FAIRCHILD SEMICONDUCTOR®

April 2009

SG6742HL/HR
Highly Integrated Green-Mode PWM Controller

Features

- High-Voltage Startup
- Low Operating Current: 2.7mA
- Linearly Decreasing PWM Frequency to 22KHz
- Frequency Hopping to Reduce EMI Emission
- Fixed PWM Frequency: 100KHz
- Peak-Current-Mode Control
- Cycle-by-Cycle Current Limiting
- Leading-Edge Blanking (LEB)
- Synchronized Slope Compensation
- Internal Open-Loop Protection
- GATE Output Maximum Voltage Clamp: 18V
- V_{DD} Under-Voltage Lockout (UVLO)
- V_{DD} Over-Voltage Protection (OVP)
- Programmable Over-Temperature Protection (OTP)
- Internal Latch Circuit (OVP, OTP)
- Internal-Sense, Short-Circuit Protection
- Built-in 6ms Soft-Start Function
- Constant Power Limit (Full AC Input Range)
- Internal OTP Sensor with Hysteresis

Applications

General-purpose switch-mode power supplies and flyback power converters, including:

- Power Adapters
- Open-Frame SMPS

Description

The highly integrated SG6742HL/HR PWM controller provides several features to enhance the performance of flyback converters.

To minimize standby power consumption, a proprietary green-mode function provides off-time modulation to linearly decrease the switching frequency at light-load conditions. To avoid acoustic-noise problems, the minimum PWM frequency is set above 22KHz. This green-mode function enables the power supply to meet international power conservation requirements. With the internal high-voltage startup circuitry, the power loss due to bleeding resistors is eliminated. To further reduce power consumption, SG6742HL/HR is manufactured using the BiCMOS process, which allows an operating current of 2.7mA.

SG6742HL/HR integrates a frequency-hopping function internally that helps reduce EMI emission of a power supply with minimum line filters. Its built-in synchronized slope compensation achieves stable peak-current-mode control. The proprietary, internal line compensation ensures constant output power limit over a wide AC input voltage range, from $90V_{AC}$ to $264V_{AC}$.

SG6742HL/HR provides many protection functions. In addition to cycle-by-cycle current limiting, the internal open-loop protection circuit ensures safety should an open-loop or output short-circuit failure occur. PWM output is disabled until V_{DD} drops below the UVLO lower limit, when the controller starts up again. As long as V_{DD} exceeds ~25V, the internal OVP circuit is triggered.

SG6742HL/HR is available in an 8-pin SOP package.

Ordering Information

Part Number	Operating Temperature Range	OLP Function	Package	Eco Status	Packing Method
SG6742HLSY	-40 to +105°C	Latch	8-Lead Small Outline Package (SOP)	Green	Tape & Reel
SG6742HRSY	-40 to +105°C	Restart	8-Lead Small Outline Package (SOP)	Green	Tape & Reel

For Fairchild's definition of "green" Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs_green.html.

