

Introduction

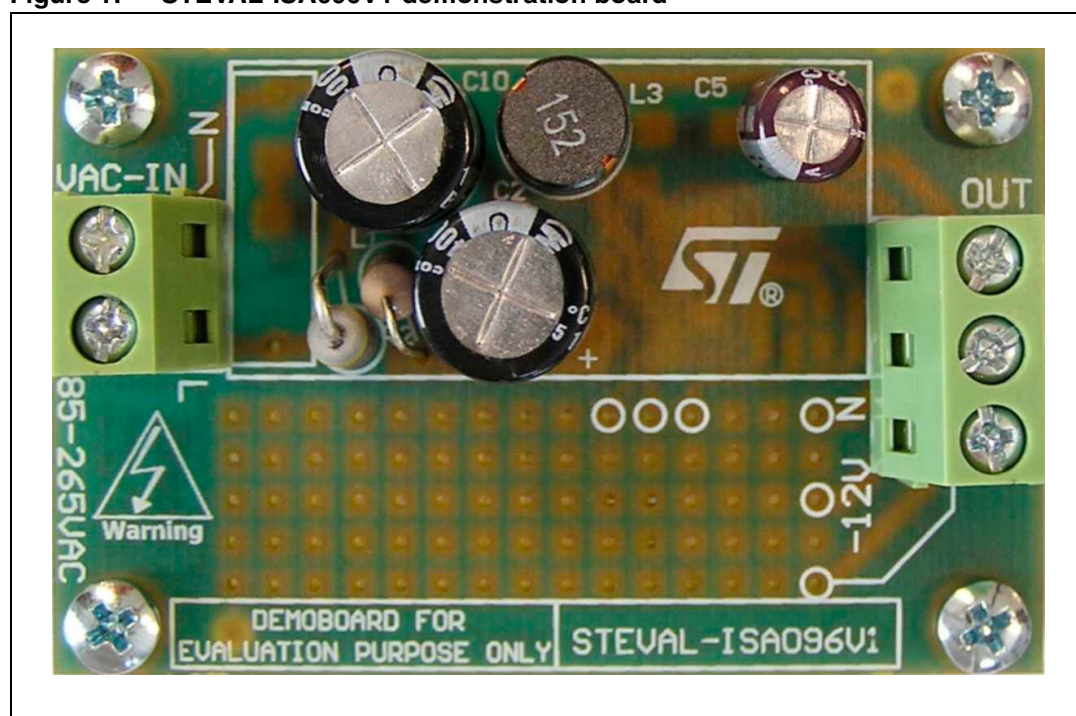
The purpose of this document is to describe the STEVAL-ISA096V1 switched mode power supply (SMPS) demonstration board. The STEVAL-ISA096V1 is a non-isolated SMPS designed in buck-boost topology capable of delivering up to 2 W output over a wide input voltage range, providing a cost-effective and space-saving solution.

It also offers the user the possibility of adapting the circuit to their needs thanks to the availability of a free PCB area.

The STEVAL-ISA096V1 SMPS generates a 12 V nominal output voltage. This board is based on VIPer™06XS - a monolithic converter integrating an 800 V avalanche rugged MOSFET and PWM controller in one package.

This document contains a basic technical description of the demonstration board (schematic diagram, PCB details, and bill of material) as well as the most significant parameter measurements (load regulation, efficiency, standby behavior, EMI and thermal behavior data).

Figure 1. STEVAL-ISA096V1 demonstration board



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1 Main characteristics

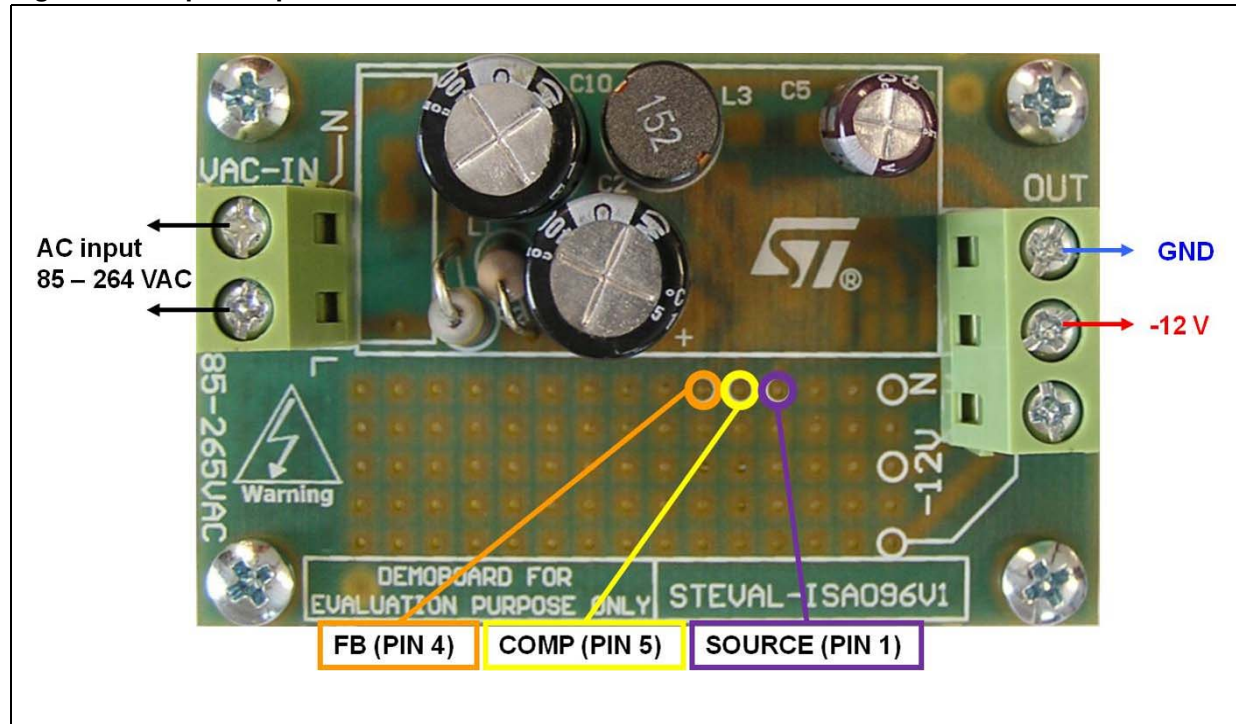
The main characteristics of the SMPS are listed below:

