AN2097
APPLICATION NOTE

VIPower: 10W POWER SMPS USING VIPer22A FOR AIR-CONDITIONER APPLICATION

1. ABSTRCT

New air-conditioner systems use two main low-voltage outputs to supply the internal electronic equipment, respectively these values are +12V and +5V. These low output voltages are generated by a switch mode power supply. Many important features are requested by the power supply: high efficiency, light weight with compact size and low power consumption in stand-by condition just to mention some of them.

VIPerX2 family allows to develop power supply having all these features together hence these devices are a suitable solution to develop air-conditioner applications. Specifically, the board shown here following has been developed in order to improve the features explained in figure 1.

The application, mentioned in this note, complains the technical specifics summarized in table 1.

Figure 1. Board Layout

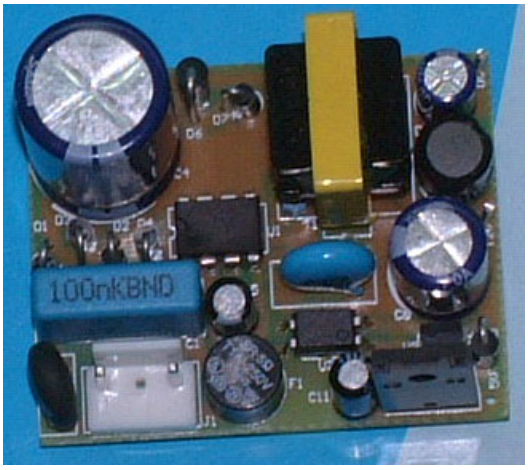


Table 1. Electrical Specification

Input AC range	85-265 V_{ac}
Output 1	12V
Output 2	5V/400mA (linear regulator from output 1)
Ripple	<50mV
Output current (12V & 5V)	800mA - continuous
	900mA - peak, less than 5 minutes
Stand-by consumption	<1W

1. VIPERX2A DESCRIPTION

The VIPerX2A family combines a dedicated current mode PWM controller with a high voltage Power MOSFET, on the same monolithic chip, within one package only. That allows to obtain a components reduction achieving a cost reduction and a design and PCB simplification. For these reasons this family is widely used in many off-line switching mode power supplies. Furthermore, a tiny size package for SMD technology is available (SO-8). VIPer family is able to meet the Blue Angels and Energy Star standards in matter of stand-by power consumption (less than 1W).

1.1. General Features

The VIPerx2A devices are built in the proprietary VIPower M0-3 H.V.

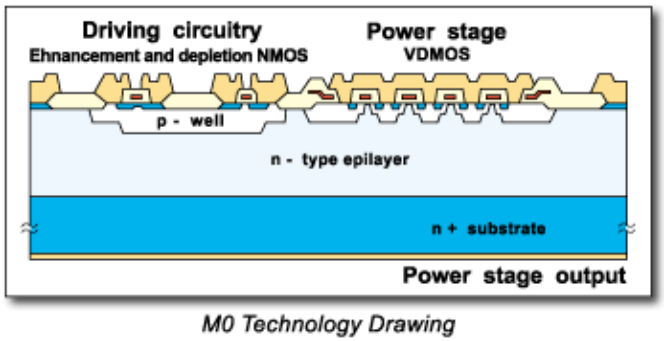
The M0-3 H.V. technology allows to put the low voltage systems (PWM) and the power stage with vertical current flow in the same chip by means of a P-type buried layer, as illustrated in figure 2.

The VIPerX2A devices have the below general features:

- Automatic thermal shutdown.
- High voltage start-up current source.
- HICCUP mode in order to avoid the break-down condition for output short circuits.
- Burst mode to assure low-power consumption in low-load condition.

Moreover, VIPower M0-3 Technology allows to develop Power MOSFETs able to guarantee a minimum breakdown voltage of 730V. Table 2 shows the device power capability, in different packages and different work conditions.

