AN4419
Application note

VIPER37HE: 15 W wide range single output evaluation board

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Introduction

This application note describes a 15 W wide range evaluation board, based on Viper37HE, which is designed as an example of an isolated auxiliary power supply.

The board and the transformer were designed and optimized in order to have a very compact size evaluation board.

Contents

1 Test board: design and evaluation

Table 1 summarizes the electrical specification of the power supply, *Table 2* provides the BOM and *Table 4* lists transformer's spec. The electrical schematic is shown in *Figure 2* and the PCB layout in *Figure 3* and *Figure 4*.

Table 1. VIPer37H evaluation board electrical specification

Parameter	Min.	Typ.	Max.	Unit
AC Main Input voltage	100		265	V_{AC}
Mains frequency (f_L)	50		60	Hz
Output Voltage	11.7	12 V	12.3	V
Output Current			1.25	A
Output ripple voltage			50	mV
Rated output power		15		W
Input power in standby @ 230V_{AC}			50	mW
Active mode efficiency	78			%
Ambient operating temperature			60	°C

Figure 1. Electrical schematic

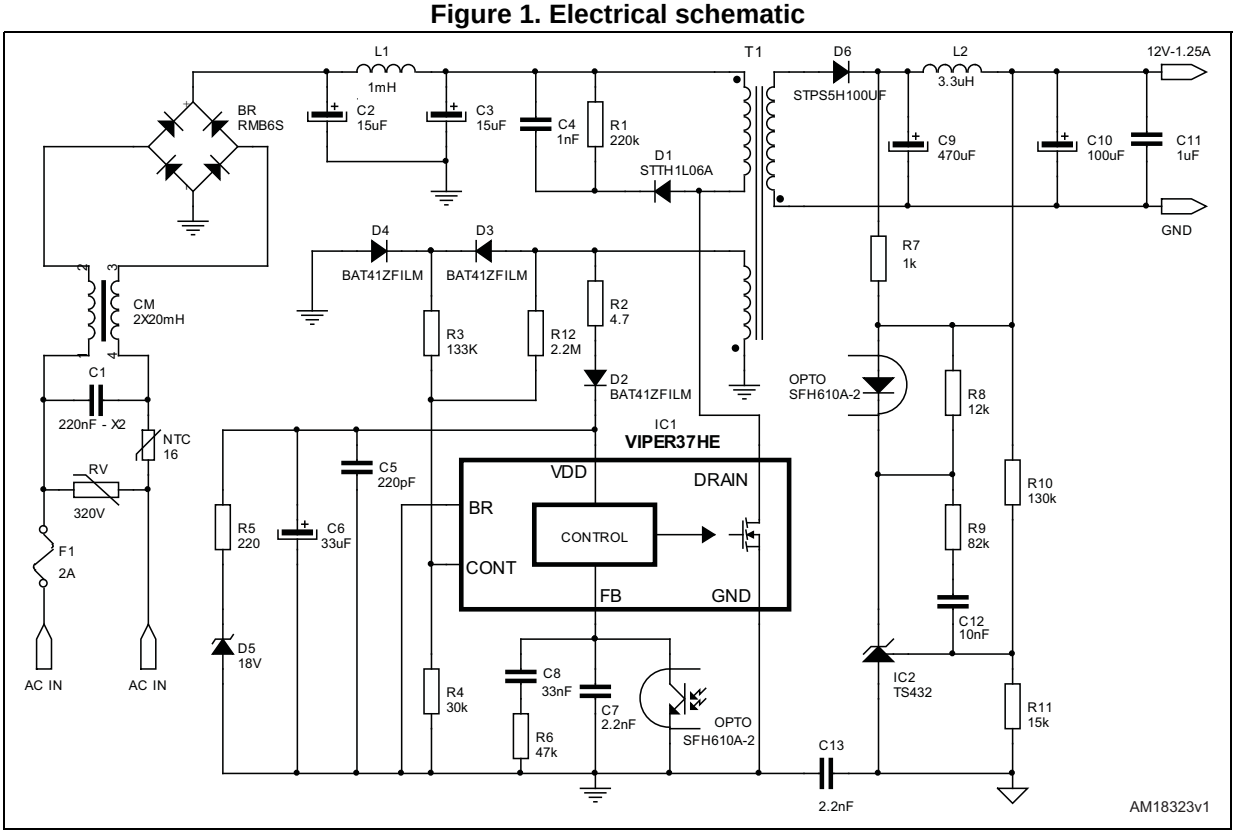

Figure 2. Evaluation board (30 x 72 mm) max

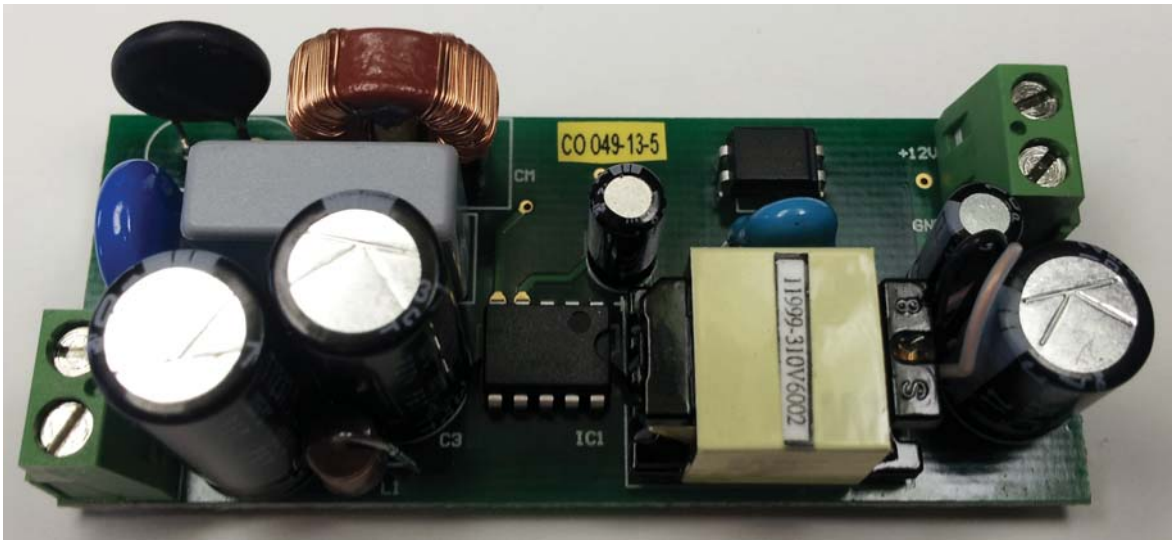

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Table 2. VIPer37H evaluation board: bill of material