- Input:
 - V_{IN} : 85 ~ 264 Vrms
 - f: 45 ~ 66 Hz
- Output:
 - -12 VDC $\pm$ 10%, 150 mA
- Standby < 30 mW at 264 VAC
- Short-circuit: protected
- PCB type and size:
 - FR4
 - Single side 35 μ m
 - SMPS size 19 x 39 mm, board size 38 x 61 mm
- Isolation: isolated 4 kV/8 mm
- EMI: according to EN55022 Class B

2 Board connection

The STEVAL-ISA096V1 demonstration board is shown in [Figure 2](#), with input and output locations.

Figure 2. Input/output connection of SMPS

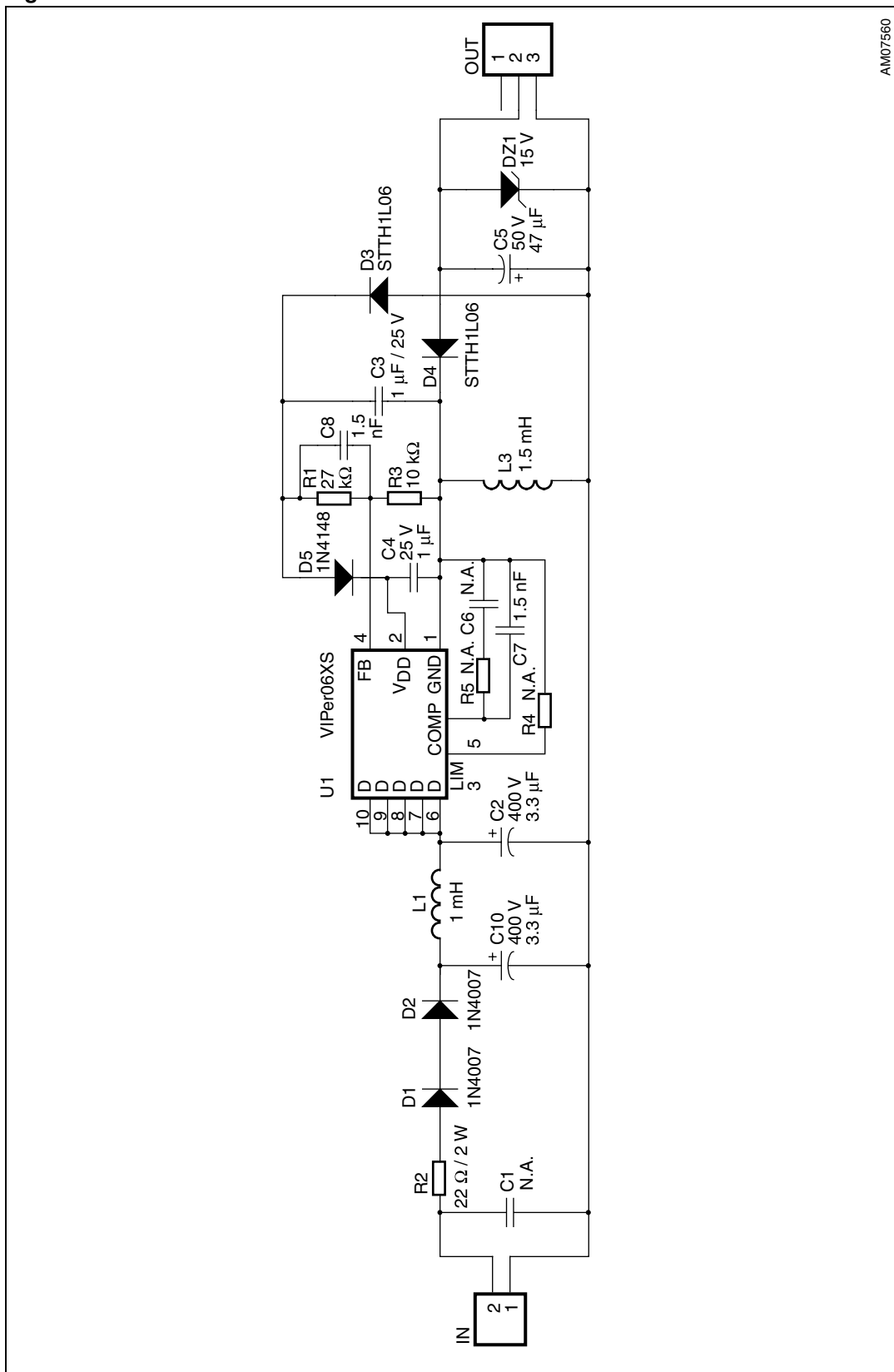


3 Board description

3.1 Schematic

A schematic diagram of the buck-boost converter board based on the VIPer06XS is provided in [Figure 3](#).

