

VIPOWER M3

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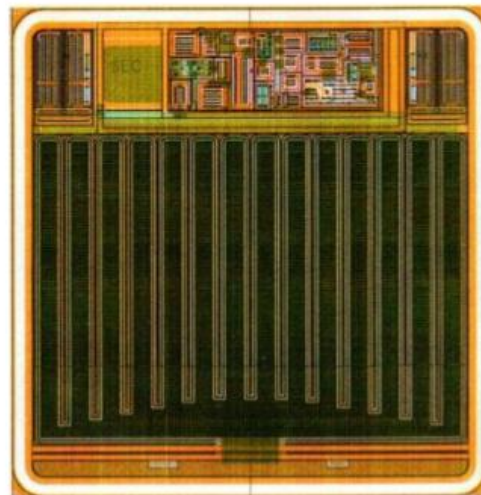
A NEW SMART POWER TECHNOLOGY FOR HIGH VOLTAGE, HIGH SPEED APPLICATIONS

After several years of experience using the well consolidated VIPower M0 and M1 technologies, ST is now introducing the innovative, versatile and cost-effective, VIPower M3. This technology, combining an emitter switching BIPOLAR - MOSFET power stage and a BCD control part, offers the high current carrying capacity and the relatively low cost of a high voltage bipolar structure, with the switching speed and ease-of-drive of a low voltage power MOSFET.

In the VIPower M3 structure the substrate is a N+ type, and its thickness and resistivity is chosen according to the voltage requirement of the application and can range from 400V to 1500V.

The current capability of a device is defined by the size of the Power Stage and, in typical applications, can range from some hundred milliamps to 10-15Amps.

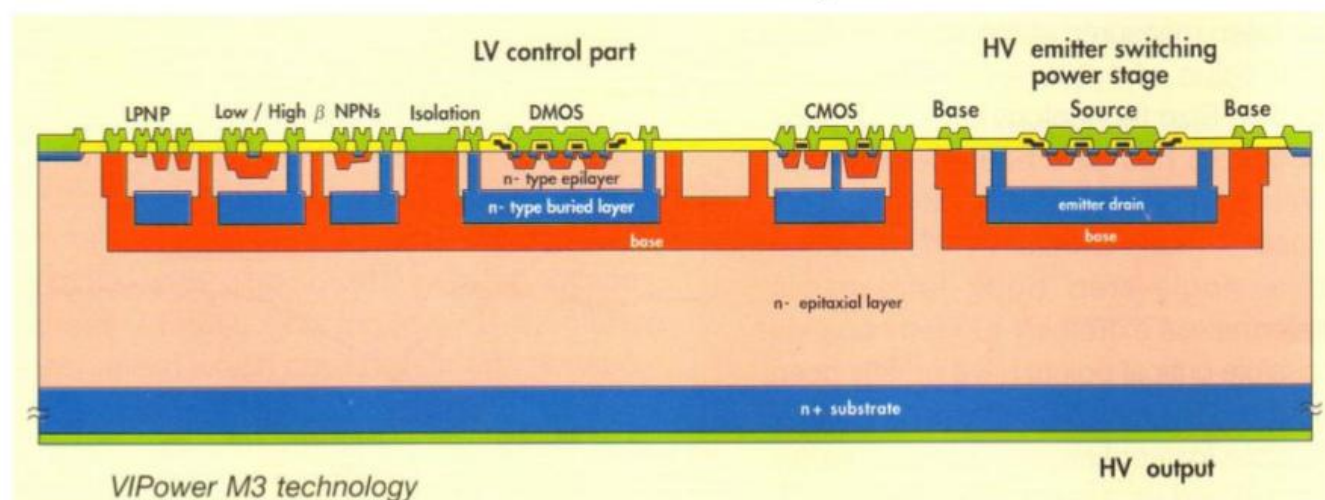
In the control part a BCD circuit can be implemented according to the required complexity. The typical voltage allowed is about 25V. Many different kinds of resistances can be integrated ranging from the very low resistivity (10 mΩ/sq) of the