Reference	Part	Description	Note
R1		220 kΩ	0.33 W – 200 V
R2		4.7 Ω	1% tolerance
R3		133 kΩ	1% tolerance
R4		30 kΩ	1% tolerance
R5		220 Ω	0.25 W
R6		47 kΩ	1% tolerance
R7		1 kΩ	
R8		12 kΩ	
R9		82 kΩ	1% tolerance
R10		130 kΩ	1% tolerance
R11		15 kΩ	1% tolerance
R12		2.2 MΩ	1% tolerance
C1	BFC233920224	220 nF - 275 V x 2	Vishay
C2, C3	450BXF15M10X20	15 µF - 450 V electrolytic	Rubycon
C4	C3216C0G2J102JT	1 nF - 630 V MLCC	TDK
C5	GRM188R71H221KA01D	220 pF - 16 V MLCC	Murata
C6	35YXM33MEFC5X11	33 µF - 35 V electrolytic	Rubycon
C7	GRM1885C1H222FA01D	2.2 nF - 50 V MLCC	Murata
C8	GRM188R71H333KA61D	33 nF -16 V MLCC	Murata
C9	25ZLJ470M10X12.5	470 µF - 25 V electrolytic	Rubycon

Table 2. VIPer37H evaluation board: bill of material (continued)

Reference	Part	Description	Note
C10	25YXJ100M5X11	100 µF - 25 V electrolytic	Rubycon
C11	GRM188C81E105KAADD	1 µF - 25 V MLCC	Murata
C12	GRM188R71H103KA01D	10 nF - 50 V MLCC	Murata
C13	DE2E3KY222MA2BM01	2.2 nF - 250 V X1/Y1 CAP	Murata
D1	STTH1L06A	Ultra-fast diode 600 V - 1 A	STMicroelectronics
D2, D3, D4	BAT41ZFILM	Signal Schottky diode	STMicroelectronics
D5	MMSZ5248B-V-GS08	18 V Zener diode	Vishay
D6	STPS5H100B	Power Schottky 100 V - 5 A	STMicroelectronics
L1	B82144A2105J	1 mH Axial inductor	Epcos
L2	SD43-332ML	3.3 µH Power inductor	Coilcraft
CM	744821120	20 mH CM choke	Wurth Elektronik
IC1	VIPer37LE	Offline HV converter	STMicroelectronics
IC2	TS432ILT	1.24 V Shunt voltage reference	STMicroelectronics
OPTO	SFH610A-2	Optocoupler	Vishay
TF	YJ-310V600210	Flyback transformer	Yujing Technology
BR	RMB6S	Bridge 600 V - 1 A	Taiwan Semiconductor
NTC	B57236S160M	NTC Inrush current limiter	Epcos
Fs	0461002.ER	2 A fuse	Littlefuse

Note: If not otherwise specified, all resistors are ± 5%, 0.1 Ω

Table 3. Transformer characteristic

Reference	Description
Manifacturer	Yujing Technology CO. LTD.
Part number	YJ-310V600210
Core	EEE - 13 V
Ferrite	3C94 Ferroxcube
Primary Inductance	0.85 mH ±10%.
Leakage inductance	40 µH max
Primary turns (N1+N3)	75
Secondary turns (N2)	12
Auxiliary turns (N4)	14

Figure 3. Electrical scheme

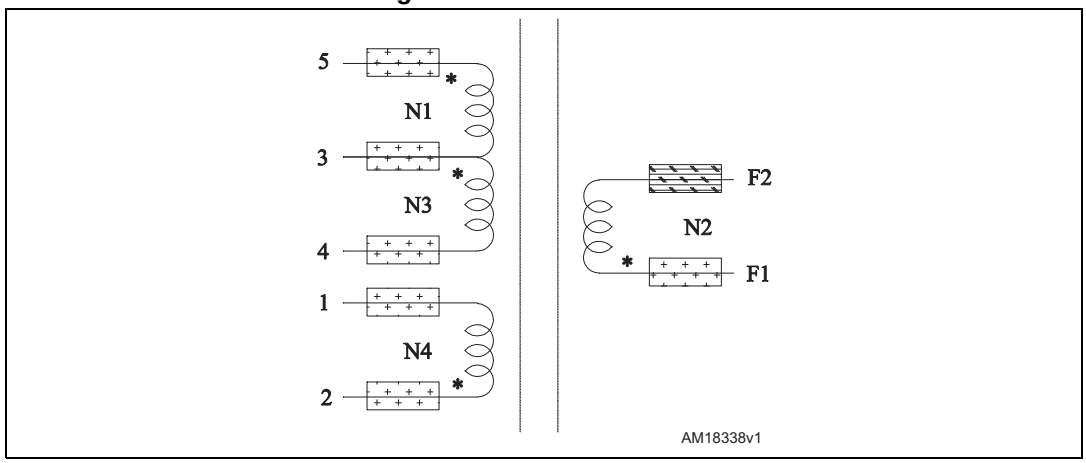
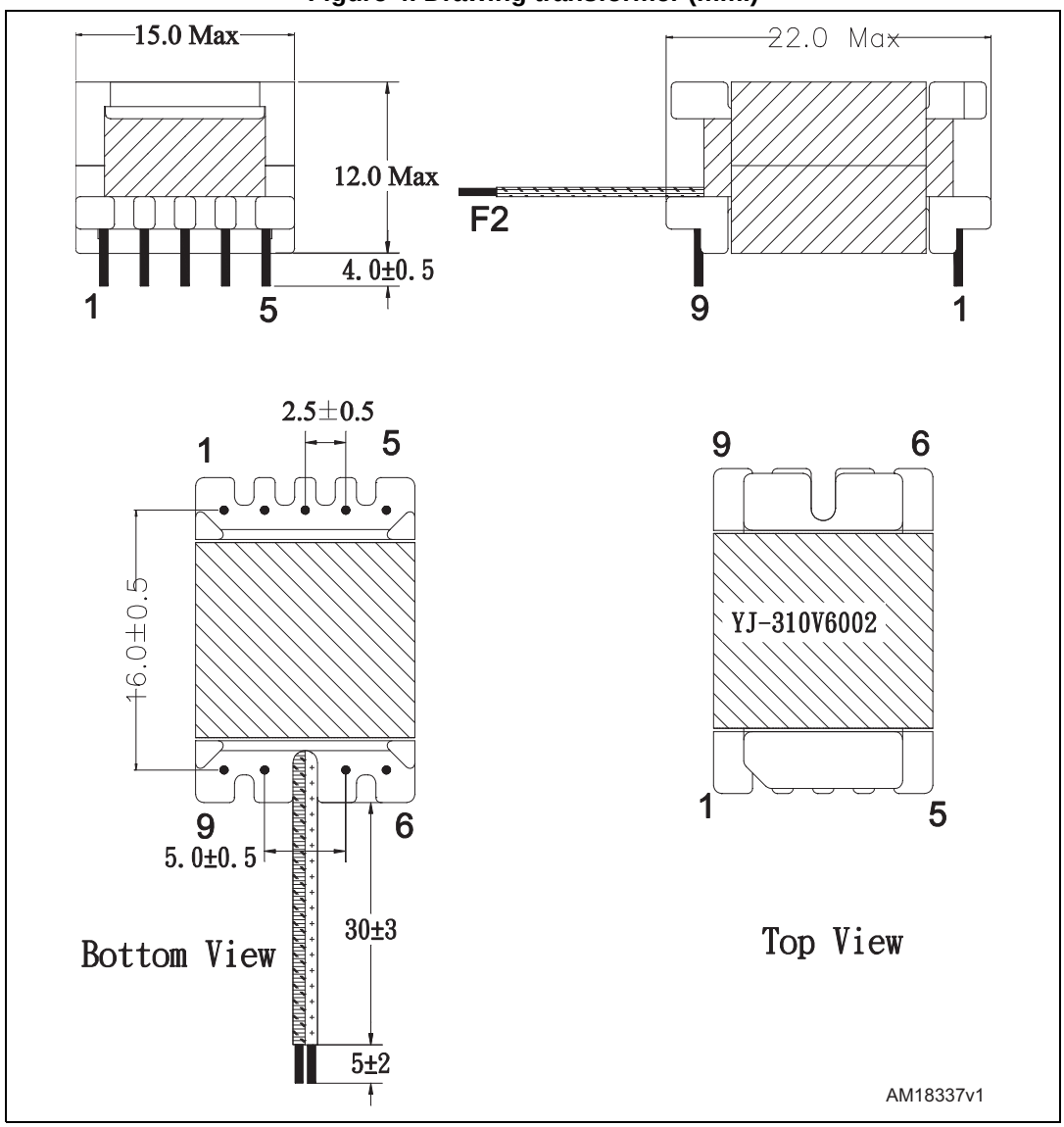