Application Diagram

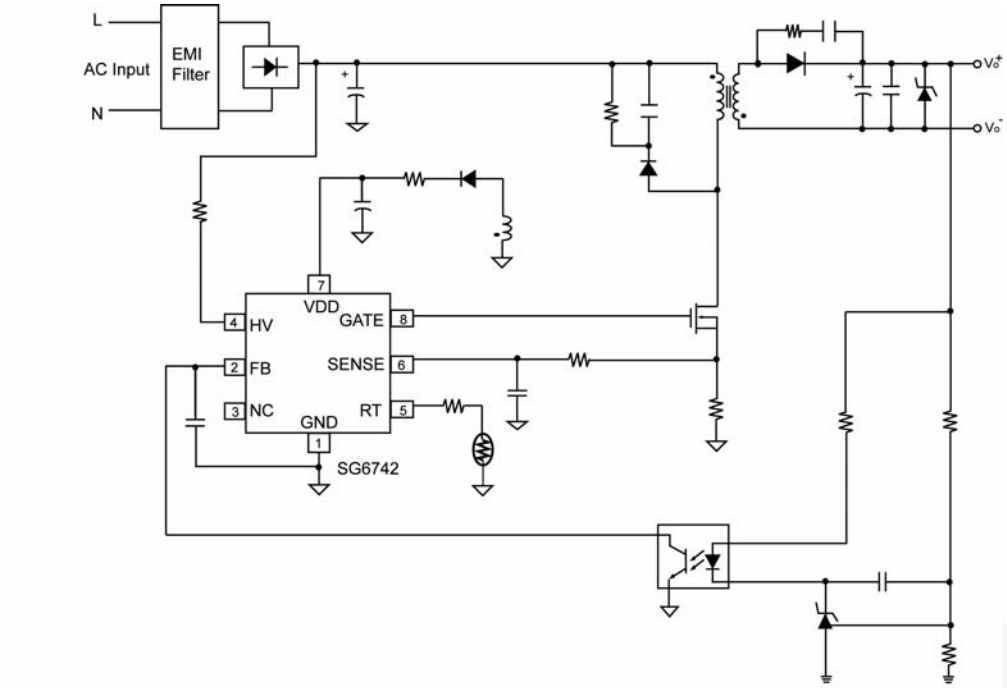


Figure 1. Typical Application

Internal Block Diagram

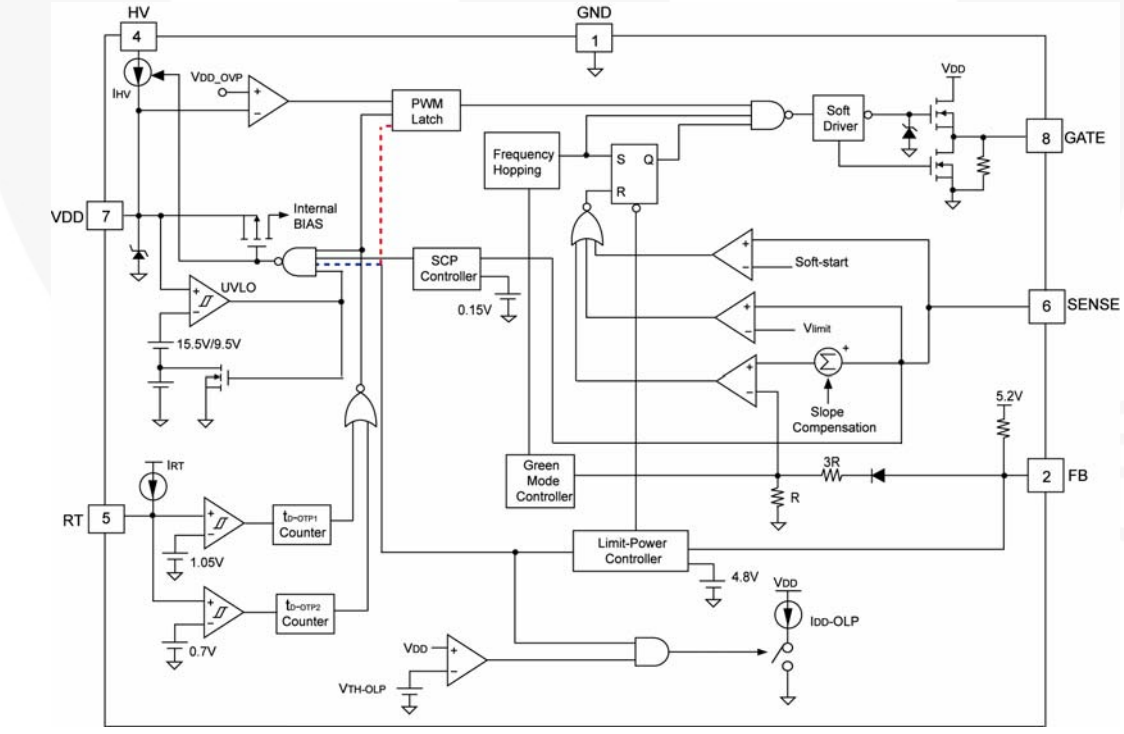
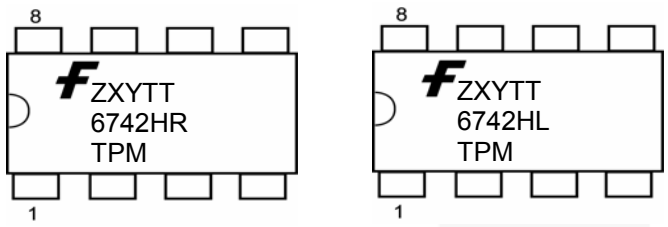


Figure 2. Functional Block Diagram

Marking Information



F - Fairchild Logo
Z - Plant Code
X - 1-Digit Year Code
Y - 1-Digit Week Code
TT - 2-Digit Die Run Code
T - Package Type (S=SOP)
P - Y: Green Package
M - Manufacture Flow Code

Figure 3. Top Mark

Pin Configuration

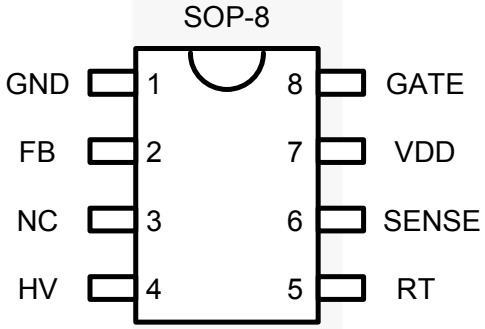


Figure 4. Pin Configuration (Top View)

Pin Definitions

Pin #	Name	Description
1	GND	Ground.
2	FB	The signal from the external compensation circuit is fed into this pin. The PWM duty cycle is determined in response to the signal on this pin and the current-sense signal on the SENSE pin.
3	NC	No connection.
4	HV	For startup, this pin is pulled high to the line input or bulk capacitor via resistors.
5	RT	For over-temperature protection, an external NTC thermistor is connected from this pin to the GND pin. The impedance of the NTC decreases at high temperatures. Once the voltage of the RT pin drops below a fixed limit, PWM output is latched.
6	SENSE	Current sense. The sensed voltage is used for peak-current-mode control and cycle-by-cycle current limiting.
7	VDD	Power supply. The internal protection circuit disables PWM output as long as V_{DD} exceeds the OVP trigger point.
8	GATE	The totem-pole output driver. Soft driving waveform is implemented for improved EMI.

