SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

FLEXIBLE LOW COST HIGH EFFICIENCY 130W SMPS USING SGSD00055 AND TEA2018A

By R. LETOR - S. FLERES

ABSTRACT

A low cost, high efficiency, flexible and reliable 130W flyback power supply has been designed using the new Fastswitch high voltage Darlington SGSD00055 and the TEA2018A PWM controller.

The advantages of the new Darlington are low cost together with low switching and driving losses, a large safe operating area and simple drive requirements.

The TEA2018A provides the SMPS with comprehensive protection whilst using very few components.

The low cost of this design makes it a viable option for use in personal computers, telecommunication equipment, battery chargers and TVs.

The example evaluated in this paper is intended for CTV applications.

INTRODUCTION

The SGSD00055 is a new 1000V Darlington designed in high voltage planar technology.

The main features of this device are fast switching capability, large reverse safe operating area and very low cost.

This high efficiency 130W flyback SMPS capitalises on the features of this transistor to produce a highly reliable power supply.

By adding to this the facilities offered by the TEA2018A, significant component reduction can be made whilst retaining all the desirable features.

The high voltage that the Darlington can withstand plus the large safe operating area allows the use of a low cost transformer with high leakage inductance.

The leakage inductance of a low cost transformer is likely to produce voltage spikes in excess of 850V at turn-off, a voltage that standard Darlingtons are unlikely to be able to handle.

An added advantage of this high voltage capability is that smaller snubber networks can be used giving reduced dissipation in these networks.

The switch mode power supply characteristics are summarised in the following table :

Operating mode :	non continuous flyback	
A.C. input voltage :	110/220V	± 15%
Maximum frequency :	25kHz	
Maximum output power :	130W	
Outputs :	+ 200V	50mA
	+ 150V	500mA
	+ 25V	1.5mA
	+ 16V	500mA
Line regulation :	.016%/V	
Load regulation :	.035%/W	
110W efficiency :	82%	

CIRCUIT DESCRIPTION

Figure 1 shows the complete circuit and component list.

The rectified mains voltage applied to the primary of the flyback transformer is switched at 20KHz by the Darlington Q1 with a duty cycle of about 30%.

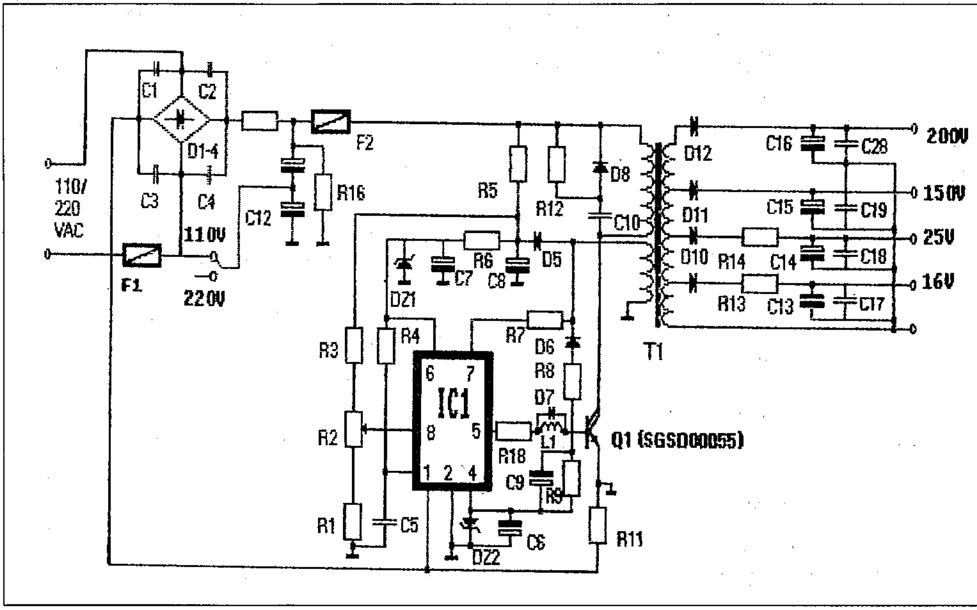
During the on-state the base current value depends upon the collector current, the TEA2018A performing the proportional base drive.