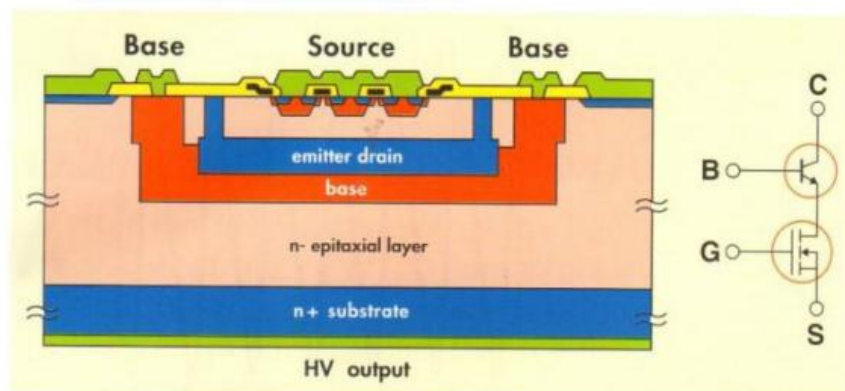


metal resistance used to sense large currents, to about 1KΩ/sq of implanted resistance. High voltage resistors are also allowed to sense the status of the high voltage collector of the power device.

EMITTER SWITCHING POWER DEVICE

The high voltage power device allowed by the technology is bipolar, however, thanks to the different layers available in the technology to build-up the control part, a monolithic emitter switching configuration combining a high voltage bipolar NPN transistor and a low voltage DMOS transistor are integrated in a sandwich structure.

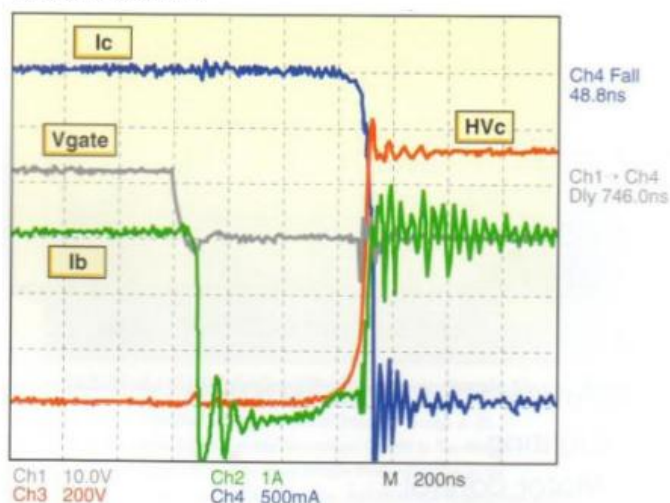




Emitter switching structure and electrical configuration

The electrical schematic shows a series connection of two power devices; the silicon area used is only that of the bipolar due to the “sandwich” patented structure that allows the integration of the low voltage DMOS inside the emitter area of the high voltage bipolar transistor. The electrical output terminals are shown inside the technology structure. Of course the common emitter-drain terminal is buried into the structure making the current path much shorter than the one that can be obtained using a discrete approach.

When looking at the dynamic characteristics of the integrated emitter switching device many advantages of this structure are evident. The waveforms during a (3A, 950V) turn-off transition for a 1500V 5A device are shown below.



Emitter switching turn-off waveforms
HVC scale is 200V/div

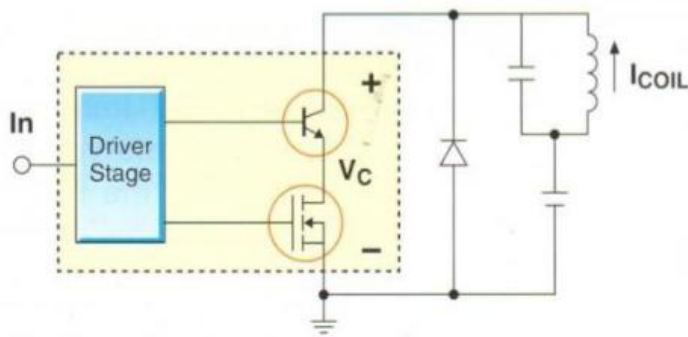
Starting from a “steady state” condition in which the device is in an “ON” state, we can analyse a switch-off transition. As soon as the gate voltage (V_{gate}) goes low, the Power DMOSFET device turns off and its source current is immediately stopped. As a consequence, all the current that was flowing into the collector through the bipolar

and the DMOSFET and then out of the Source, changes its path and, flowing from the collector and out of the base of the HV bipolar, it becomes a reverse base current still maintaining the same value.