Figure 3. STEVAL-ISA096V1 circuit schematic



3.2 Description of the schematic

The input part of converter consists of an input single-wave rectifier, EMI/EMC filter and bulk capacitor.

The input rectifier is based on two 1 A/1 kV general purpose diodes (D1, D2). The 2 kV blocking voltage is selected to increase robustness against input surge pulse.

The EMI filter is based on a π filter (C10, C2, L1) and the possibility to place an input foil capacitor may also be an option. This capacitor is not mandatory in order to satisfy EMI limits (see [Figure 9](#)), but it can be used in case a wider margin of EMI limits is required.

The input EMC filter is based on the inrush resistor R2 and bulk capacitors C10 and C2.

The buck-boost converter itself uses a standard connection. The VIPer06XS (U1), containing an active switch and controller, is placed as the high side with floating reference. After turn-ON of the internal MOSFET the energy is stored in the inductor L3. After U1 is turned off the energy stored in the L3 is distributed to the output capacitor C5 via diode D4 and in capacitor C3 via diode D3. It can be expected that the voltage drop over capacitor C3 is almost the same as the voltage drop over output capacitor C5. The feedback loop performs constant voltage regulation and the output voltage is measured across C3 by a voltage divider (R1 and R3) connected to the FB pin of U1.

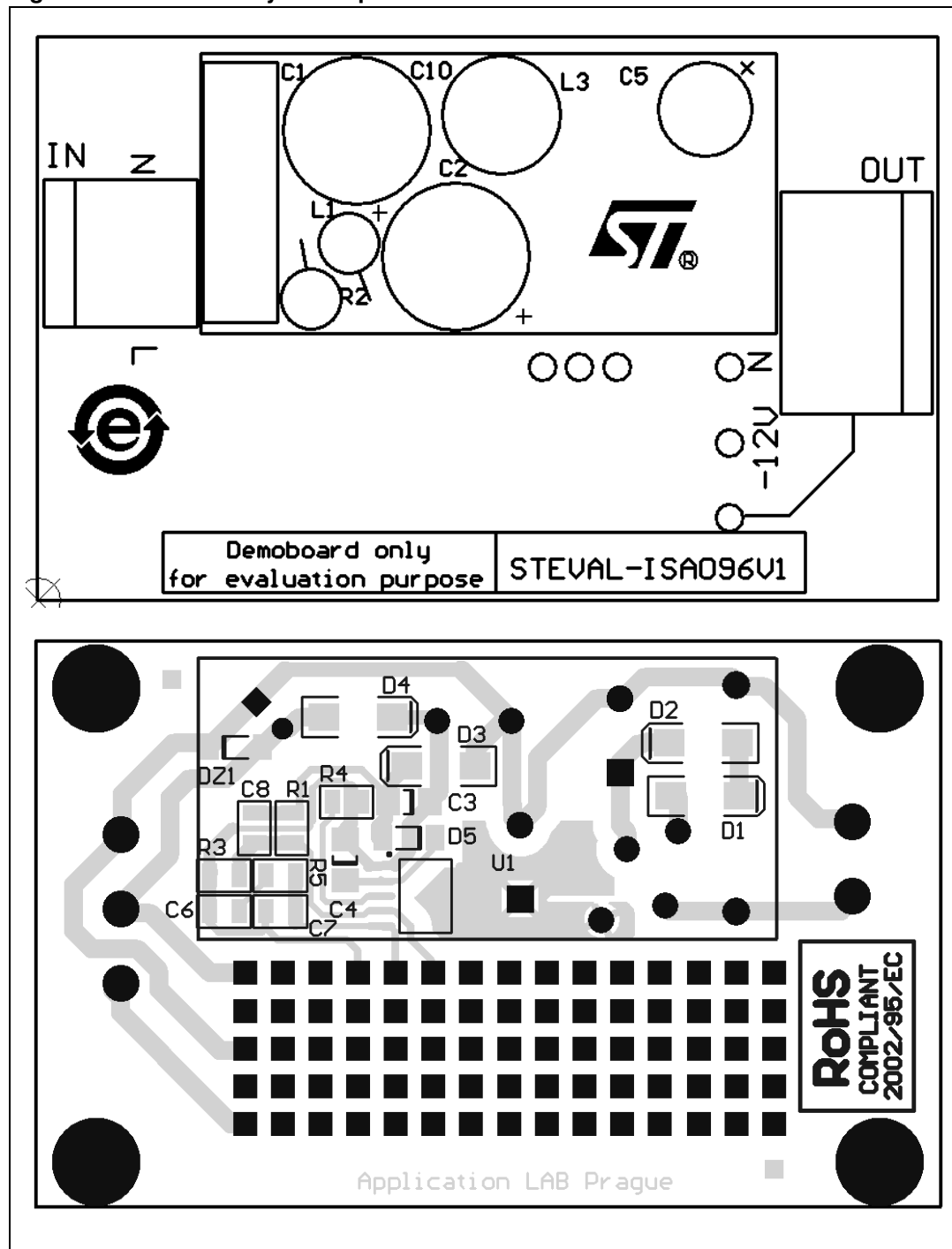
3.3 Layout

The layout of the PCB is based on a one-sided FR4 with a 35 μ m thickness and is shown in [Figure 4](#).

The size of the PCB dedicated for the SMPS itself is 39 mm x 19 mm while the size of the complete PCB is 61 x 38 mm; this extra space (area provided by through-hole connections) is intended to give the user the possibility of modifying certain board specifications.

It is possible, for example, to apply an output linear regulator generating precisely 3.3 or 5 V or to realize different types of feedback loop to minimize load regulation.