The negative voltage necessary for the turn-off is provided by the D6, R8, R9, C9 network, which charges the C6 capacitor during the on-state.

At turn-off, the inductor L1 limits the reverse base current and prevents the turn-off from being too fast hence reducing any "tail turn-off" problem.

The snubber network R12, C10, D8 ensures safe switch off inside the safe operating area and very low switching losses at turn-off.

Figure 1 : 130W SMPS Using SGSD00055.



COMPONENT LIST

R1	1K	1/4W
R2 trimmer	22K	
R3	1K	1/4W
R4	56K	1/4W
R5	100K	1W
R6	220K	2W
R7	10K	1/4W
R8	10	1W
R9	470	2W
R10	2.7	1/2W
R11	0.33	2W
R12	2.2K	7W
R13	1	2W
R14	0.75	4W
R15	4	4W
R16	100K	1/2W
L1	4.7µH	
C1 - C4	1nF	1kV
C5	680pF	1kV
C6	4.7µF	6.3V
C7	100µF	16V

C8	100µF	25V
C9	4.7µF	6.3V
C10	1.8nF	1kV
C11 - C12	220µF	250V
C13 - C14	220µF	63V EKA
C15	10µF	250V
C16	10µF	300V
DZ1	10V	1W
DZ2	4.7V	1/2W
D1 - D4	2A 250V	Rectifier Bridge
D5	1N4001	
D6	BA157	
D7	1N4148	
D8	BYT13-800	
D9 - D10	BYW98	
D11 - D12	BY299	
Q1	SGSD00055	
IC1	TEA2018A	
T1	SAREA 29.6024	
F1	0.5 A FUSE	
F2	0.5 A FUSE	

Figure 2 shows the power losses in the Darlington and in R12 as C10 is varied.

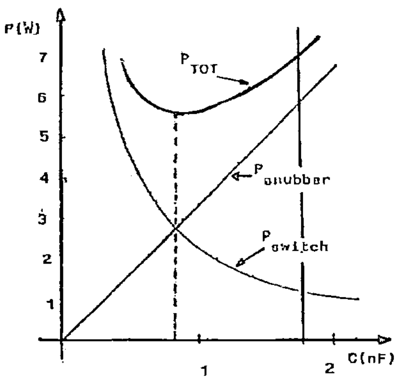
The minimum power losses occur when C10 has a value of 1.0nF.

In fact a value of 1.8nF was used in order to give a sufficient safety margin at turn-off.

In this way a 1W reduction of the power losses in the Darlington was obtained (see figure 3).

This in turn reduced the working temperature with a consequent improvement in reliability. To obtain the same safety margin with a 850V Darlington a 2.2nF capacitor would have to be used for C10.

Figure 2 : Power Losses vs $C_{Snubber}$.



This would result in higher losses. Using the 1000V Darlington permits the use of a cheaper "lossy" transformer as the Darlington itself will withstand the higher voltage peaks caused by a leakage inductance 4 times greater than the peak that a 850V Darlington can withstand.

The TEA2018A demagnetisation circuit allows the following features to be designed into the circuit :
- non-continuous flyback mode for all load conditions
- soft start
- short circuit protection

Figure 3 : Load Line Shape at Turn-off.

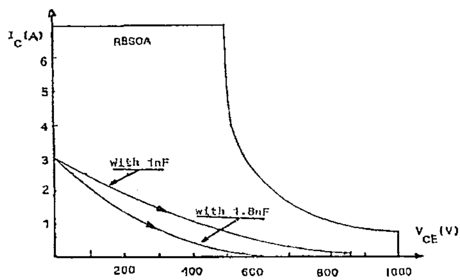


Figure 4 shows the short circuit conditions both with and without the demagnetisation control. During normal operation the maximum current is limited by the current mode control.