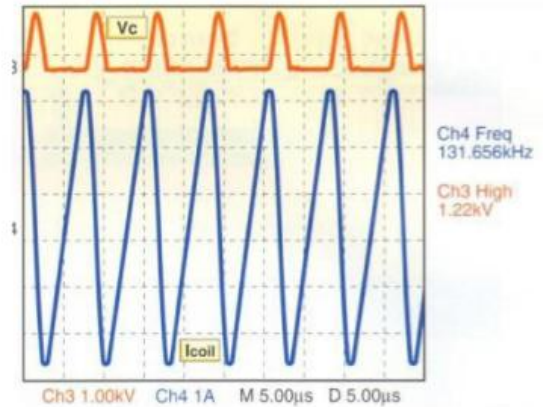
Since the negative base current that removes the stored charge from the base of the bipolar device is as large as the collector current, the speed of the device is greatly improved. This in turn makes the switching performances much better than a standard HV bipolar device and comparable with a Power MOSFET.

As soon as the storage phase is over, the voltage on the collector begins to rise up to the final point set by the external circuitry together with the fall of the collector current (I_c). In order to allow the correct operation of the device during this turn-off period, it is necessary to provide a discharge path for the reverse base current. This is easily done using the capabilities of the technology that allow the integration of discharge paths having several voltage values. The most suitable discharge circuit will be applied according to the application related constraints.

The high voltage, high speed and high current capability ($I_c=6A$, $V_{ce}>1.2KV$, $F_{sw}=130KHz$) of the VIPower M3 technology are shown in the figure on the next page.



Application waveforms in a TV deflection equivalent circuit



COMPARISON WITH POWER MOSFETs

In several applications the VIPower M3 compares favourably with MOSFET based circuits thanks to the better ratio of the current over the area of silicon.

For simplicity, a Darlington structure has been chosen for the emitter switching, supposing that a current I_0 having a sinusoidal shape flows through both structures.

The voltage drop across the emitter switching device is the sum of the bipolar Darlington V_{CEsat} plus the voltage drop of the low voltage MOSFET:

$$V_{CS(on)} = V_{CEsat} + R_{DSLV} * I_0$$

The voltage drop across the H.V. Power MOSFET is simply given by Ohm's Law:

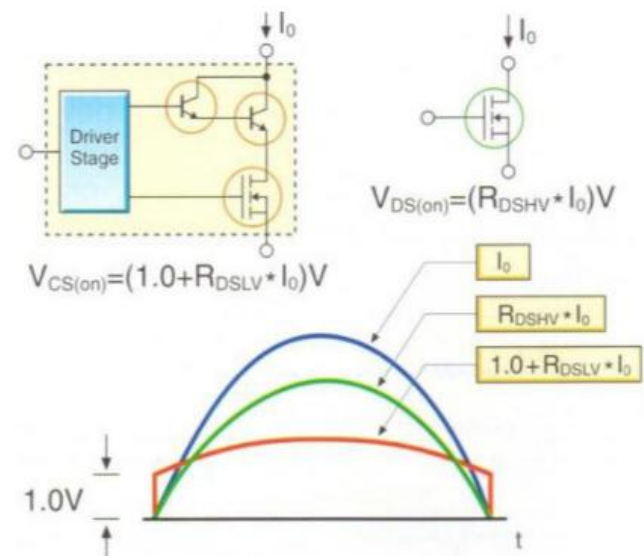
$$V_{DS(on)} = R_{DSHV} * I_0$$

Some considerations need to be made:

- ▶ The V_{CEsat} of the bipolar stage is almost independent from: the voltage capability, the current level and the temperature of the device; so it is almost a constant.
- ▶ The $R_{DS(on)LV}$ of the emitter switching device is much smaller than the $R_{DS(on)HV}$ of the Power MOSFET, so the shape of its voltage drop has a much smoother slope.
- ▶ The thermal evaluation of the whole voltage drop is much more favourable for the emitter switching device because the only sensitive part is the low voltage MOSFET $R_{DS(on)}$ that is a small percentage

of the total losses. To give a comparison, the HV MOSFET doubles its voltage drop in 100°C, while the emitter switching voltage drop will increase by only 20%.

- ▶ Because of the bipolar fixed voltage drop that is still present even for a very low current level, the emitter switching solution is much more attractive as the current level increases; and even more so in applications where there is always an average DC level.