Figure 2. M0-3 Technology

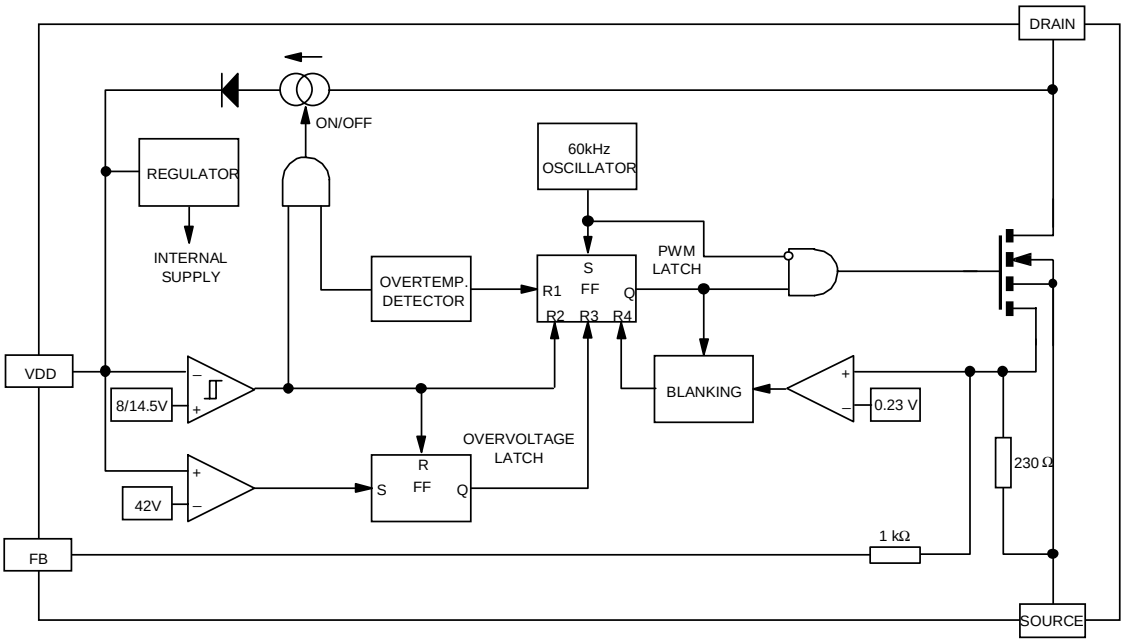


M0 Technology Drawing

Table 2. Power Capability for Different Input Range and Different Package

	Wide Range (85-265V)		Single Range (180-265V)	
	SO-8	**DIP**	**SO-8**	**DIP**
VIPer12A	5W	8W	8W	13W
VIPer22A	7W	12W	12W	20W

Figure 3. Block Diagram



1.2. Block Diagram

Examining the block diagram in figure 3, it is possible to observe that the power section is driven by a current mode structure with a fast comparator using the current delivered by the N-MOS sense and by the feed-back pin (FB). The comparator output is connected to the Blanking Time Block in order to assure the minimum turn on time. An internal oscillator fixes the switching frequency at 60kHz, so further external component will not be necessary. Other internal blocks are the Regulator, used by internal supply and able to even support 45V on V_{DD} pin and the Over-temperature Detector to provide the thermal shutdown at 170°C typical.