Figure 4. The PCB layout - top and bottom



3.4 Bill of materials

Table 1. BOM

Index	Quantity	Ref.	Value / generic part number	Package / class	Manufacturer
1	1	R1	27 k Ω / 1% / 0.1 W	0805	
2	1	R2	22 Ω / 2 W / 5%/WW	TH - wire wound	
3	1	R3	10 k Ω / 1% / 0.1 W	0805	
4	0	R4	N. A.	0805	
5	0	R5	N. A.	0805	
6	0	C1	N. A.	18 x 6 x RM 15	
7	1	C2, C10	3.3 μ F / 400 V	R 10 x 13, RM 5 mm	
8	1	C3, C4	1 μ F / 25 V / X7R	1206	
9	2	C5	47 μ F / 50 V	R 6.3 x 11 RM 2.5 mm	
10	0	C6	N. A.	0805	
11	1	C7, C8	1.5 nF / 50 V	0805	
12	1	L1	1 mH / 80 mA		
13	1	L3	1.5 mH/400 mA, HV 768 772 152	R 8 x 10, RM 5 mm	Würth Elektronik
14	2	D1, D2	1N4007	MELF / SMA	
15	2	D3, D4	STTH1L06A	SMA	STMicroelectronics™
16	1	D5	1N4148	SOD80	
17	1	DZ1	ZD / 15 V / 5%	SOD80	
18	1	U1	VIPer06XS	SSO10	STMicroelectronics
19	1	J1	Screw terminal 2 pos.	RM 5 mm	
20	1	J2	Screw terminal 3 pos.	RM 5 mm	

4 Measurements

4.1 Efficiency

The output voltage efficiency depending on the output current of 12 V output is displayed in [Figure 5](#).

Figure 5. Efficiency at 120 VAC and 230 VAC depending on the output current

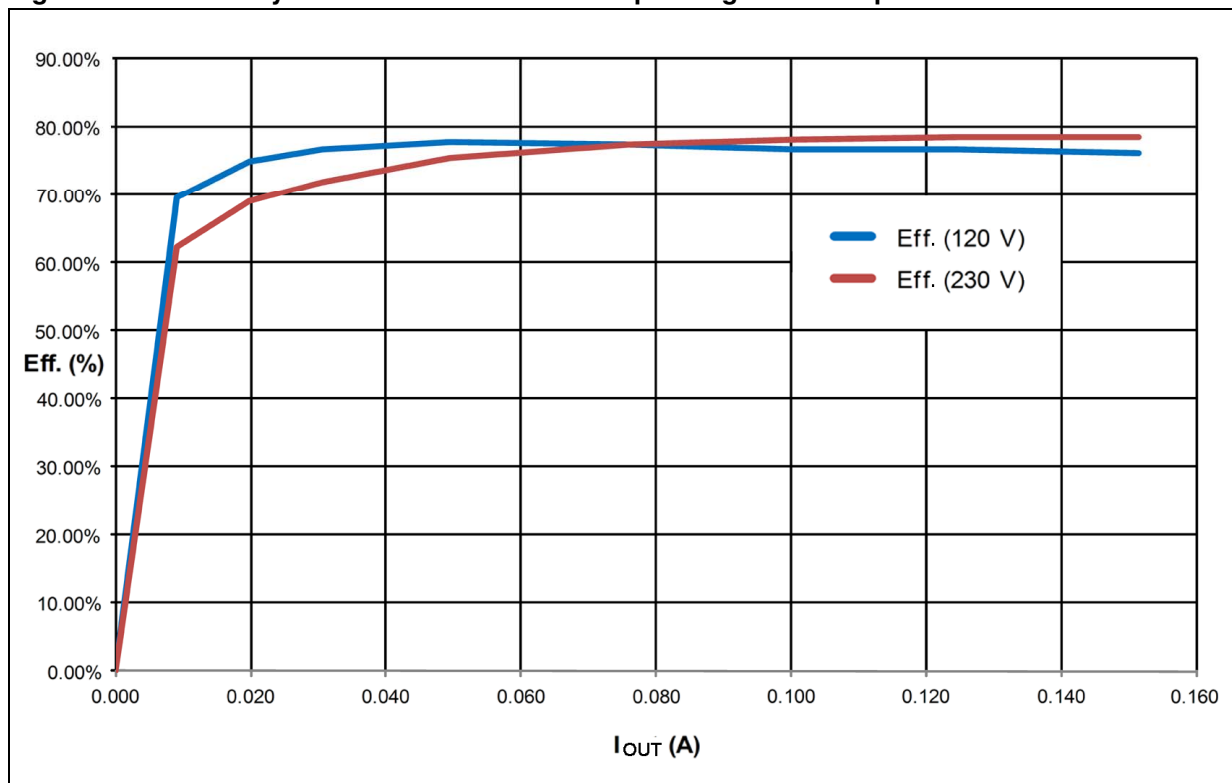
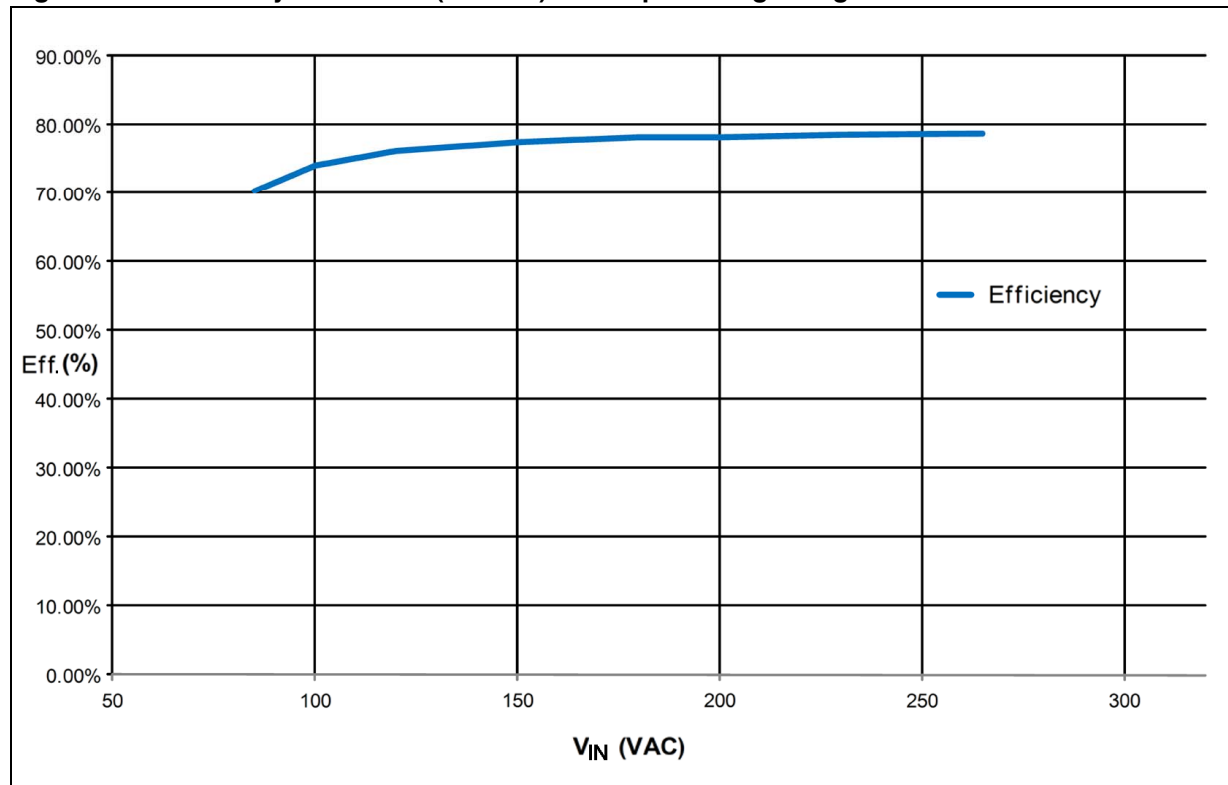