Comparison between emitter switching power stage and a Power MOSFET

VIPower M3 APPLICATIONS

- ▶ Lighting
- ▶ Motor control
- ▶ Deflection for monitors and high end TVs
- ▶ SMPS

VIPer100

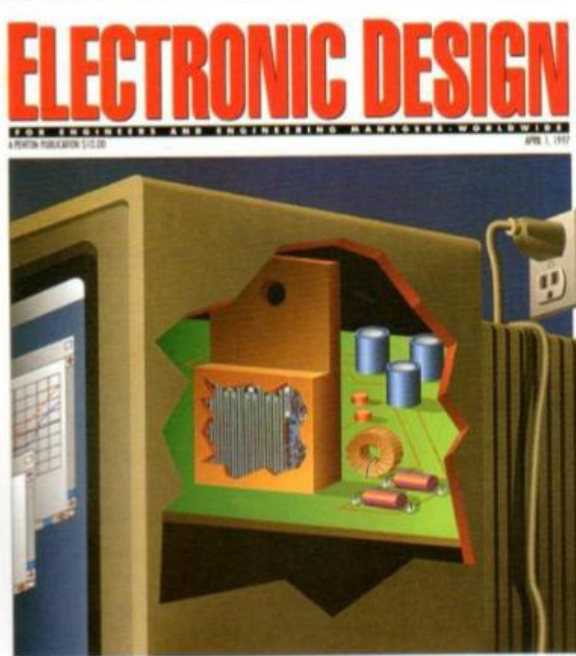
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ADVANCED MONOLITHIC SOLUTION FOR OFF-LINE SMPS PRIMARY CONVERTERS

After the announcement of the first silicon of the VIPer100 (see express 54) and the enthusiastic reaction of the market, we can now forecast that the final silicon will be ready for preproduction by Q3'97. The VIPer100A, a new option with a higher V_{DSS} will also be available soon. The new devices provide an unparalleled combination of performance, flexibility and cost-effectiveness, delivering an output power capability of 100W over the European mains voltage range (180 to 270V AC) or 50W for a universal input voltage range (85 to 270V AC), while using more than 50% fewer components than a discrete solution. Key features of the VIPer100/100A include automatic Burst Mode operation in stand-by condition, an integrated start-up supply, excellent line regulation due

to current mode operation, programmable switching frequency (up to 200kHz) and adjustable current limitation (up to 3A). The automatic Burst Mode operation allows the VIPer100/100A to meet the new German "Blue Angel" Eco Norm with less than 1W total power consumption for the system when working in stand-by. The datasheet for VIPer100 family describes the operation and suggests basic ideas and schematics to implement specific functions. In order to evaluate the performance of the VIPer100 ST has developed two demoboard.

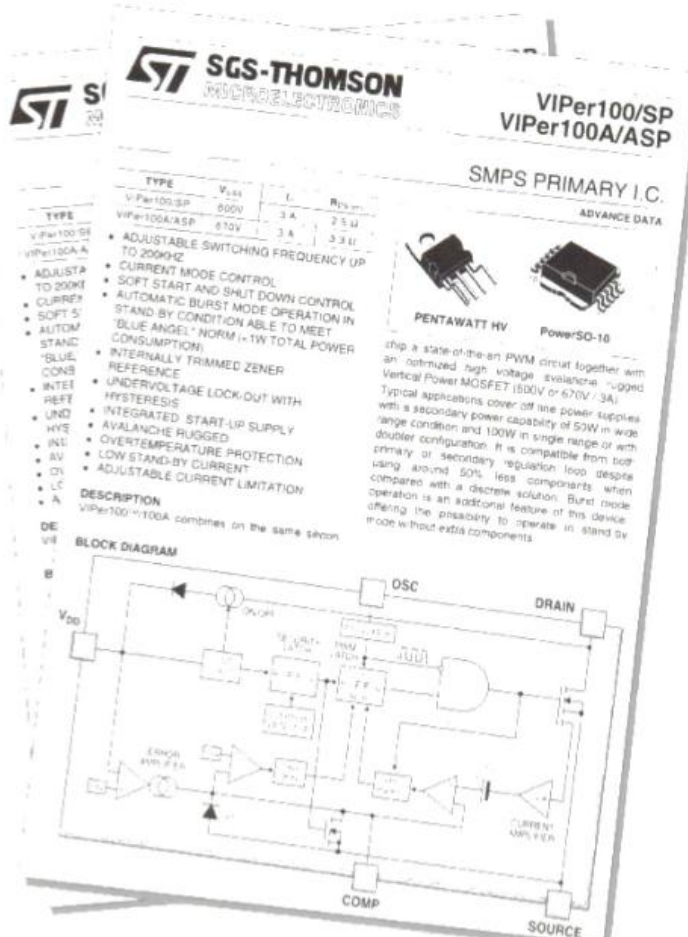
Type	V_{DSS}	I_D	$R_{DS(on)}$	Package
VIPer100/SP	600V	3A	2.5	PowerSO-10
VIPer100A/ASP	670V	3A	3.3	PENTAWATT



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SGS-THOMSON MICROELECTRONICS

**VIPer100/SP
VIPer100A/ASP**

SMPS PRIMARY I.C.