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter		Min.	Max.	Unit
V_{VDD}	DC Supply Voltage[1, 2]			30	V
V_{FB}	FB Pin Input Voltage		-0.3	7.0	V
V_{SENSE}	SENSE Pin Input Voltage		-0.3	7.0	V
V_{RT}	RT Pin Input Voltage		-0.3	7.0	V
V_{HV}	HV Pin Input Voltage			500	V
P_D	Power Dissipation (T_A＜50°C)			400	mW
Θ_{JA}	Thermal Resistance (Junction-to-Air)			141	°C/W
T_J	Operating Junction Temperature		-40	+125	°C
T_{STG}	Storage Temperature Range		-55	+150	°C
T_L	Lead Temperature (Wave Soldering or IR, 10 Seconds)			+260	°C
ESD	Human Body Model, JEDEC:JESD22-A114	All pins except HV pin		4.0	kV
	Charged Device Model, JEDEC:JESD22-C101	All pins except HV pin		1.5	

Notes:
1. All voltage values, except differential voltages, are given with respect to the network ground terminal.
2. Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device.

Electrical Characteristics

V_{DD}=15V and T_A=25°C unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{DD} Section						
V_{OP}	Continuously Operating Voltage				22	V
V_{DD-ON}	Start Threshold Voltage		14.5	15.5	16.5	V
V_{DD-OFF}	Minimum Operating Voltage		8.5	9.5	10.5	V
I_{DD-ST}	Startup Current	V_{DD-ON} – 0.16V			30	µA
I_{DD-OP}	Operating Supply Current	V_{DD}=15V, GATE Open		2.7	3.7	mA
I_{DD-OLP}	Internal Sink Current	V_{TH-OLP}+0.1V	30	60	90	µA
V_{TH-OLP}	I_{DD-OLP} off Voltage		6.5	7.5	8.0	V
V_{DD-OVP}	V_{DD} Over-Voltage Protection		24	25	26	V
$t_{D-VDDOVP}$	V_{DD} Over-Voltage Protection Debounce Time		75	125	200	µs
HV Section						
I_{HV}	Supply Current from HV Pin	V_{AC}=90V (V_{DC}=120V), V_{DD}=0V	1.75	2.30	3.35	mA
I_{HV-LC}	Leakage Current After Startup	HV=500V, V_{DD}=V_{DD-OFF}+1V		1	20	µA
Oscillator Section						
f_{OSC}	Frequency in Normal Mode	Center Frequency	90	100	110	KHz
		Hopping Range	±4.2	±4.7	±5.2	
t_{HOP}	Hopping Period		4.9	5.6	6.3	ms
f_{OSC-G}	Green-Mode Frequency		18	22	25	KHz
f_{DV}	Frequency Variation vs. V_{DD} Deviation	V_{DD}=11V to 22V			5	%
f_{DT}	Frequency Variation vs. Temperature Deviation	T_A=-40 to 105°C			5	%

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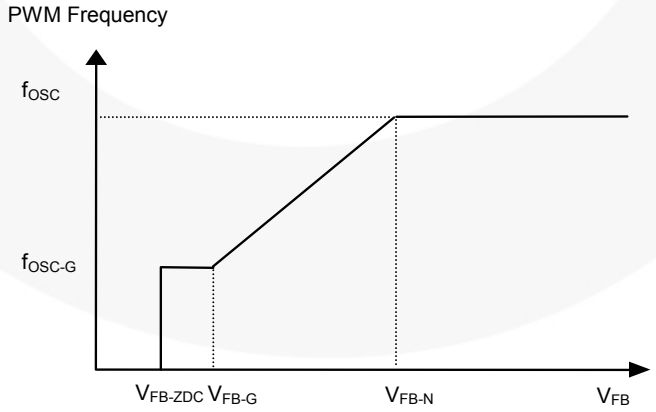

Figure 5. V_{FB} vs. PWM Frequency

Electrical Characteristics (Continued)

V_{DD}=15V and T_A=25°C unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Feedback Input Section						
A_V	Input Voltage to Current-Sense Attenuation		1/4.15	1/4.00	1/3.85	V/V
Z_{FB}	Input Impedance		4		7	kΩ
$V_{FB-OPEN}$	Output High Voltage	FB Pin Open		5.2		V
V_{FB-OLP}	FB Open-Loop Trigger Level		4.6	4.8	5.0	V
t_{D-OLP}	Delay Time of FB Pin Open-loop Protection		50	56	62	ms
V_{FB-N}	Green-Mode Entry FB Voltage		3.1	3.3	3.5	V
V_{FB-G}	Green-Mode Ending FB Voltage			V_{FB-N}-0.5		V
V_{FB-ZDC}	Zero Duty-Cycle Input Voltage			1.6		V
Current-Sense Section						
Z_{SENSE}	Input Impedance			12		KΩ
V_{STHFL}	Current Limit Flatten Threshold Voltage	Duty cycle=45%	0.97	1.00	1.03	V
V_{STHVA}	Current Limit Valley Threshold Voltage	V_{STHFL}–V_{STHVA}	0.27	0.30	0.33	V
t_{PD}	Delay to Output			100	200	ns
t_{LEB}	Leading-Edge Blanking Time		100	140	180	ns
V_{S-SCP}	Threshold Voltage for SENSE Short-Circuit Protection		0.10	0.15	0.20	V
t_{D-SSCP}	Delay Time for SENSE Short-Circuit Protection	V_{SENSE}<0.15V	100	150	200	µs
t_{SS}	Period During Soft-Startup Time	Startup Time	5	6	7	ms
GATE Section						
DCY_{MAX}	Maximum Duty Cycle		60	65	70	%
V_{GATE-L}	Gate Low Voltage	V_{DD}=15V, I_O=50mA			1.5	V
V_{GATE-H}	Gate High Voltage	V_{DD}=12V, I_O=50mA	8			V
t_r	Gate Rising Time	V_{DD}=15V, C_L=1nF	150	250	350	ns
t_f	Gate Falling Time	V_{DD}=15V, C_L=1nF	30	50	90	ns
$I_{GATE-SOURCE}$	Gate Source Current	V_{DD}=15V, GATE=6V	250			mA
$I_{GATE-SINK}$	Gate Sink Current	V_{DD}=15V, GATE=1V	300			mA
$V_{GATE-CLAMP}$	Gate Output Clamping Voltage	V_{DD}=22V			18	V
RT Section						
R_{RT}	Internal Resistor from RT Pin		10.08	10.50	10.92	KΩ
V_{RTTH1}	Over-Temperature Protection Threshold Voltage	0.7V < V_{RT} < 1.05V, After 12ms Latch Off	1.015	1.050	1.085	V
V_{RTTH2}		V_{RT} < 0.7V, After 100µs Latch Off	0.65	0.70	0.75	V
t_{D-OTP1}	Over-Temperature Latch-off Debounce	V_{RTTH2} < V_{RT} < V_{RTTH1}	16	20	24	ms
t_{D-OTP2}		V_{RT}< V_{RTTH2}	90	130	170	µs
Over-Temperature Protection Section (OTP)						
T_{OTP}	Protection Junction Temperature(3)			+135		°C
$T_{Restart}$	Restart Junction Temperature(4)			T_{OTP}-25		°C