Figure 4. Drawing transformer (mm.)

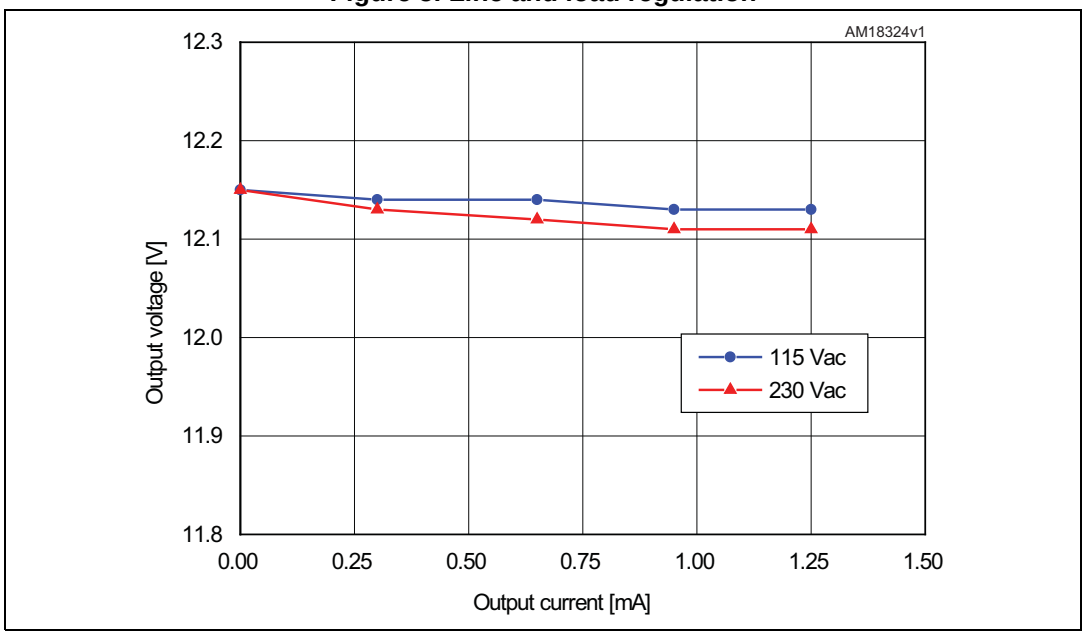


1.1 Output voltage characteristics

The output voltage of the board is measured in different line and load conditions. *Figure 5* shows the results: the output voltage variation range is a few tens mV for all the tested conditions.

All output voltages have been measured on the output connector of the board.