ADVANCE DATA

TYPE	V_{DS}	I_D	$R_{DS(on)}$
VIPer100/SP	600V	3A	2.5 Ω
VIPer100A/ASP	670V	3A	3.3 Ω

- ADJUSTABLE SWITCHING FREQUENCY UP TO 200KHZ
- CURRENT MODE CONTROL
- SOFT START AND SHUT DOWN CONTROL
- AUTOMATIC BURST MODE OPERATION IN STAND-BY CONDITION ABLE TO MEET "BLUE ANGEL" NORM (<1W TOTAL POWER CONSUMPTION)
- INTERNALLY TRIMMED ZENER REFERENCE
- UNDERVOLTAGE LOCK-OUT WITH HYSTERESIS
- INTEGRATED START-UP SUPPLY
- AVAILANCHE RUGGED
- OVERTEMPERATURE PROTECTION
- LOW STAND-BY CURRENT
- ADJUSTABLE CURRENT LIMITATION

DESCRIPTION
VIPer100-VIPer100A combines on the same silicon

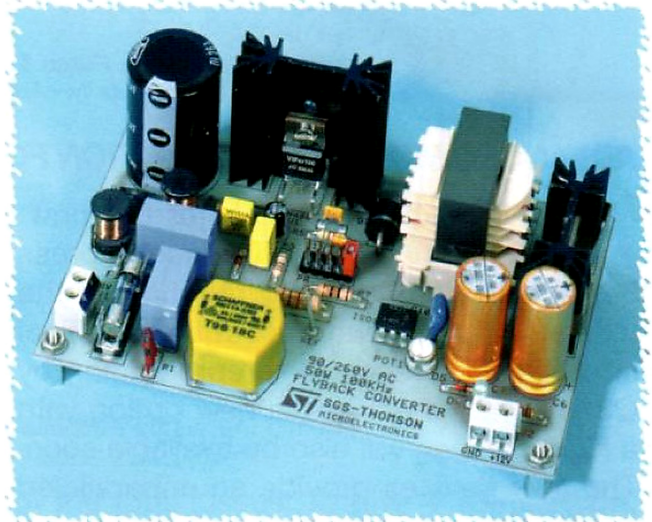
BLOCK DIAGRAM

chip a state-of-the-art PWM circuit together with an optimized high voltage avalanche rugged Vertical Power MOSFET (600V or 670V / 3A). Typical applications cover off line power supplies with a secondary power capability of 50W in wide range condition and 100W in single range or with doubler configuration. It is compatible from both primary or secondary regulation loop despite using around 50% less components when compared with a discrete solution. Burst mode operation is an additional feature of this device offering the possibility to operate in stand by mode without extra components.

