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SG6849
Low-Power, Green-Mode PWM Flyback Power Controller without Secondary Feedback

Features

- Linearly Decreasing PWM Frequency
- Green-Mode Under Light-Load and Zero-Load Conditions
- Constant Voltage (CV) and Constant Current (CC)
- No Secondary Feedback
- Low Startup Current: 5µA
- Low Operating Current: 3.6mA
- Leading-Edge Blanking (LEB)
- Constant Power Limit
- Universal AC Input Range
- Synchronized Slope Compensation
- 150°C OTP Sensor with Hysteresis
- V_{DD} Over-Voltage Clamping
- Cycle-by-Cycle Current Limiting
- Under-Voltage Lockout (UVLO)
- Fixed PWM Frequency: 65kHz
- Gate Output Maximum Voltage Clamped at 16.7V
- Small SSOT-6 Package

Applications

Low-power, flyback power converters, such as:

- Battery chargers for cellular phones, cordless phones, PDAs, digital cameras, and power tools
- Power adapters for ink jet printers, video game consoles, and portable audio players
- Open-frame SMPS for TV/DVD standby and other auxiliary supplies, home appliances, consumer electronics, and PC 5V standby-power
- Replacements for linear transformers and RCC SMPS

Description

This highly integrated PWM controller provides several features to enhance the performance of low-power flyback converters. To minimize standby power consumption, the proprietary green-mode function provides off-time modulation to linearly decrease the switching frequency under light-load and zero-load conditions. This green-mode function enables the power supply to meet international power conservation requirements.

The supply voltage V_{DD} is also used for feedback compensation to regulate the output voltage without requiring a conventional TL431 and a photo-coupler. An advantage of the SG6849 is a typical startup current of only 5µA, while the typical operating current can be as low as 3.6mA. A large startup resistance can be used to achieve even higher power conversion efficiency.

Built-in synchronized slope compensation maintains the stability of peak current-mode control. Proprietary internal compensation ensures constant output power limiting over a universal range of AC input voltages, from $90V_{AC}$ to $264V_{AC}$.

The SG6849 provides many protection functions. Pulse-by-pulse current limiting ensures a constant output current, even if a short circuit occurs. The internal protection circuit disables PWM output if V_{DD} exceeds 22.7V. The gate output is clamped at 16.7V to protect the power MOS from over-voltage damage. The built-in over-temperature protection (OTP) function shuts down the controller at 150°C with a 20°C hysteresis.

The SG6849 is designed to provide a low-cost total solution for flyback converters. It is available in a small footprint, 6-pin, SSOT-6 package.

Related Resources

- *AN-6849 - Low Cost, Green-Mode PWM Controller for Flyback Converters*

Ordering Information

Part Number	Operating Temperature Range	Package	Eco Status	Packing Method
SG684965TZ	-40°C to +105°C	Small SOT-26 Package	RoHS	Tape & reel
SG684965DZ	-40°C to +105°C	8-pin Dual in-line Package (DIP)	RoHS	Tube
SG684965DY	-40°C to +105°C	8-pin Dual in-line Package (DIP)	Green	Tube

Application Diagram
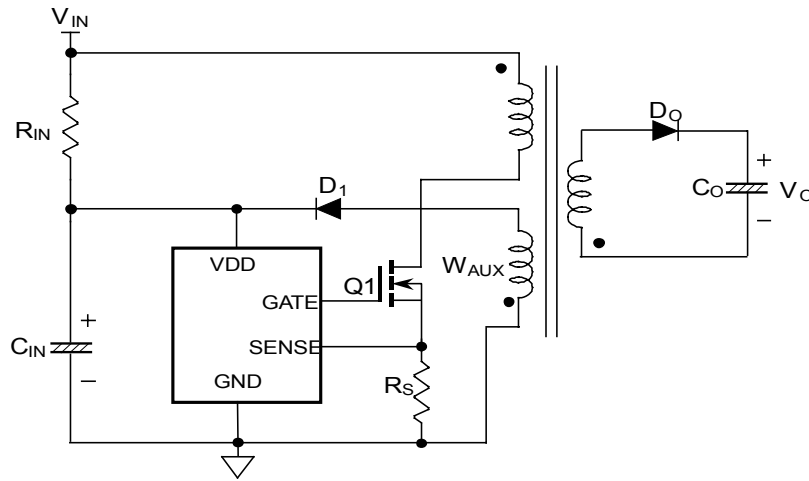
Figure 1.   Typical Application