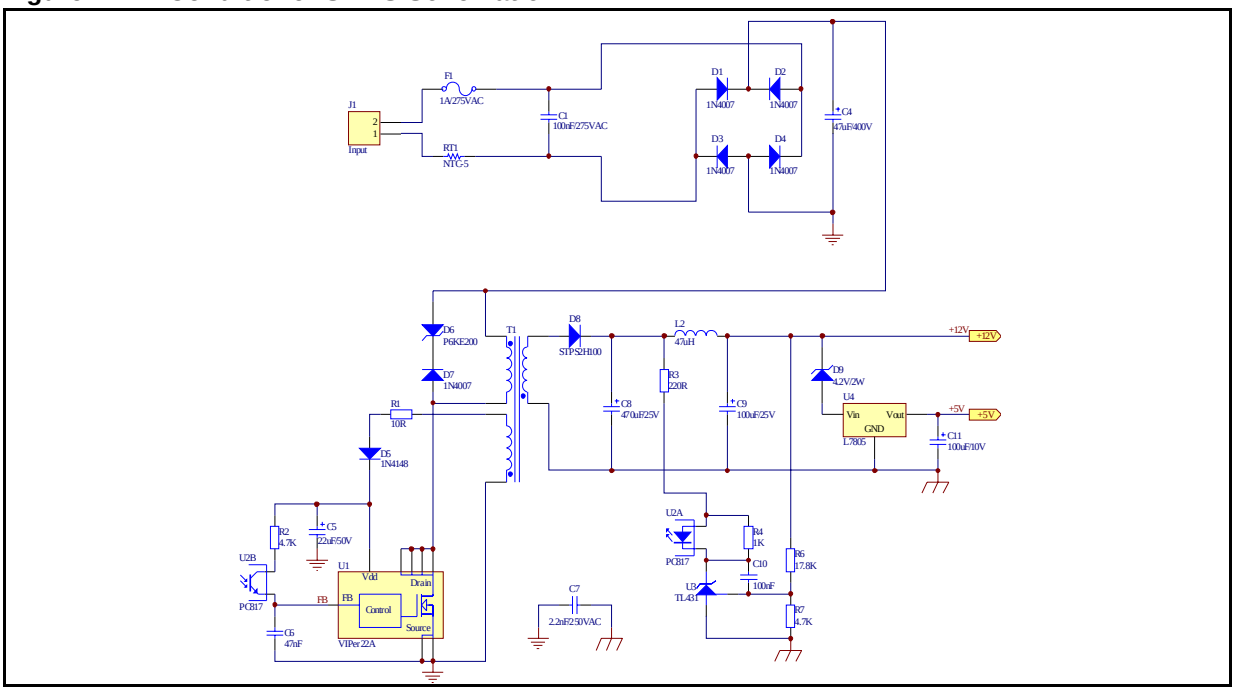
The device system control is a current mode structure in which the N-MOS sense current and the FB current are summed in the resistor R2. The voltage across R2 depends on this current value and this voltage value is compared with an internal fixed voltage reference (0.23V). The comparator output drives the MOSFET, therefore the switching frequency depends on the feedback current value and the Id value. In this application the feedback loop is implemented by driving this FB pin with the output voltage using an optocoupler in order to assure the electrical isolation between the input and the output. V_{DD} voltage is monitored by a hysteresis comparator able to manage the start-up current generator. In fact, it is switched on in order to charge the V_{DD} capacitor in as long as the V_{DD} voltage value becomes greater than the V_{DDON} value. Once this condition is reached, the Power MOSFET starts to switch. Burst mode condition works skipping same switching cycles decreasing the power consumptions when the load becomes light.

2. AIR-CONDITIONER APPLICATION

2.1 Schematic

Figure 4 gives the schematic of the power supply with VIPer22 used in the air-conditioner application described in this note. It is designed to have two voltage outputs, respectively 12V and 5V. The maximum power capability is 10W and it is delivered on the 12V output. Peak current value of this output is 900mA. Instead, the second output (5V) is obtained connecting in the first output in cascade of a linear voltage regulator (7805) and a zener diode D9 that is used in order to share the voltage drop. This solution allows to have a very high accuracy in 5V output voltage value, therefore this solution is suitable for supplying microcontroller or/and logical circuit, LCD and buzzer. The current capability of this second output is 400mA. The solution proposed, shown in figure 4, is an isolated fly-back topology in secondary feedback. The control loop is obtained through an optocoupler, with a high stability voltage reference (TL431), in order to check the 12V output assuring the complete insulation between the input and the output. A transil snubber circuit (D6-D7), allows to have a reliable protection for spikes voltage due to the reflected voltage and the leakage inductance.

Figure 4. Air-Conditioner SMPS Schematic



2.2 Result

The main purpose of this application is to have both the output voltages very accurate. The first one (12V) has a high accurateness because it is in secondary regulation feedback, while the second one (5V) has a high precision because this line is obtained using a standard linear regulator. This air-conditioner application is developed to work in wide range (85-265 VAC). The stand-by power consumption is always lower than 1W, as shown in figure 5, satisfying the Energy Star rules regarding stand-by power consumption.

Instead, figure 6 shows the efficiency measurement achieved keeping the 5V output in no-load condition.

