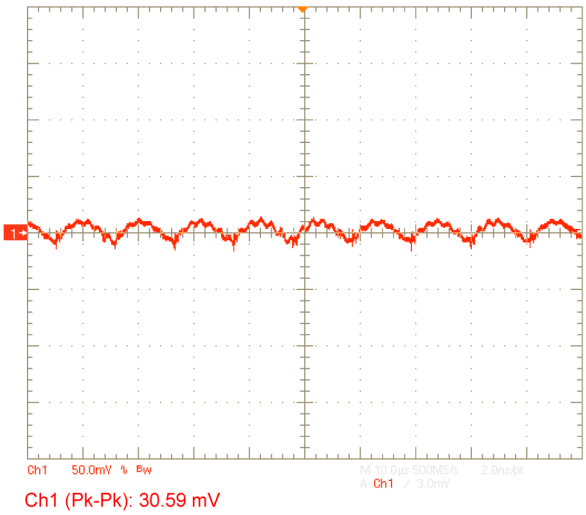
GSPG1501161050SG



Ch1 (Pk-Pk): 59.86 mV
M: 200.0 µs/div

Figure 19. Output voltage ripple at full load

GSPG1501161055SG



Ch1 (Pk-Pk): 30.59 mV
M: 10.0 µs/div

2 Conducted noise measurements

A pre-compliance test for EN55022 (Class B) European normative was conducted using average the measurements detected for the conducted noise emissions at full load and nominal mains voltages. Figure 20. CE average measurement at 115 V_{AC} and full load and Figure 21. CE average measurement at 230 V_{AC} and full load: peak measurement show the results. As seen in the diagrams, the measurements under test conditions are well within the prescribed limits.

Figure 20. CE average measurement at 115 V_{AC} and full load

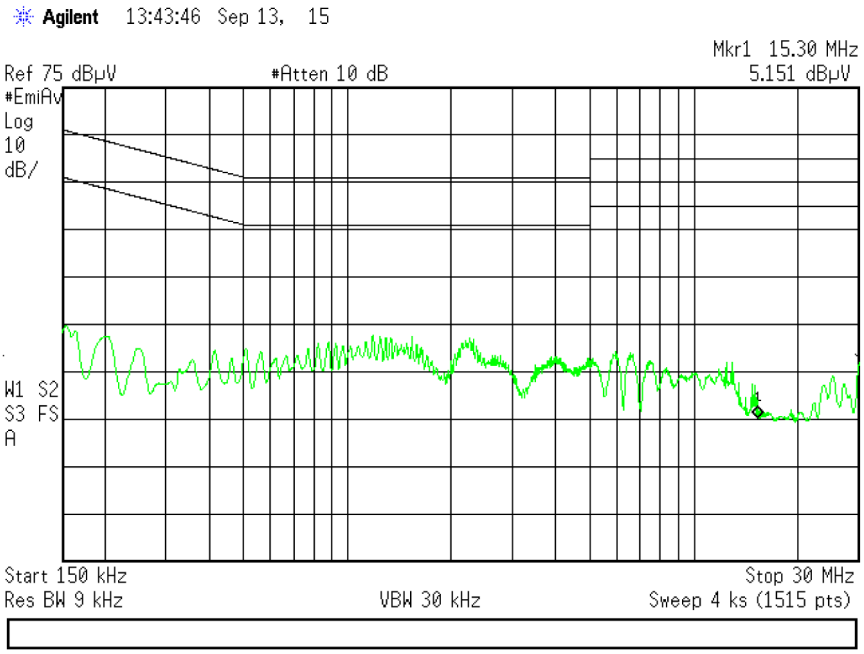
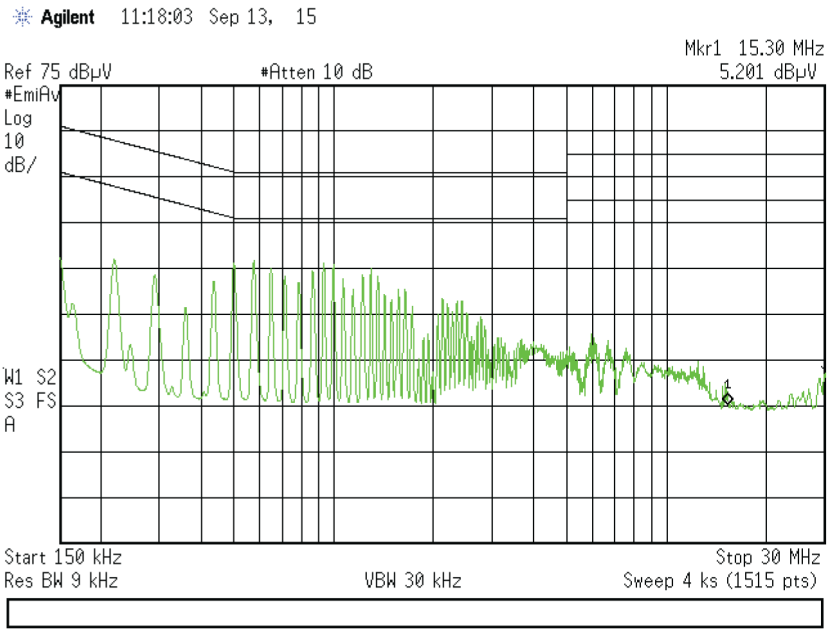


Figure 21. CE average measurement at 230 V_{AC} and full load: peak measurement



3 Conclusions

The results presented here for a 15 W wide range single output flyback converter using the new VIPER35HD demonstrate that these power supply units are especially suitable for applications requiring an external adapter or auxiliary power supply able to deliver high performance while maintaining a relatively small dimensions.

4 Demonstration tools and documentation

The VIPER35HD evaluation board order code is STEVAL-ISA171V1. Consult the VIPer35 datasheet at www.st.com for further information.

Revision history

Table 5. **Document revision history**

Date	Revision	Changes
25-Jan-2016	1	Initial release.
19-Sep-2019	2	Updated Figure 1. Electrical schematic

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