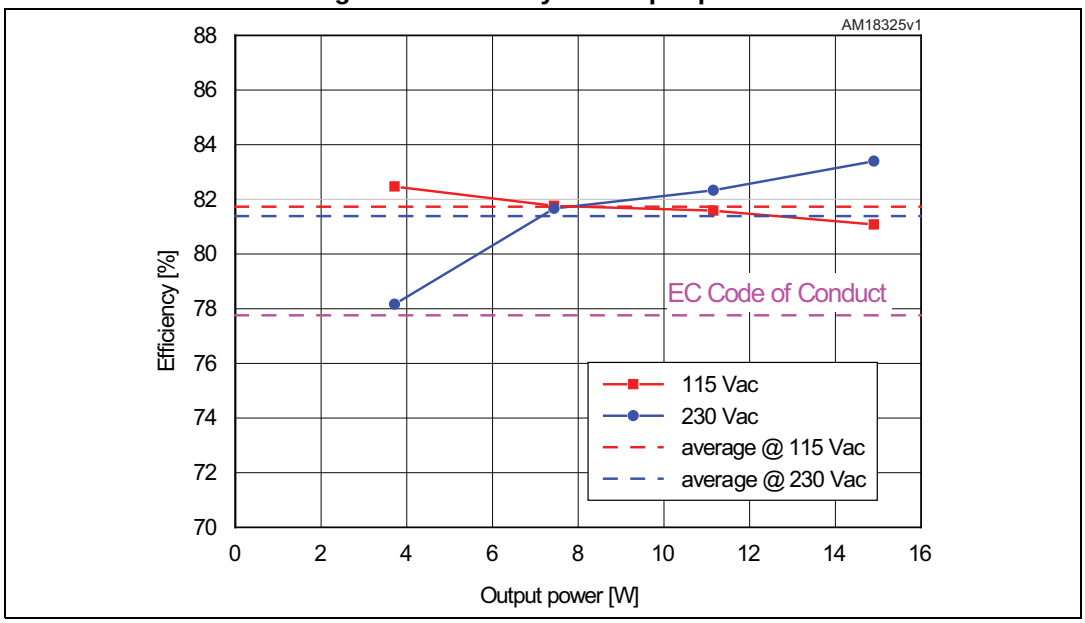
Figure 5. Line and load regulation



1.2 Efficiency and light load measurements

Any external power supply (EPS) must be capable to meet the international regulation agency limits. The European code of conduct (EC CoC) and US department of energy (DoEUS EISA 2007) limits are taken as reference. EPS limits are fixed up to 77.76%, when the average efficiency is measured. The average efficiency measures the average value at 25%, 50%, 75% and 100% of the rated output power, at both 115 VAC and 230 VAC. *Figure 6* shows the results.

Figure 6. Efficiency vs. output power



1.3 No-load and light load consumptions

No-load consumptions and light load consumption are two important parameters that must be considered when selecting the IC controller and very often they are the key parameters of choice.

The presented board was optimized in order to provide an extremely low consumption at zero load but also in order to meet EµP Lot 6 energy saving regulation, which requires that the efficiency of the converter must be higher than 50% when the output is loaded with 250 mW.

In *Figure 7* and *Figure 8* the consumption in the said condition are shown.

Figure 7. No load consumption vs. input voltage

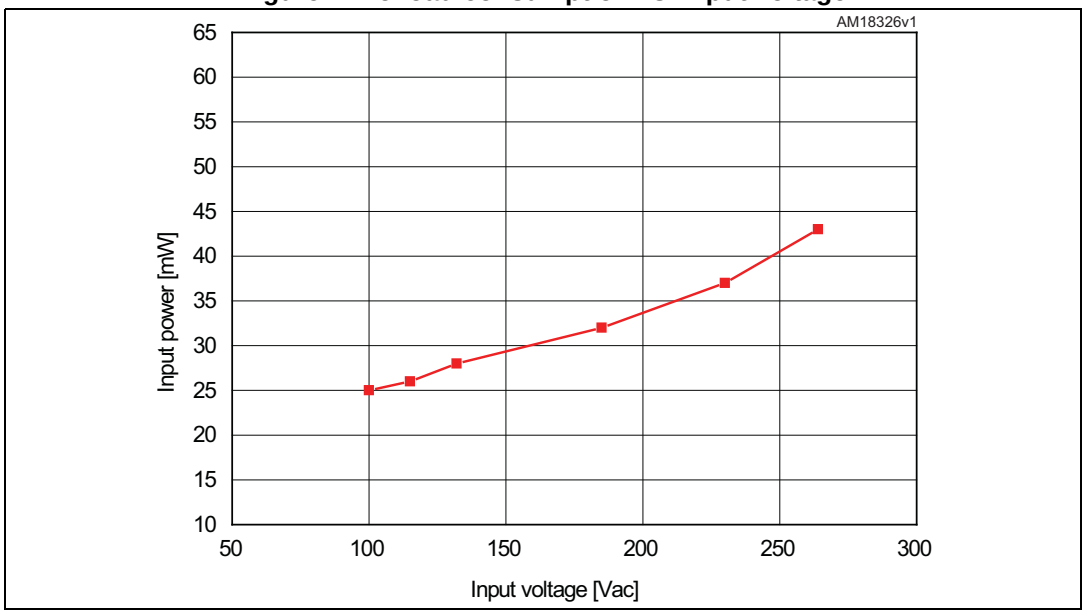
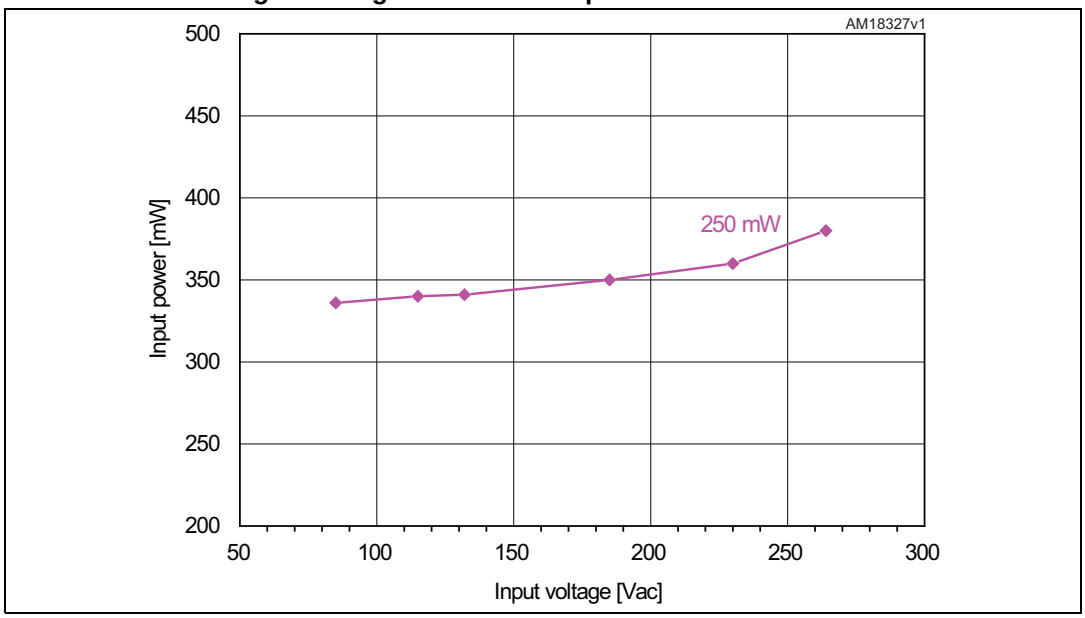


Figure 8. Light load consumptions at 250 mW O/P



1.4 Typical board waveforms

In this section, typical waveforms are reported.