When a short circuit occurs without the demagnetisation circuit, the collector current increases until the transformer core is saturated.

This happens because collector current continues increasing even after the current limiter intervenes due to the storage current, at a rate 0.25A/µS.

Hence the energy stored in the transformer core during $t_{storage}$ eaches a value of about 50µJ, while during the discharge cycle the energy reduces to about 3µJ.

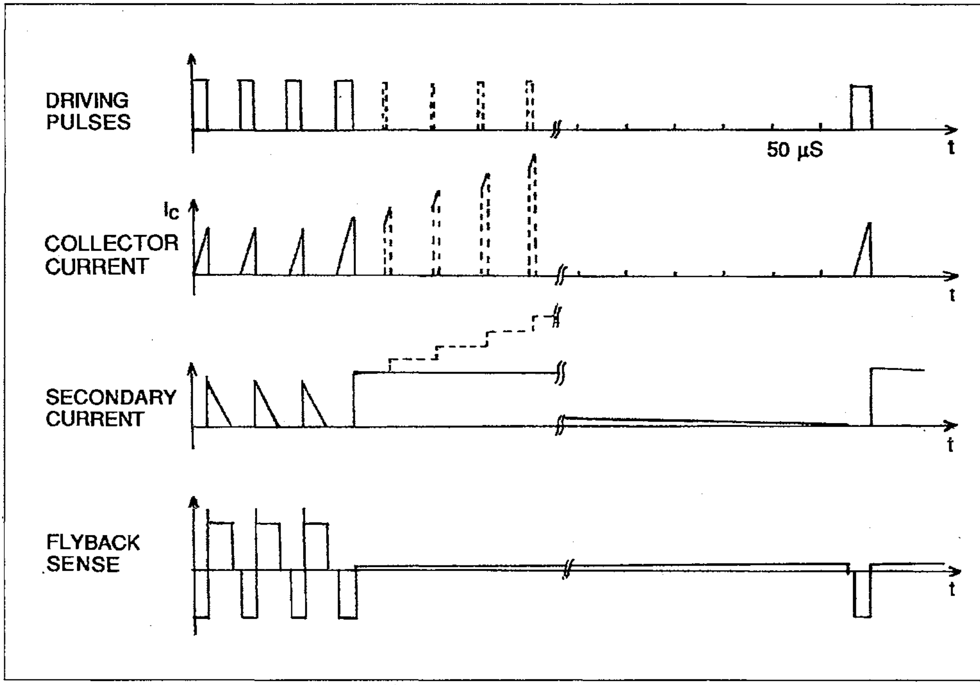
In this application the demagnetisation circuit inhibits the base drive until all the stored energy in the core of the transformer has been discharged through the diode, the secondary winding and the short circuit resistances.

The demagnetisation current behaves in the same way during start-up avoiding extra currents.

It also ensures non-continuous mode operation under every load condition.

The following figures and photographs illustrate the performance of this power supply.

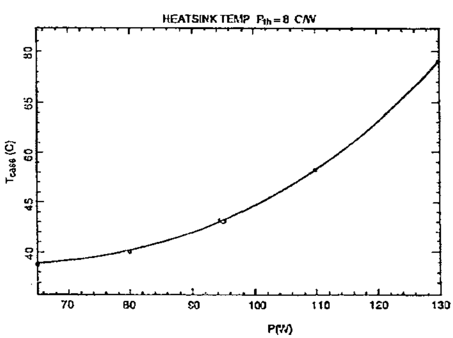
Figure 4 : Short Circuit Operation.

