SG1825 DESIGN BRIEF: A 200KHz CURRENT-MODE SUPPLY

Reza Amirani and Stan Dendinger
Silicon General, Inc.

INTRODUCTION

To demonstrate the high-speed capabilities of the new SG1825 Pulse Width Modulator, a small 200 KHz switching power supply was designed and constructed. A push-pull current mode architecture was chosen because of its inherent anti-saturation properties. This choice of more efficient magnetic structure and the 200 KHz switching frequency allowed the transformer bulk to be minimized.

DESIGN SPECIFICATIONS

Input Voltage: +22 to +32 VDC
Output Voltage: +5.0 Volts
Output Current: 0.5 to 2.0 Amps
Line Regulation: ± 1%
Load Regulation: ± 1%
Output Noise and Ripple: 50 mV RMS
Full Load Efficiency: 73%
Total Weight: 10 oz.

CIRCUIT DESCRIPTION

The circuit uses a bootstrap winding and the micropower start-up capabilities of the SG1825 to efficently provide controller supply voltage. Typical start-up current is only 600 µA, an improvement of 2.5 over alternate-source controller ICs.

When the +28 volt input is applied, the 680 µF start capacitor is trickle-charged by the 2.7K bleeder. While the controller is in micropower mode, the driver outputs are switched to ground, providing protection against leakage currents which could turn on both power MOSFETs.

At +9.2 volts the SG1825 turns on, driving the transformer primary through the two International Rectifier IRF840s. The 50 ohm series resistor at each gate provides isolation from the C_{GD} kick-back voltage, while the 1N5819 Schottky diodes provide a low-impedance drive at turn-off. The bootstrap winding then becomes active, providing the low-voltage high-current supply required by the control device. The turns ratio beween the regulated +5 volt output and the bootstrap winding is 2/4 or 0.5, resulting in a nominal 10 volt semi-regulated supply. Since the rectifier filter is capacitive-input rather than inductive, the actual controller supply is +15 volts.

Peak transformer primary current, which can be scaled to the output filter inductor current through the turns ratio, is sensed by a 1.0 ohm resistor in series with the MOSFET sources. After a low pass filter to remove leading edge peaking, the waveform is applied to the Ramp input pin. The current pulse is compared to the output of the error amplifier, and the drive to the power devices is terminated when the peak current exceeds the threshold set by the outer voltage control loop.

Slope compensation, required for loop stability above 50% duty cycle, is implemented by buffering the ramp waveform at the C_T pin with an 2N2222 emitter follower to preserve linearity. The ramp is summed with the supply output voltage sample at the inverting input of the error amplifier.

Short circuit protection is provided by passing the current waveform through a somewhat narrower bandwidth filter, and applying it to the dual threshold I_{LIM}/Shutdown pin. At light overloads, the +1.0 volt threshold will be exceeded, triggering pulse-by-pulse current limiting. If the output load increases further, the +1.4 volt threshold will be crossed. This discharges the soft-start capacitor, causing a low-frequency “hiccup” mode of current limit.

The transformer flux swing was chosen to be ± 0.1 Tesla (± 1000 Gauss) to keep losses low in the H_{7C4} ferrite core. Primary and bootstrap windings were bifilar wound to minimize leakage inductance, and the high current secondary was quadfilar construction for the same reason.

CONCLUSION

The completed power supply was bench-tested and met all design specifications. At 400KHz oscillator frequency the PWM chip had a wide modulation range, with nearly text-book waveforms. The improved layout and ground partitioning inside the integrated circuit minimized crosstalk problems between the high-current output drivers and the high-speed pulse-processing logic. Most importantly, the SG1825 controller was functional and well-behaved down to -55°C, making it particularly well suited to high-frequency military power supplies.

January 1990

APPLICATION CIRCUIT

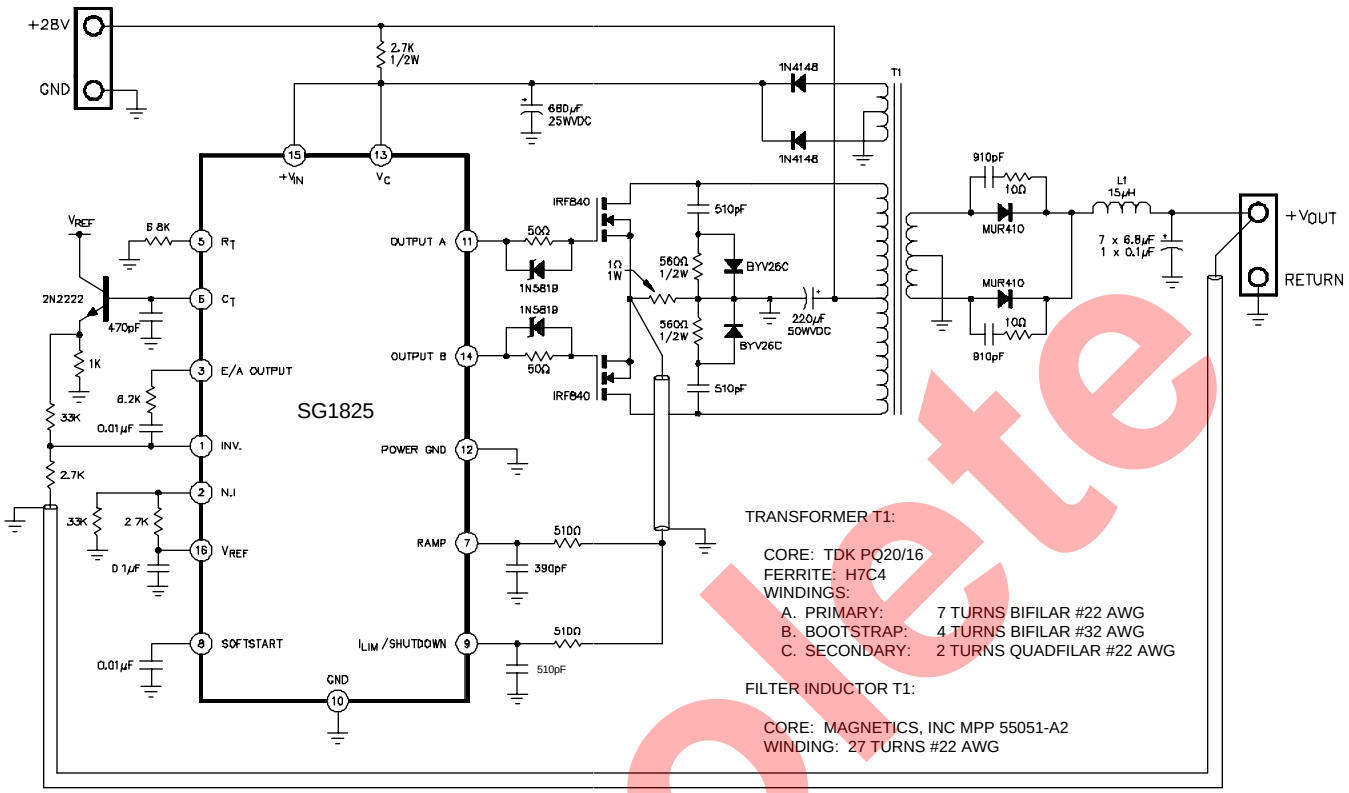

FIGURE 1 - SG1825 200KHz CURRENT-MODE POWER SUPPLY