Notes:

3. When activated, the output is disabled and the latch is turned off.
4. The threshold temperature for enabling the output again and resetting the latch after OTP has been activated.

Typical Performance Characteristics

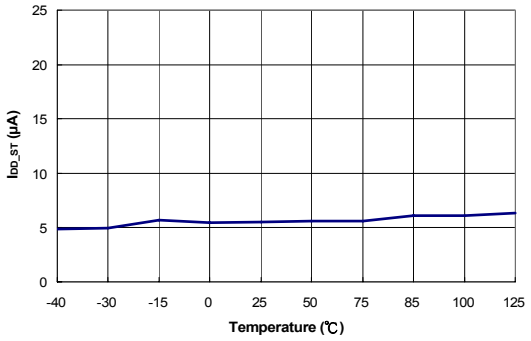

Figure 6. Startup Current (I_{DD-ST}) vs. Temperature

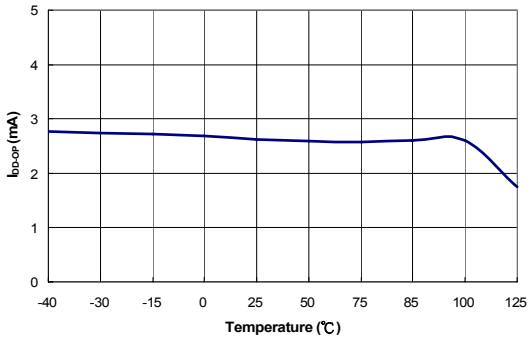

Figure 7. Operation Supply Current (I_{DD-OP}) vs. Temperature

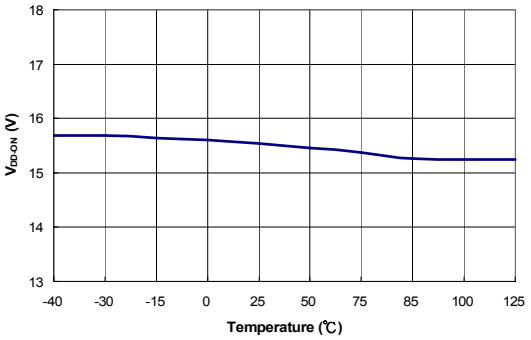

Figure 8. Start Threshold Voltage (V_{DD-ON}) vs. Temperature

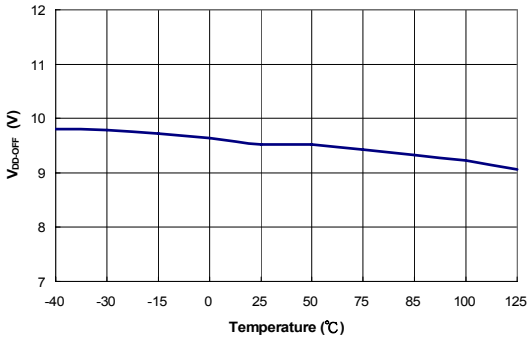

Figure 9. Minimum Operating Voltage (V_{DD-OFF}) vs. Temperature

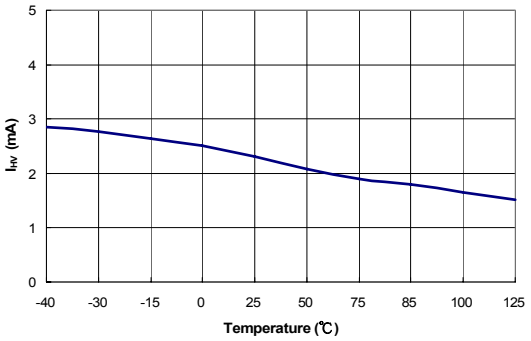

Figure 10. Supply Current Drawn from HV Pin (I_{HV}) vs. Temperature

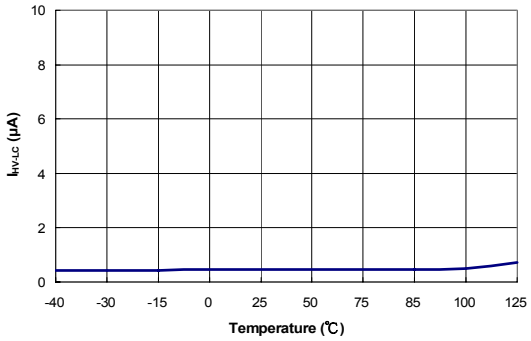

Figure 11. HV Pin Leakage Current after Startup (I_{HV-LC}) vs. Temperature