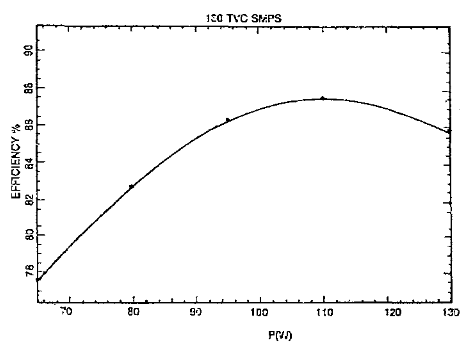


- - - - - - - - -	without demagnetisation circuit
————	with demagnetisation circuit

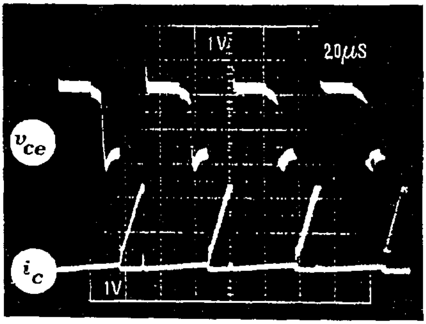
Figure 5a : Efficiency versus Output Power.

Figure 5b : Heatsink Temperature versus Output Power for R_{th} (heatsink) 8°C/W.



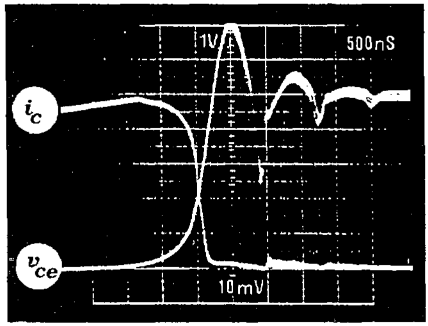


Photograph 1 : Collector Voltage and Current Waveforms.



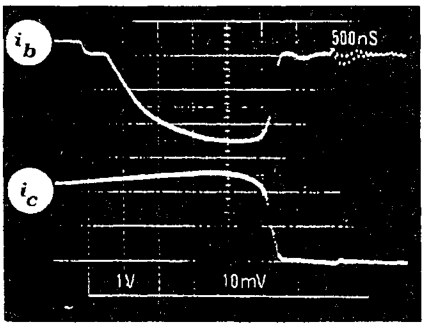
I_C = 1A/div V_{CE} = 100V/div V_{CC} = 250V

Photograph 2 : Turn-off Waveforms.



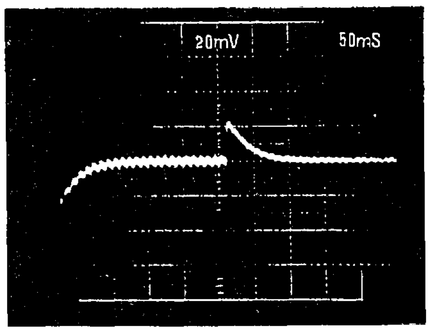
I_C = 0.5A/div V_{CE} = 100V/div

Photograph 3 : Collector and Base Current at Turn-off.



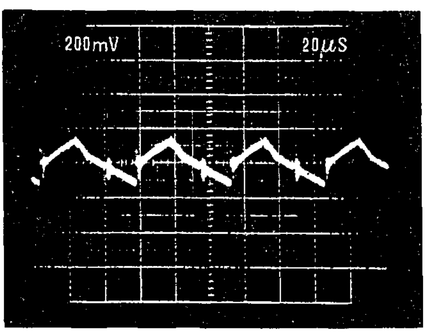
I_C = 1A/div I_B = 0.2A/div

Photograph 4 : Transient Response to a step Load



V = 2V/div

Photograph 5 : Output Ripple on the 25V Output.



V= 200mV/div I = 1.5A

CONCLUSIONS

The new 1000V Darlington allows the construction of a flexible, reliable and low cost switching power supply.

It has a high efficiency even at low loads due to the very low driving energy required, the low switching losses and the reduced snubber losses.