Figure 5. Power consumption in stand-by condition

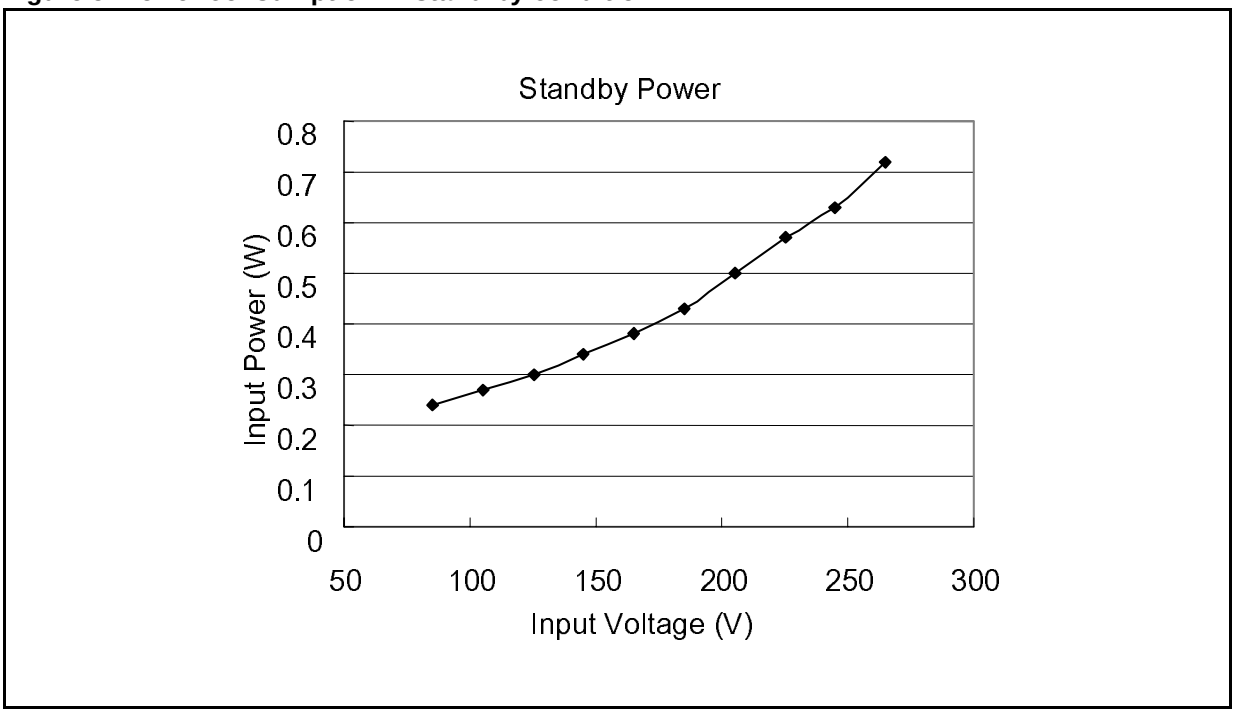
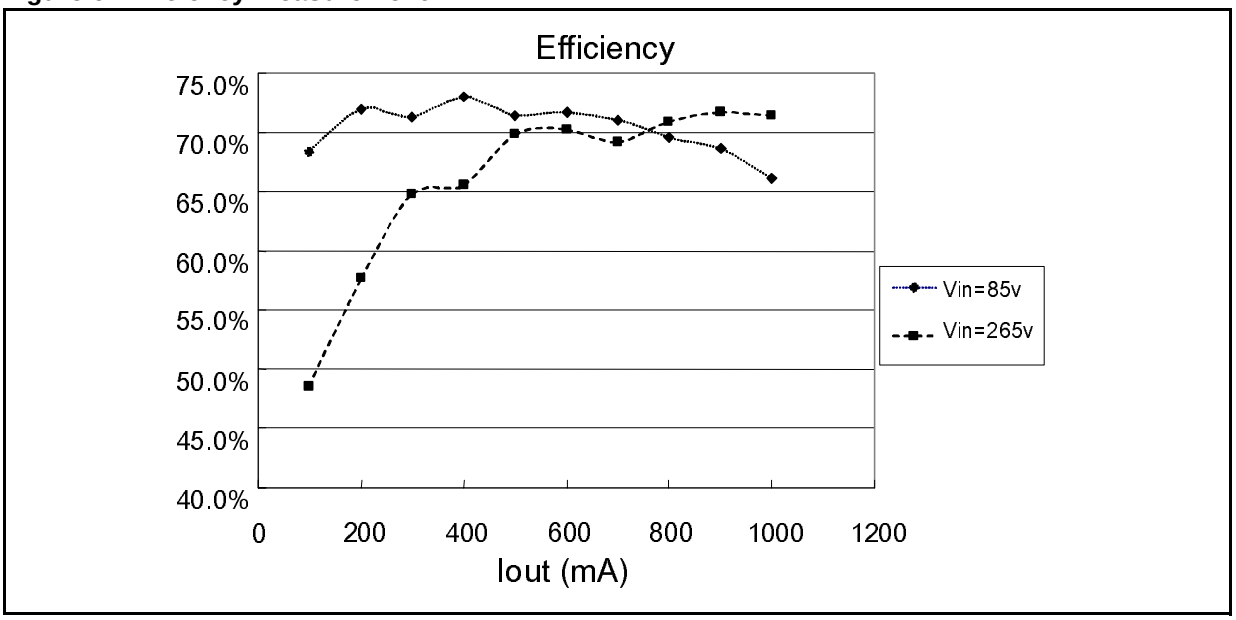