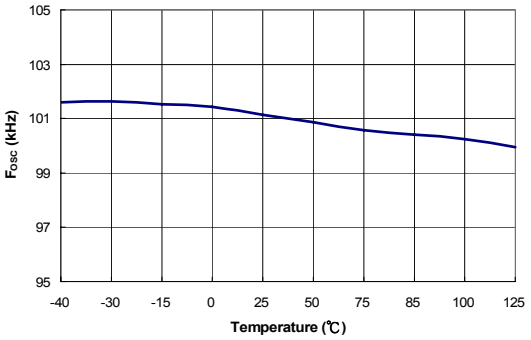

Figure 12. Frequency in Normal Mode (f_{OSC}) vs. Temperature

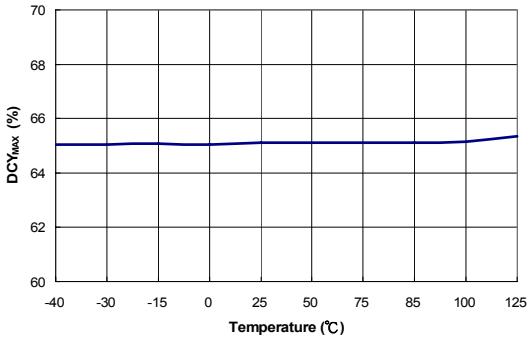

Figure 13. Maximum Duty Cycle (DCY_{MAX}) vs. Temperature

Typical Performance Characteristics

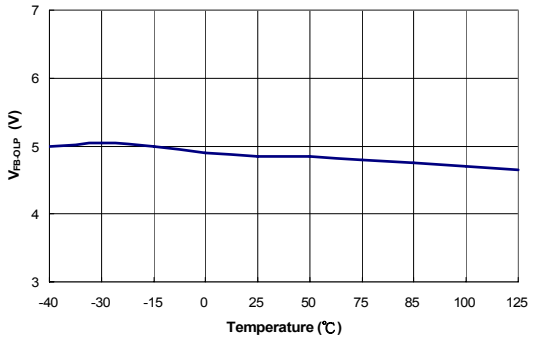

Figure 14. FB Open-Loop Trigger Level (V_{FB-OLP}) vs. Temperature

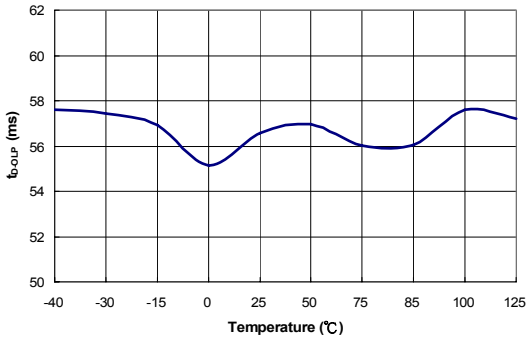

Figure 15. Delay Time of FB Pin Open-Loop Protection (t_{D-OLP}) vs. Temperature

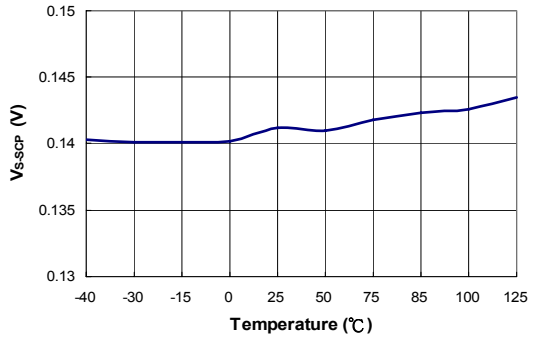

Figure 16. Threshold Voltage for SENSE Short-Circuit Protection (V_{S-SCP}) vs. Temperature

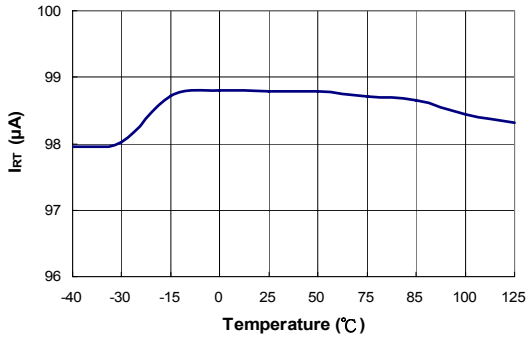

Figure 17. Output Current from RT Pin (I_{RT}) vs. Temperature

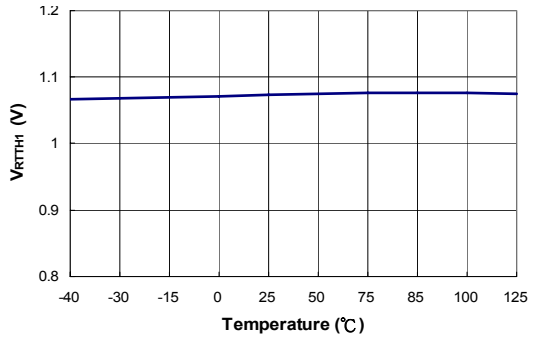

Figure 18. Over-Temperature Protection Threshold Voltage (V_{RTTH1}) vs. Temperature