PENTAWATT HV **PowerSO-10**

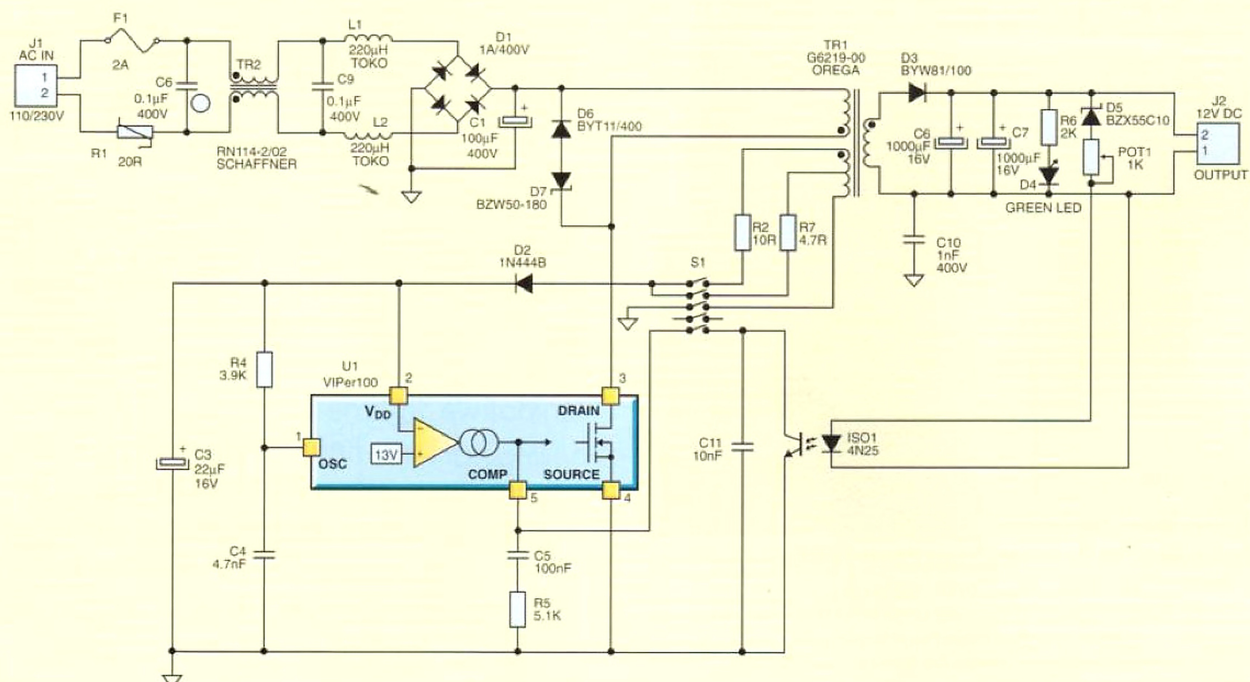
VIPer100 STANDARD DEMOBOARD

The VIPer100 standard demoboard is a wide voltage range input off-line single switch Flyback, working at 100kHz and allows the user to choose between primary and secondary regulation. Primary regulation is carried out by the auxiliary winding which delivers the low level supply voltage on the V_{DD} pin of the device. Secondary regulation is achieved by an optocoupler directly from secondary output voltage. It acts on the COMP pin, and the auxiliary winding delivers the low level supply voltage at a lower value than when in primary regulation configuration, thanks to R7. The internal error amplifier is consequently saturated in high state, sourcing a constant current of about 0.5mA on the COMP pin. No power limitation has been set on the VIPer device, so the demoboard is able to deliver up to 130W in continuous running (for 5 seconds max). The demoboard withstands the no load condition and is fully protected against



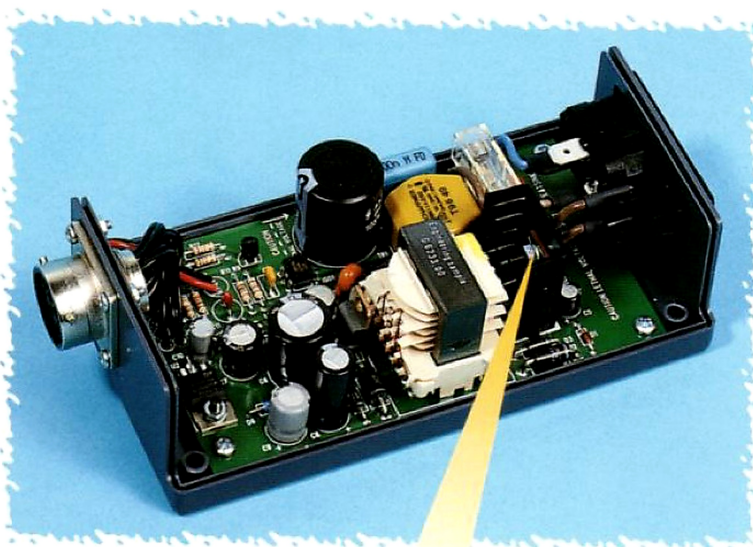
short circuits. This type of condition leads to a burst operation, with a peak current of up to 25A on the output.

AC input voltage	90-265V AC
Maximum output power	50W
DC output voltage/load	Vout = +12V, 4A
Operating frequency	100kHz



VIPer100 DEMOBOARD FOR SET TOP BOX SMPS

The power supply is intended to provide all the voltage used by the set top box board. To guarantee safety conditions, primary and secondary components were implemented in the opposite side of the board. The components TR2, ISO1, and C12 assure the isolation between the primary and secondary circuits, and are subject to safety standards such as VDE and UL. In order to reduce radiated EMI all high current loops have been minimized closing off the associated components one from the other.



Output line	Voltage	Max current
Main and Tuner	+5.0V	2.3A
Tuner	+3.3V	0.2A
Tuner	+28.0V	0.05A
Main	+12.0V	0.5A