Figure 6 shows the efficiency of the SMPS at full load applied on the 12 V, depending on the different input voltage. A drop of efficiency at low input voltage is mainly caused by an increase in the losses in the input inrush resistor and EMI filter.

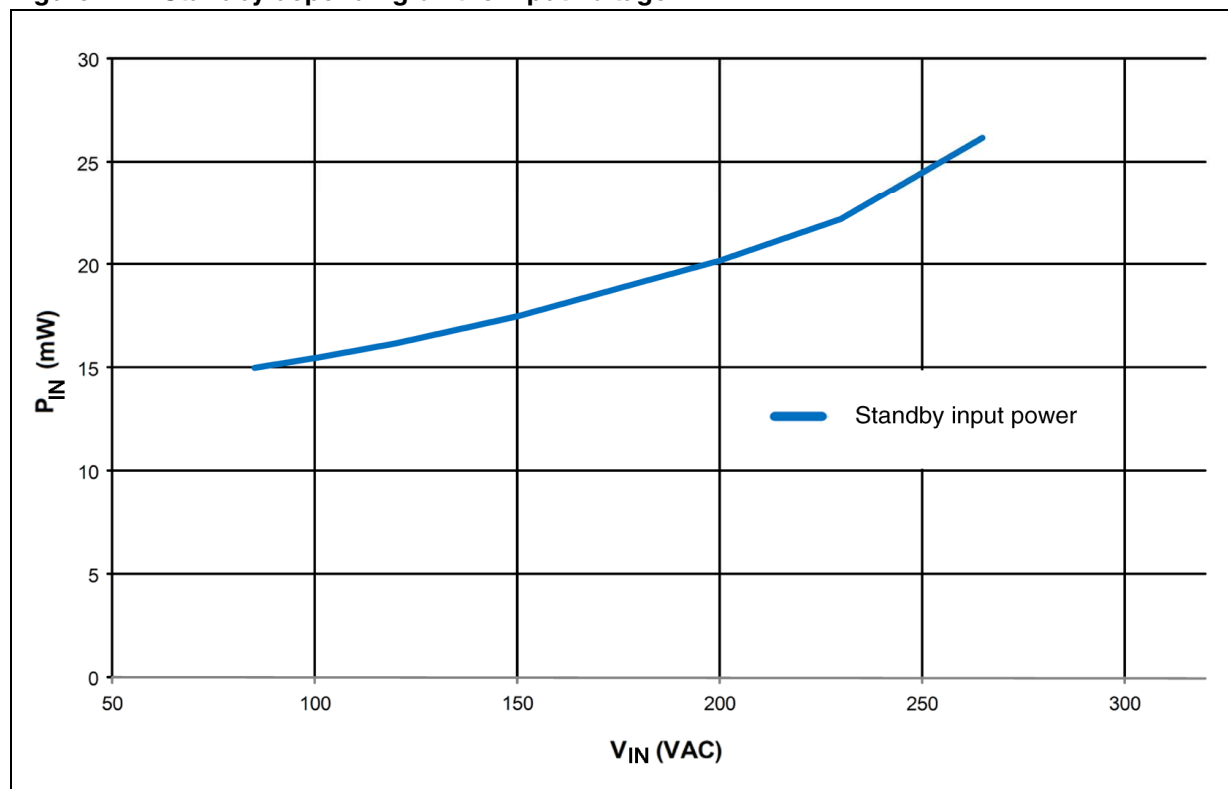
Figure 6. Efficiency at full load (150 mA) over input voltage range



4.2 Standby

The standby behavior of the board is displayed in [Figure 7](#). This value is for any input voltage below 30 mW. The measured value could be partly reduced by using a higher value of resistors R1 and R3. The power loss over these resistors is about 4.5 mW. By using a higher value voltage divider (5 - 10 times) the standby losses drop by about several mW, but this action increases load regulation.