Figure 6. Efficiency measurement

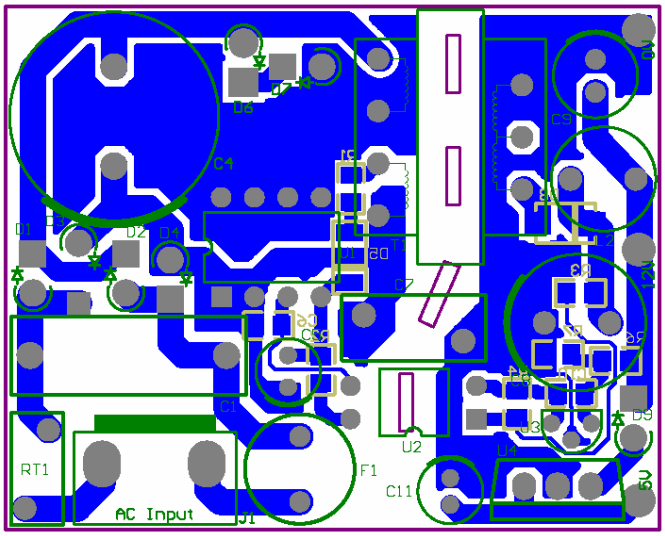


3. DEMOBOARD DESCRIPTION

3.1 Board Layout

It is a single layer type with copper on bottom side, and serigraphy on top side. Both of them are represented in figure 7. This PCB Layout dimension is 50mm x 40mm.

Figure 7. PCB Layout (dimension is 50mmX40mm)



3.2 Bill of material

Table 3 gives the list of the components used to develop this application.

Table 3. Bill of Material

Reference	Value	Description
C1	100nF/275VAC	X-Capacitor Evox Rifa
C4	47µF/400V	Polarized Capacitor (Radial)
C5	22µF/50V	Polarized Capacitor (Radial)
C6	47nF	Capacitor
C7	2.2nF/250VAC	Y-Capacitor Evox Rifa
C8	470µF/25V	Polarized Capacitor (Radial)
C9	100µF/25V	Polarized Capacitor (Radial)
C10	100nF	Capacitor
C11	100µF/10V	Polarized Capacitor (Radial)
D1	1N4007	1.0A General Purpose Rectifier
D2	1N4007	1.0A General Purpose Rectifier
D3	1N4007	1.0A General Purpose Rectifier
D4	1N4007	1.0A General Purpose Rectifier
D5	1N4148	80V-0.5A Schottky Diode
D6	**P6KE200**	**STMicroelectronics Zener Diode**
D7	1N4007	Default Diode
D8	**STPS2H100**	**STMicroelectronics 100V-2A Power Schottky Diode**
D9	4.2V/2W	Zener Diode
F1	1A/275VAC	Fuse
J1	Input	Header, 2-Pin
L2	47µH	Inductor
R1	10R	Resistor
R2	4.7KΩ	Resistor
R3	220R	Resistor
R4	1K	Resistor
R6	17.8KΩ	Resistor
R7	4.7KΩ	Resistor
RT1	NTC-5	NTC Resistor
T1		Three-winding Transformer (Non-Ideal)
U1	**VIPer22A**	**STMicroelectronics Off Line SMPS**
U2	PC817	Photocoupler Sharp
U3	**TL431**	**STMicroelectronics Programmable Voltage Reference**
U4	**L7805**	**STMicroelectronics 1A Voltage Regulator**

3.3 Transformer Parameters

The transformer used in this SMPS for air-conditioner application is wound in E19 core. The electrical, mechanical and winding specifications are given in table 4 and figure 8.

Table 4. Transformer parameters

	Core size: E19/8/5	
Primary Winding	Primary Inductance	3.0mH
	Turns	133
	Coil	0.25mm
Auxiliary Winding	Turns	21
	Coil	0.25mm
Secondary Winding	Turns	17
	Coil	0.6mm

Figure 8. Transformer Structure Description