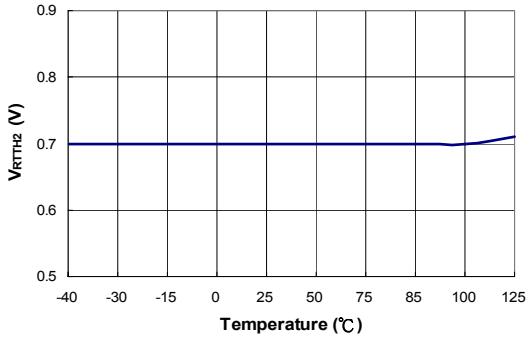

Figure 19. Over-Temperature Protection Threshold Voltage (V_{RTTH2}) vs. Temperature

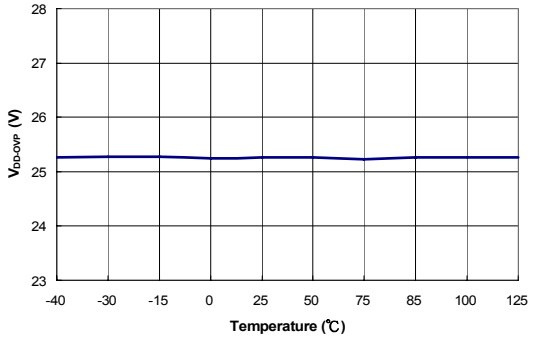

Figure 20. V_{DD} Over-Voltage Protection (V_{DD-OVP}) vs. Temperature

Functional Description

Startup Current

For startup, the HV pin is connected to the line input or bulk capacitor through an external diode and resistor, R_{HV}, (1N4007 / 100KΩ recommended). Typical startup current drawn from pin HV is 2.3mA and charges the hold-up capacitor through the diode and resistor. When the V_{DD} capacitor level reaches V_{DD-ON}, the startup current switches off. At this moment, the V_{DD} capacitor only supplies the SG6742HL/HR to keep the V_{DD} before the auxiliary winding of the main transformer to provide the operating current.

Operating Current

Operating current is around 2.7mA. The low operating current enables better efficiency and reduces the requirement of V_{DD} hold-up capacitance.

Green-Mode Operation

The proprietary green-mode function provides an off-time modulation to reduce the switching frequency in the light-load and no-load conditions. The on time is limited for better abnormal or brownout protection. V_{FB}, which is derived from the voltage feedback loop, is taken as the reference. Once V_{FB} is lower than the threshold voltage, switching frequency is continuously decreased to the minimum green-mode frequency of around 22KHz.

Current Sensing / PWM Current Limiting

Peak-current-mode control is utilized to regulate output voltage and provide pulse-by-pulse current limiting. The switch current is detected by a sense resistor into the SENSE pin. The PWM duty cycle is determined by this current sense signal and V_{FB}, the feedback voltage. When the voltage on SENSE pin reaches around $V_{COMP}=(V_{FB}–0.6)/4$, a switch cycle is terminated immediately. V_{COMP} is internally clamped to a variable voltage around 0.85V for output power limit.

Leading-Edge Blanking (LEB)

Each time the power MOSFET is switched on, a turn-on spike occurs on the sense-resistor. To avoid premature termination of the switching pulse, a leading-edge blanking time is built in. During this blanking period, the current-limit comparator is disabled and cannot switch off the gate driver.

Under-Voltage Lockout (UVLO)

The turn-on and turn-off thresholds are fixed internally at 15.5V and 9.5V. During startup, the hold-up capacitor must be charged to 15.5V through the startup resistor to enable the IC. The hold-up capacitor continues to supply V_{DD} before the energy can be delivered from auxiliary winding of the main transformer. V_{DD} must not drop below 9.5V during this startup process. This UVLO hysteresis window ensures that hold-up capacitor is adequate to supply V_{DD} during startup.

Gate Output / Soft Driving

The BiCMOS output stage is a fast totem-pole gate driver. Cross conduction has been avoided to minimize heat dissipation, increase efficiency, and enhance reliability. The output driver is clamped by an internal 18V Zener diode to protect power MOSFET transistors against undesirable gate over voltage. A soft driving waveform is implemented to minimize EMI.

Soft-Start

For many applications, it is necessary to minimize the inrush current at startup. The built-in 6ms soft-start circuit significantly reduces the startup current spike and output voltage overshoot.

Built-in Slope Compensation

The sensed voltage across the current-sense resistor is used for peak-current-mode control and pulse-by-pulse current limiting. Built-in slope compensation improves stability and prevents sub-harmonic oscillation. SG6742HL/HR inserts a synchronized positive-going ramp at every switching cycle.