Drain voltage and current waveforms were reported at nominal input voltages and full load in *Figure 9* and *Figure 10*.

The startup phase is shown in *Figure 11* and *Figure 12*: the IC starts with very clean waveforms and no overshoot/undershoot appear on the output.

Finally also the output voltage when the converter is submitted to dynamic load variations is measured, in order to be sure that good stability is ensured and no overvoltage on undervoltage occurs

The board was submitted to dynamic load variations from 0% to 100% load (*Figure 13* and *Figure 14*): no abnormal oscillations were noticed on the output and the over/under shoot were well within acceptable values.

Figure 9. Drain current and voltage at full load 115 V_{AC}

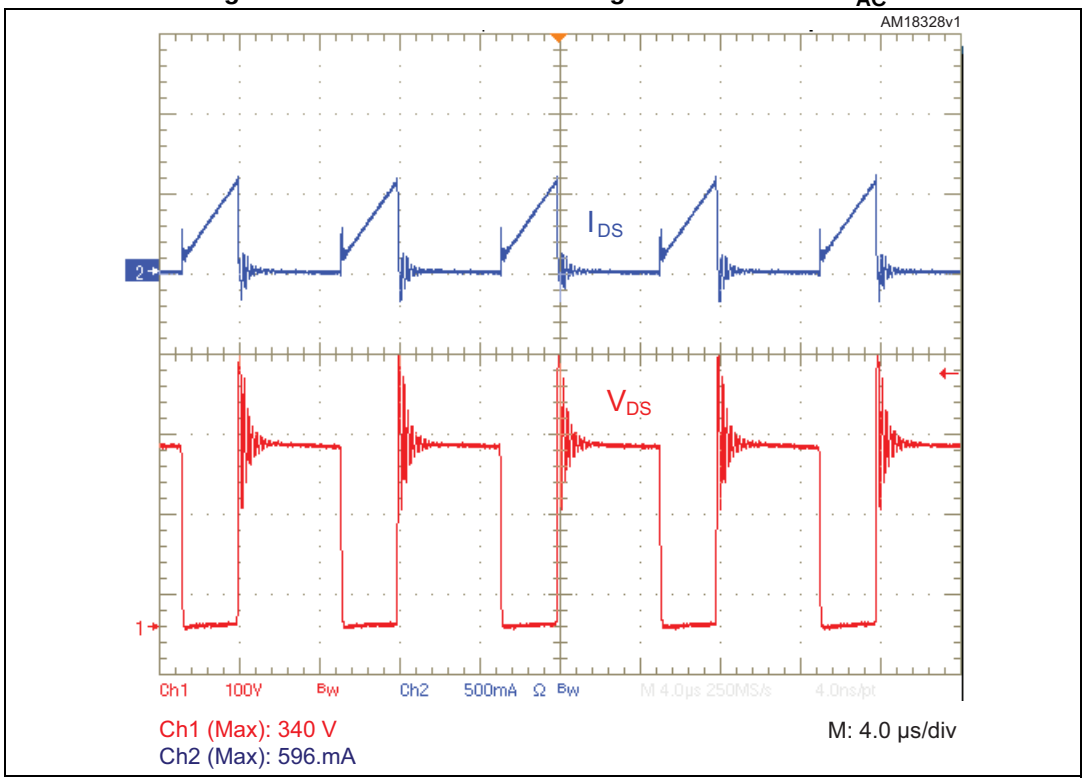


Figure 10. Drain current and voltage at full load 230 V_{AC}

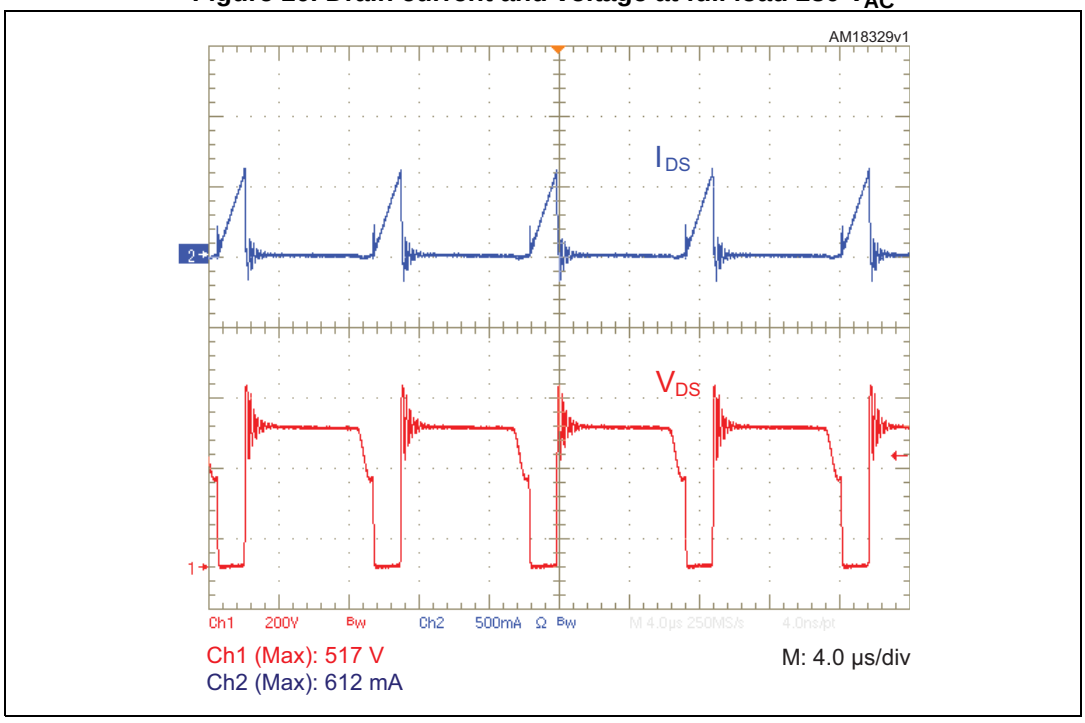


Figure 11. Startup at full load and 115 V_{AC}

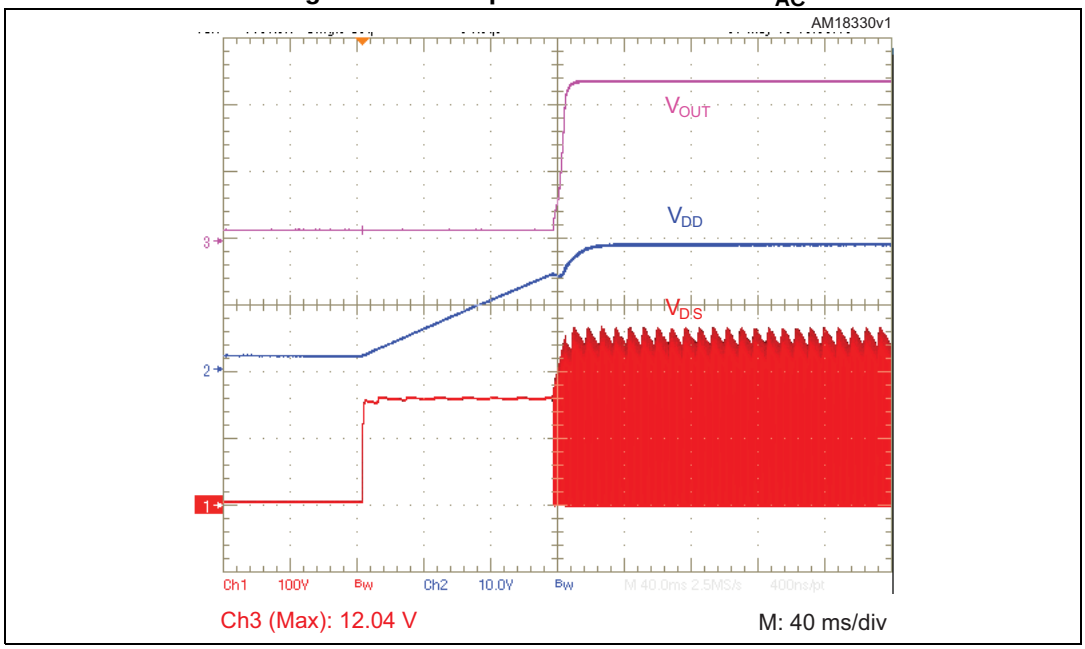


Figure 12. Startup at full load and 230 V_{AC}

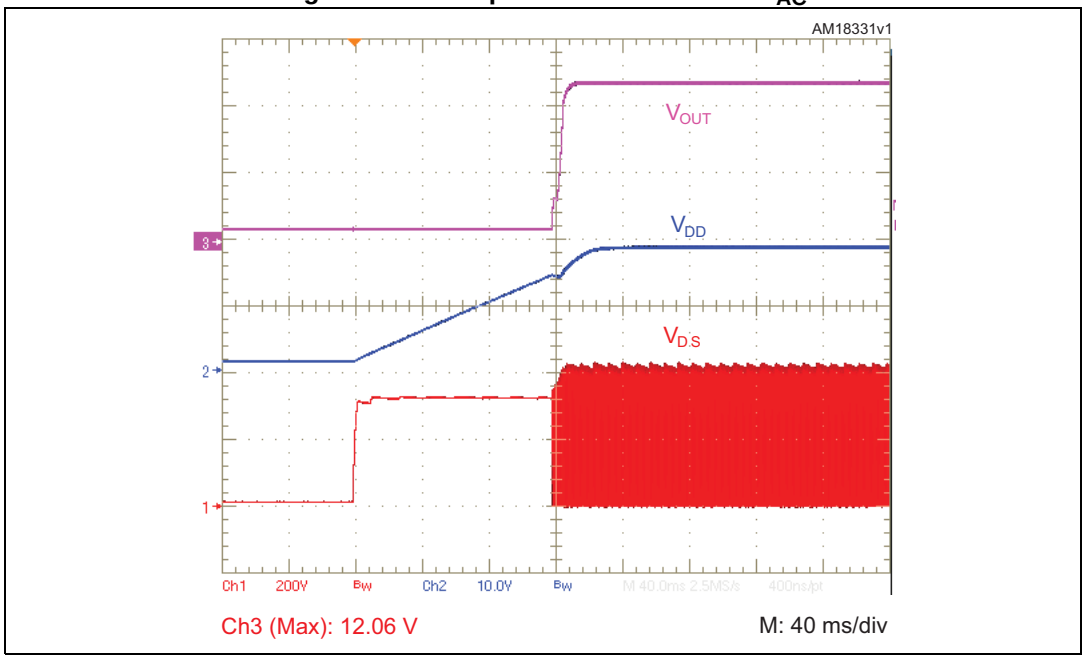


Figure 13. Step load at 115 V_{AC}

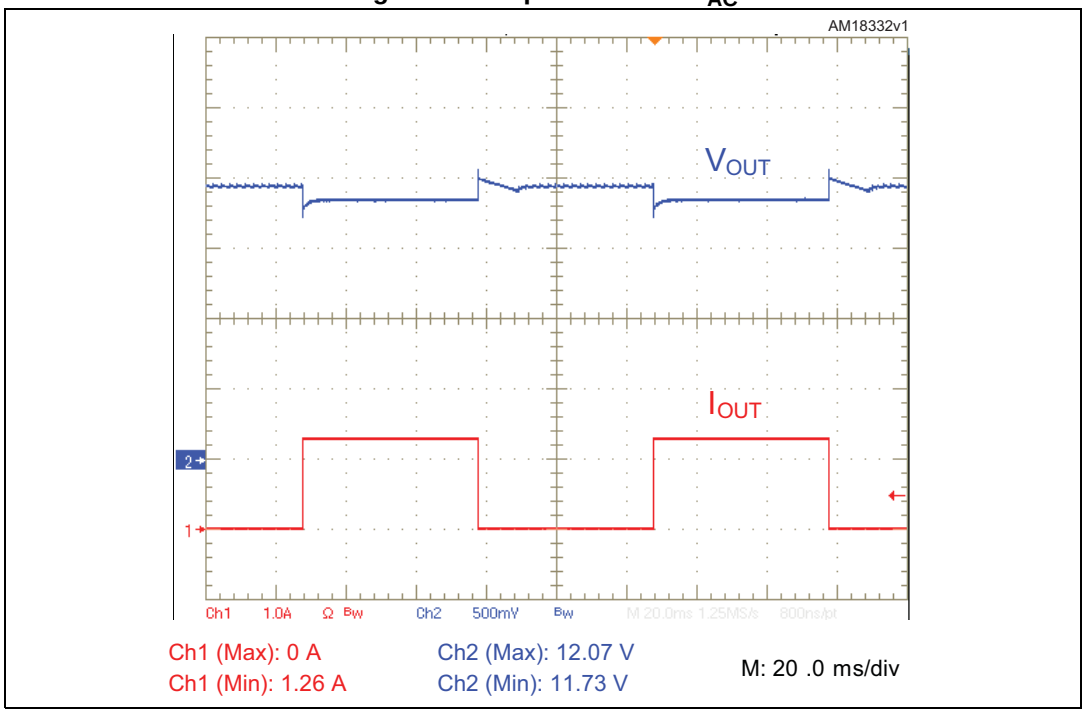
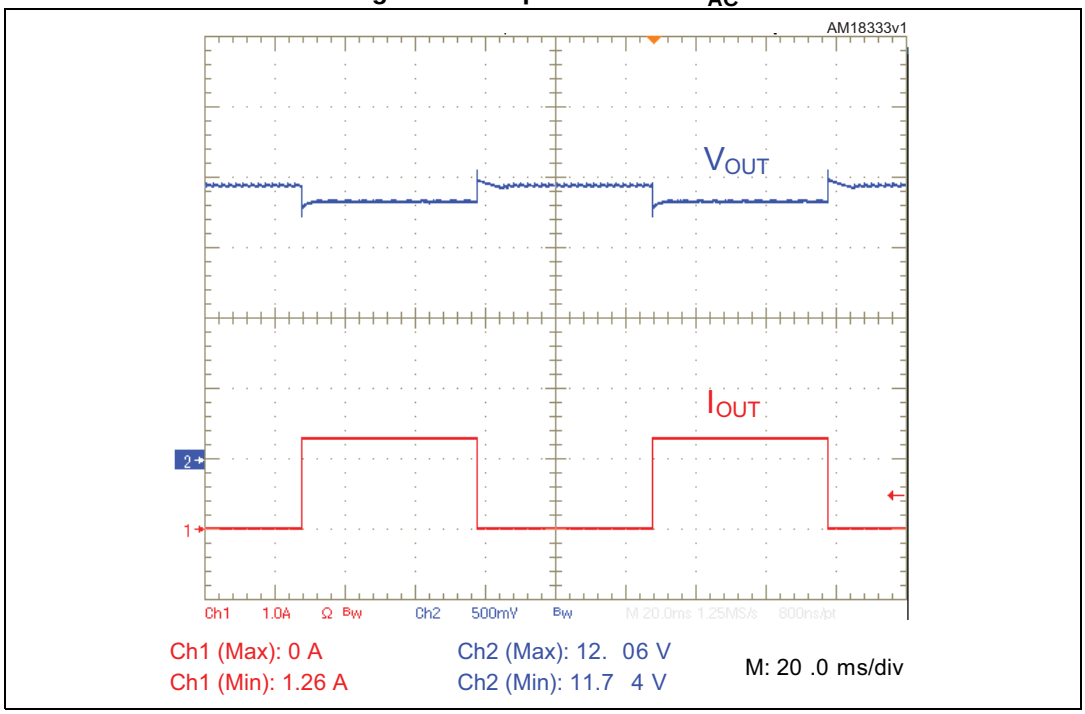


Figure 14. Step load at 230 V_{AC}