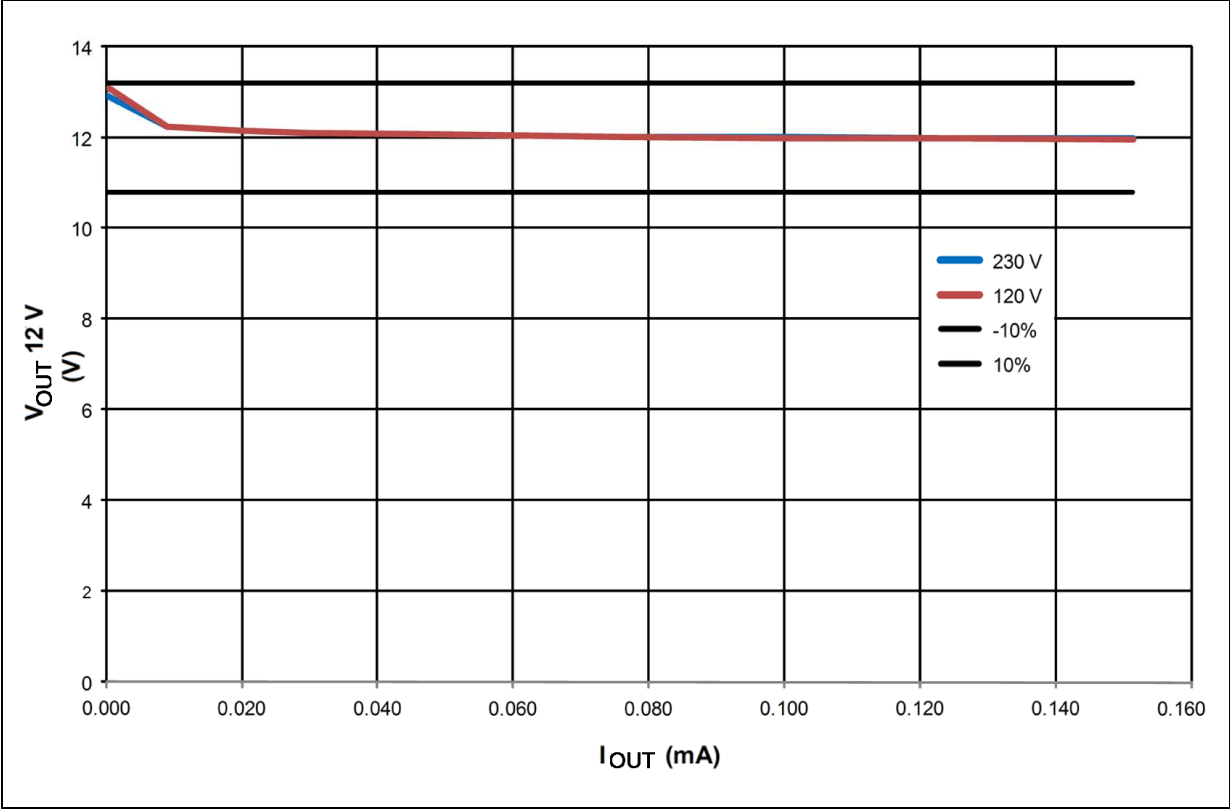
Figure 7. Standby depending on the input voltage



4.3 Load characteristics

The load characteristics of a 12 V output are displayed in [Figure 8](#). The output voltage is for any load and any input voltage within a $\pm 10\%$ tolerance.

Figure 8. The 12 V output load characteristics



4.4 EMI

The conductive EMI test of the demonstration board is displayed in [Figure 9](#) and [10](#). The AVG detector is used in [Figure 10](#), while the peak detector measurement can be seen below in [Figure 9](#).