Constant Output Power Limit

When the SENSE voltage, across the sense resistor R_S, reaches the threshold voltage, around 1V, the output GATE drive is turned off after a small delay, t_{PD}. This delay introduces an additional current proportional to $t_{PD} \cdot V_{IN} / L_P$. Since the delay is nearly constant regardless of the input voltage V_{IN}, higher input voltage results in a larger additional current and the output power limit is higher than under low input line voltage. To compensate this variation for wide AC input range, a sawtooth power-limiter is designed to solve the unequal power-limit problem. The power limiter is designed as a positive ramp signal fed to the inverting input of the OCP comparator. This results in a lower current limit at high-line inputs than at low-line inputs.

V_{DD} Over-Voltage Protection (OVP)

V_{DD} over-voltage protection has been built in to prevent damage due to abnormal conditions. If the V_{DD} voltage is over the over-voltage protection voltage (V_{DD-OVP}) and lasts for $t_{D-VDDOVP}$, the PWM pulses are disabled until the V_{DD} voltage drops below the UVLO, then starts again. Over-voltage conditions are usually caused by open feedback loops.

Functional Description (Continued)

Thermal Protection

An NTC thermistor, R_{NTC}, in series with a resistor R_A, can be connected from the RT pin to ground. A constant current I_{RT} is output from the RT pin. The voltage on the RT pin can be expressed as $V_{RT} = I_{RT} \bullet (R_{NTC} + R_A)$, where I_{RT} is 100μA. At high ambient temperatures, R_{NTC} is smaller, such that V_{RT} decreases. When V_{RT} is less than 1.05V (V_{RTTH1}), the PWM turns off after 20ms (t_{D-OTP1}). If V_{RT} is less than 0.7V (V_{RTTH2}), PWM turns off immediately after 130μs (t_{D-OTP2}).

Limited Power Control

The FB voltage increases every time the output of the power supply is shorted or overloaded. If the FB voltage remains higher than a built-in threshold for longer than t_{D-OLP}, PWM output is turned off. As PWM output is turned off, V_{DD} begins decreasing.

When V_{DD} goes below the turn-off threshold (~9.5V) the controller is totally shut down. V_{DD} is charged up to the turn-on threshold voltage of 15.5V through the startup resistor until PWM output is restarted. This protection feature continues as long as the overloading condition persists. This prevents the power supply from overheating due to overloading conditions. When V_{RT} is less than 1.05V (V_{RTTH1}), the PWM is turned off after 20ms (t_{D-OTP1}). If V_{RT} is less than 0.7V (V_{RTTH2}), PWM is turned off immediately after 130μs (t_{D-OTP2}).

Noise Immunity

Noise on the current sense or control signal may cause significant pulse-width jitter, particularly in continuous-conduction mode. Slope compensation helps alleviate this problem. Good placement and layout practices should be followed. Avoiding long PCB traces and component leads, locating compensation and filter components near the SG6742HL/HR, and increasing the power MOS gate resistance improve performance.