2 Conducted noise measurements

A pre-compliance test for EN55022 (Class B) European normative was performed using peak measurements detector of the conducted noise emissions at full load and nominal mains voltages. *Figure 15* and *Figure 16* show the results. As seen in the diagrams, in all test conditions there is a good margin for the measurements with respect to the AV and QP limits, also using the peak detector with max-hold function.

Figure 15. CE average measurement at 115 VAC and full load

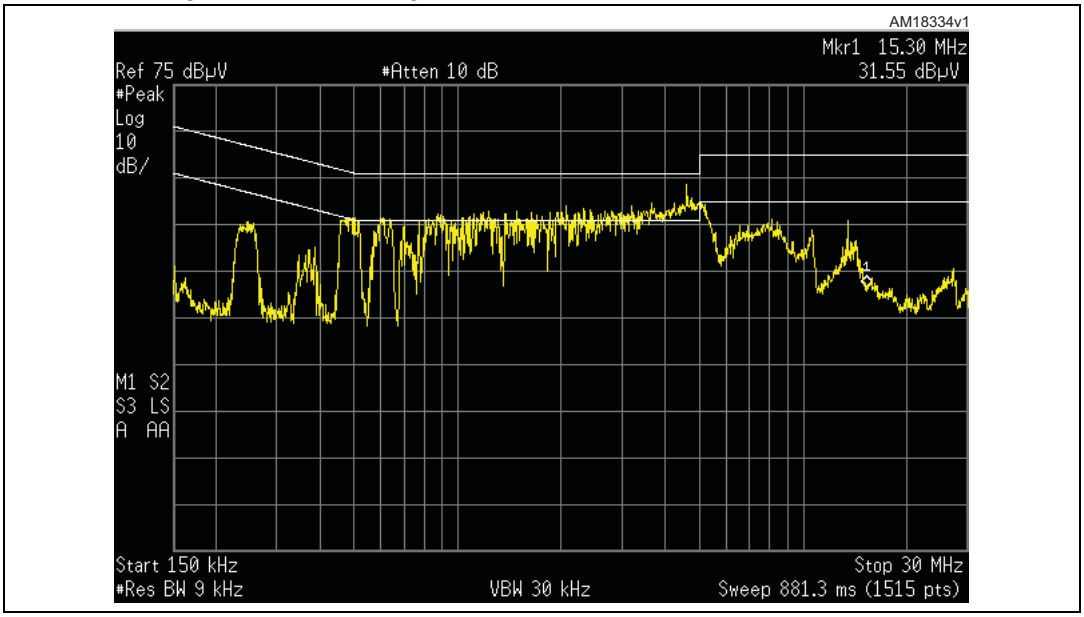
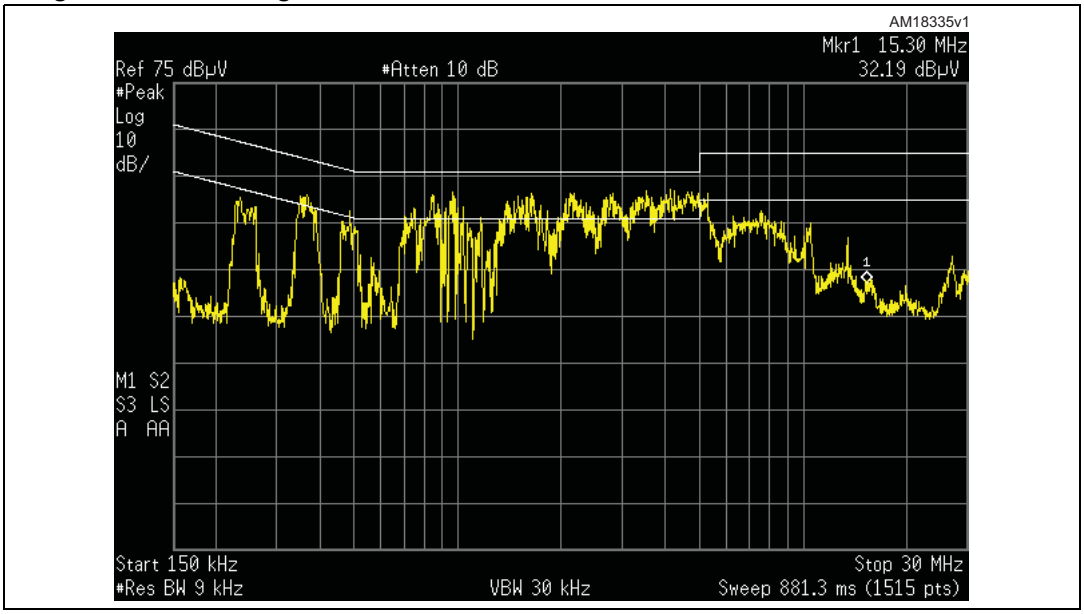