Figure 9. EMI measurement regarding EN55022 Class 2 - peak detector

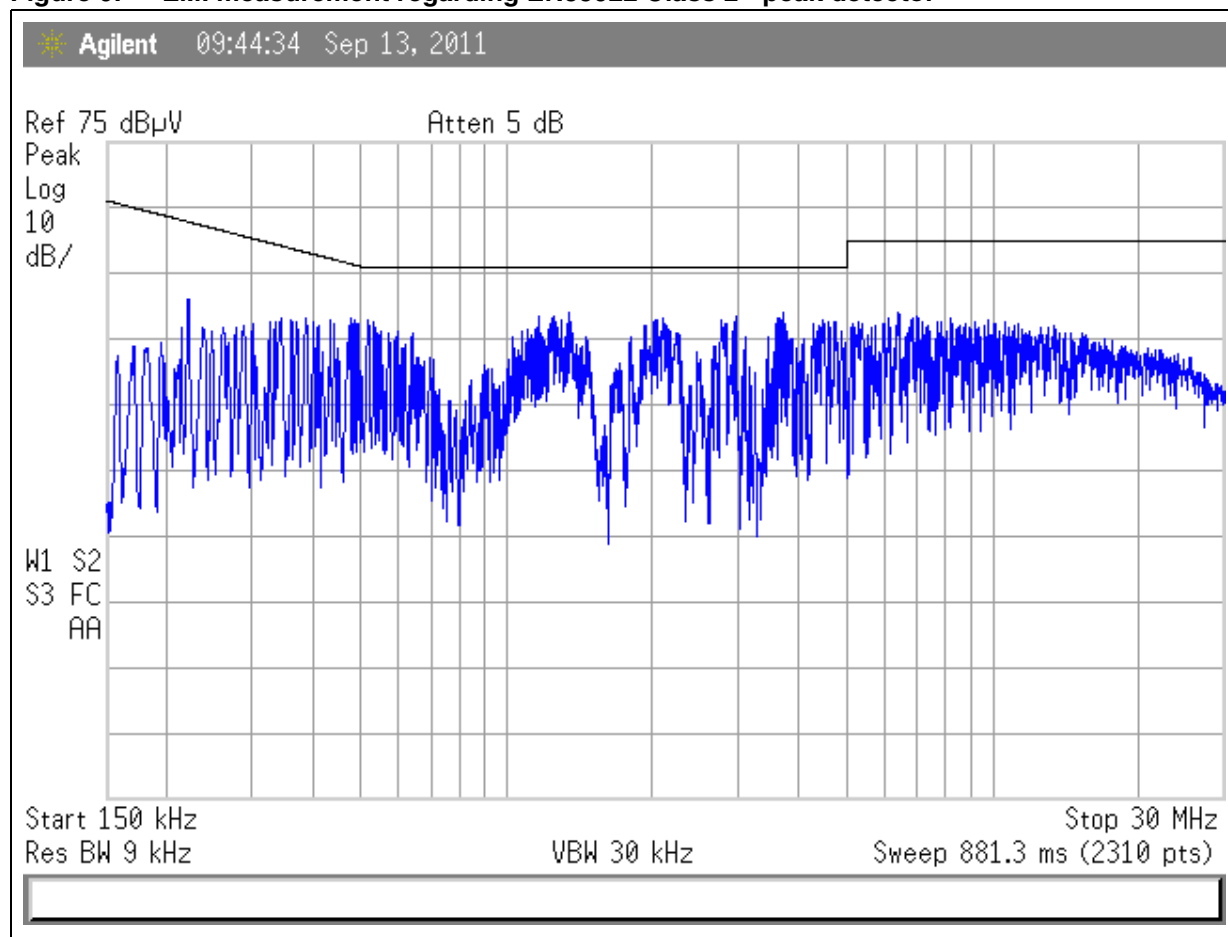
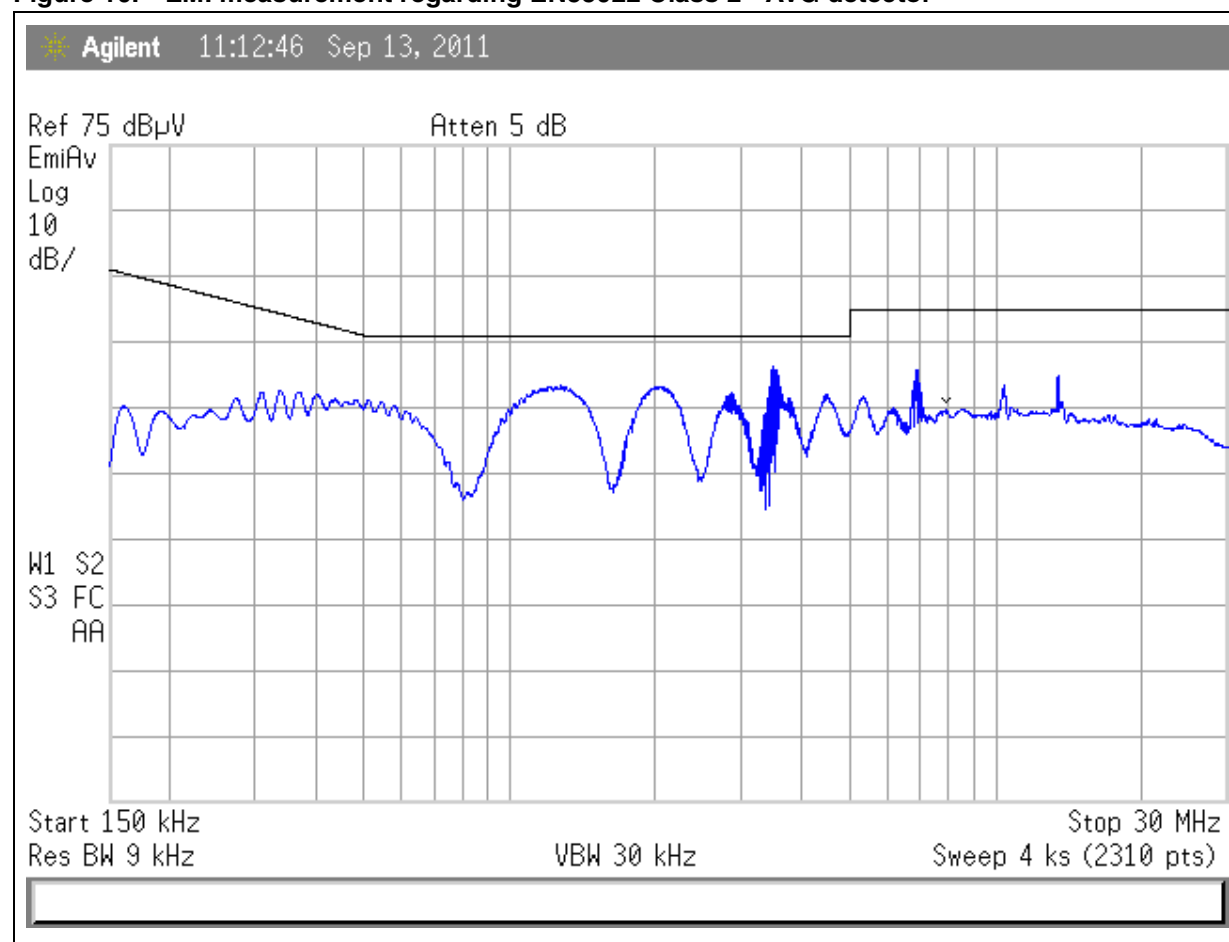