Applications Information

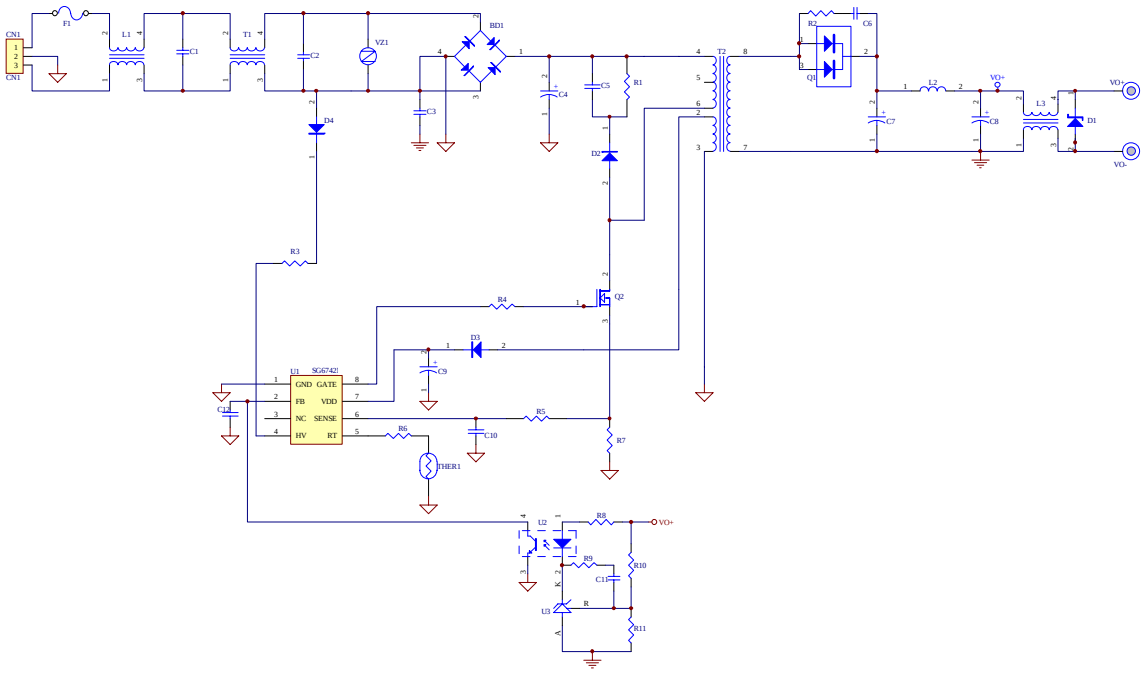

Figure 21. 60W Flyback 12V/5A Application Circuit

BOM

Designator	Part Type	Designator	Part Type
BD1	BD 4A/600V	L3	Inductor (900μH)
C1	XC 0.68μF/300V	Q1	STP20-100CT
C2	XC 0.1μF/300V	Q2	MOS 7A/600V
C3	YC 2200pF/Y1	R1	R 100KΩ 1/2W
C4	EC 120μF/400V	R2	R 47Ω 1/4W
C5	CC 0.01μF/500V	R3	R 100KΩ 1/2W
C6	CC 1000pF/100V	R4	R 4.7Ω 1/8W
C7	EC 1000μF/25V	R5	R 100Ω 1/8W
C8	EC 470μF/25V	R6, R9	R 4.7KΩ 1/8W
C9	EC 22μF/50V	R7	R 0.3Ω 2W
C10	CC 47pF/50V	R8	R 680Ω 1/8W
C11	CC 2200pF/50V	R10	R 150KΩ 1/8W
C12	CC 0.01μF/50V	R11	R 39KΩ 1/8W
D1	Zener Diode 15V 1/2W (option)	THER1	Thermistor TTC104
D2	BYV95C	T1	10mH
D3	FR103	T2	255μH(PQ2620)
D4	1N4007	U1	IC SG6742
F1	FUSE 4A/250V	U2	IC PC817
L1	Inductor (900μH)	U3	IC TL431
L2	Inductor (2μH)	VZ1	VZ 9G

Physical Dimensions

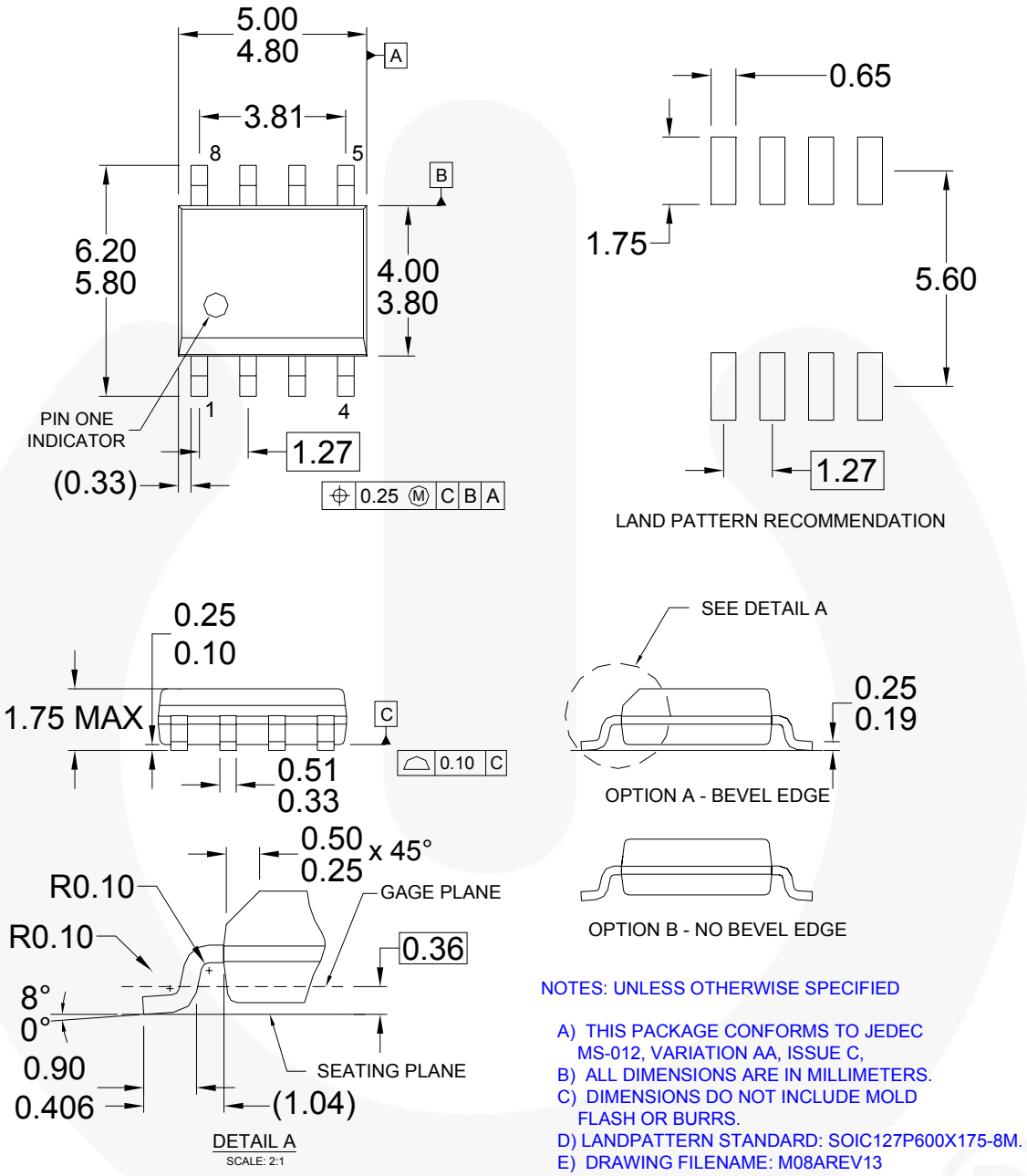

Figure 22. 8-Pin SOP-8 Package

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