Figure 16. CE average measurement at 230 VAC and full load: Peak measurement



3 Thermal measurements

A thermal analysis of the board was performed using an IR camera.

The board was submitted to full load at nominal input voltage and the thermal map was taken 30 min. after the power on at ambient temperature (25 °C).

Figure 17, *Figure 18*, *Figure 19* and *Figure 20* show the results.

Figure 17. Thermal map at 115 V_{AC} and full load top side

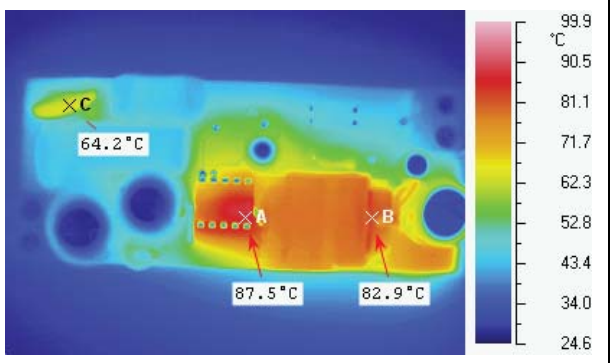


Figure 18. Thermal map at 115 V_{AC} and full load bottom side

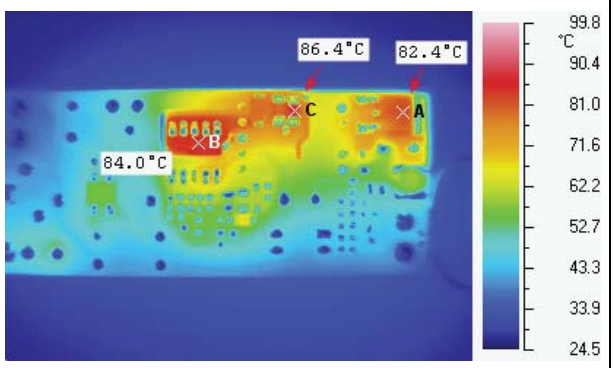


Figure 19. Thermal map at 230 V_{AC} and full load top side

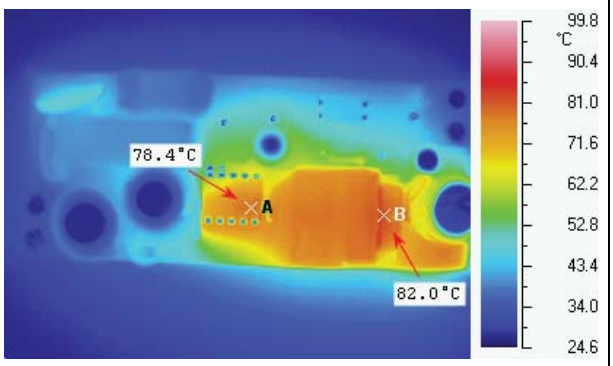
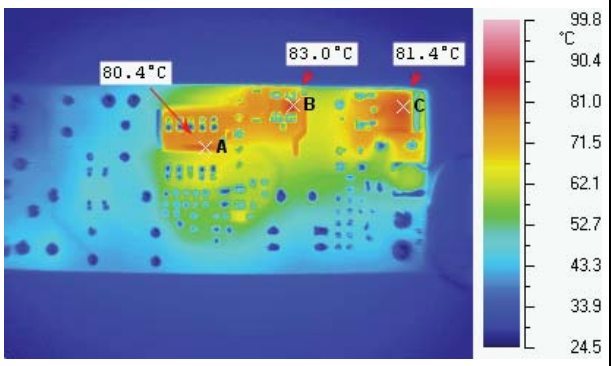


Figure 20. Thermal map at 230 V_{AC} and full load bottom side



4 Conclusions

A 15 W wide range single output flyback converter using the new VIPer37HE has been introduced and the results are presented.

The transformer arrangement and the very compact sizes make the PSU suitable as external adapter or as an auxiliary power supply in all the applications where performances and dimensions are the main constrains.

The efficiency performances were compared with requirements of the most important international regulation agencies for external AC-DC adapters, resulting in a wide margin respect the minimum required.

5 Evaluation tools and documentation

The VIPer37LE evaluation board order code is: STEVAL-ISA140V1.

Further information about this product are available in the VIPer37 datasheet at www.st.com.

6 Revision history

Table 4. Document revision history

Date	Revision	Changes
24-Feb-2014	1	Initial release.