Figure 10. EMI measurement regarding EN55022 Class 2 - AVG detector

4.5 Temperature

The thermal map at full load measured at 265 VAC and at 85 VAC is displayed in [Figure 11](#) and [Figure 12](#). The ambient temperature was 25 °C. Regarding the measurements visible below, it can be estimated that the temperature of the components is below AMR even at 85 °C of ambient temperature. This range can be extended by using a bigger Cu heatsink area connected to the drain of the VIPer06XS.

Figure 11. Thermal map of the board at 265 VAC on the input - left bottom side, right top side

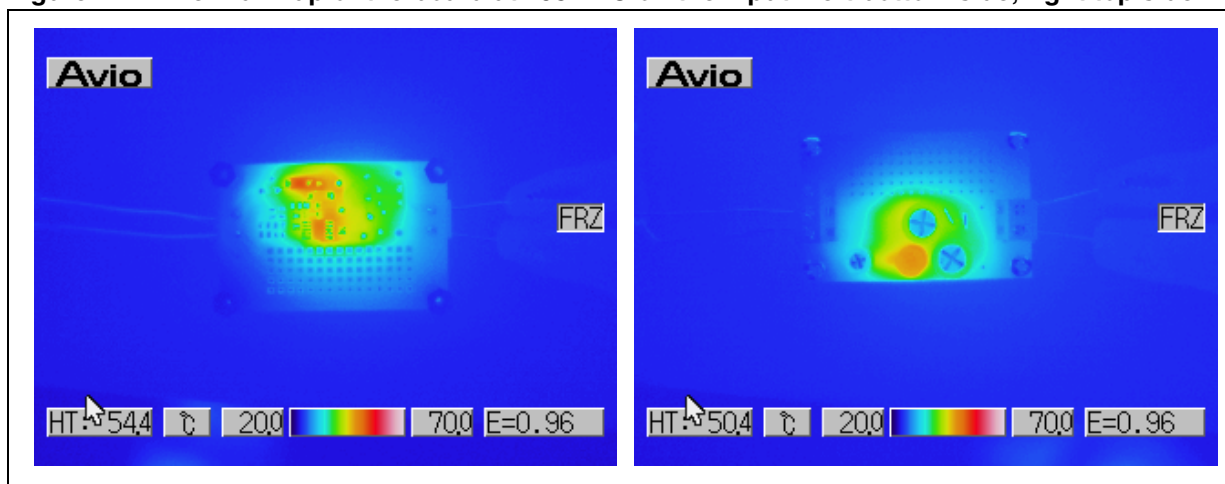
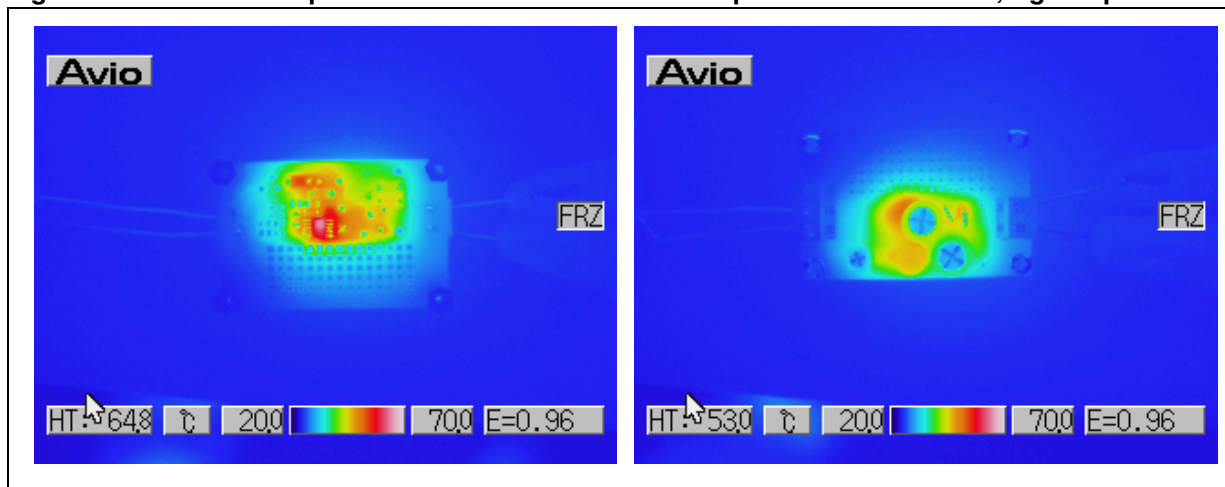


Figure 12. Thermal map of the board at 85 VAC on the input - left bottom side, right top side



5 Revision history

Table 2. Document revision history

Date	Revision	Changes
02-May-2012	1	Initial release.

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