Internal Block Diagram
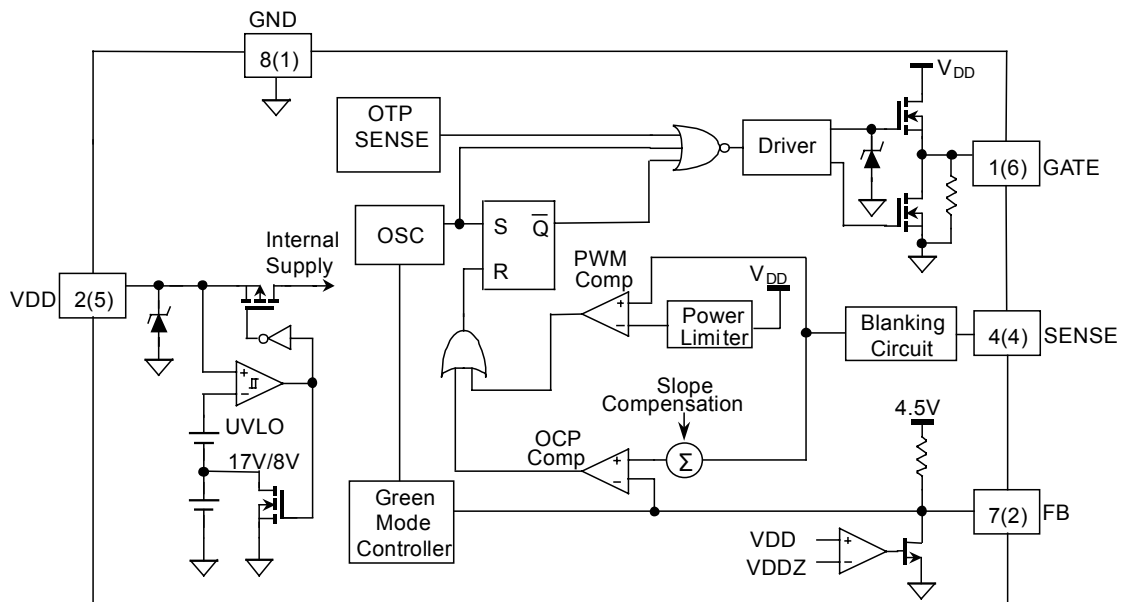
Figure 2.   Functional Block Diagram

Marking Information
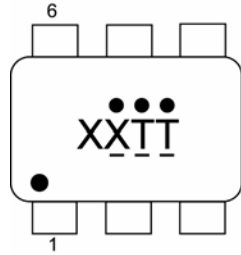
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TT : Die Run Code
. . . : Year Code
- - - : Week Code

*Marking for SG684965TZ (Pb-free)
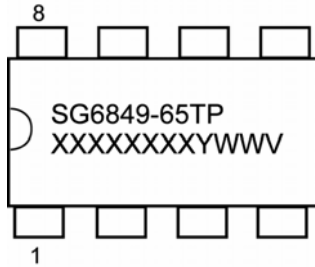
T: D=DIP
P: Z= Lead free + RoHS Compatible
    Null=Regular Package
XXXXXXXX: Wafer Lot
Y: Year
WW: Week
V: Assembly location

*Marking for SG684965DZ (Pb-free)
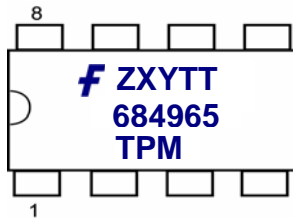
F- Fairchild Logo
Z- Plant Code
X- 1 Digit Year Code
Y- 1 Digit Week Code
TT: 2 Digits Die Run Code
T: Package Type (D=DIP)
P: Z: Pb-free, Y: Green package
M: Manufacture Flow Code

*Marking for SG684965DY (Green Compound)

Figure 3.   Top Mark

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Pin Configurations
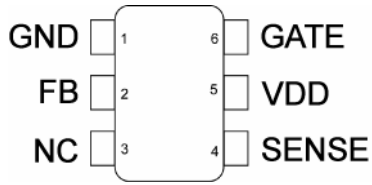
Figure 4.   SSOT-6 Pin Configuration
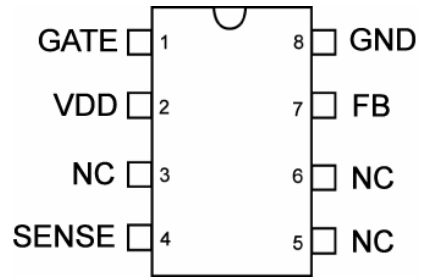
Figure 5.   DIP-8 Pin Configuration

Pin Definitions

DIP Pin #	SSOT Pin #	Name	Description
1	6	GATE	The totem-pole output driver for driving the power MOSFET.
2	5	VDD	Power supply.
3		NC	No connection.
4	4	SENSE	Current sense. It senses the voltage across a sensed resistor. To provide over-current protection, PWM output is disabled if the voltage exceeds an internal threshold. This pin provides current information for current-mode control.
5	3	NC	No connection.
6		NC	No connection.
7	2	FB	Feedback. The FB pin provides feedback information to the internal PWM comparator. This feedback is used to control the duty cycle. When no feedback is provided, this pin is left open.
8	1	GND	Ground.

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]			25	V
V_{FB}	Input Voltage to FB Pin		-0.3	7.0	V
V_{SENSE}	Input Voltage to Sense Pin		-0.3	7.0	V
T_J	Operating Junction Temperature		-40	+125	°C
Θ_{JA}	Thermal Resistance (Junction-to-Air)	SSOT		263.3	°C/W
		DIP		135.7	°C/W
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			3.0	kV
	Machine Model, JEDEC:JESD22-C101			300	V

Notes:
1. All voltage values, except differential voltages, are given with respect to GND pin.
2. Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.

Electrical Characteristics

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

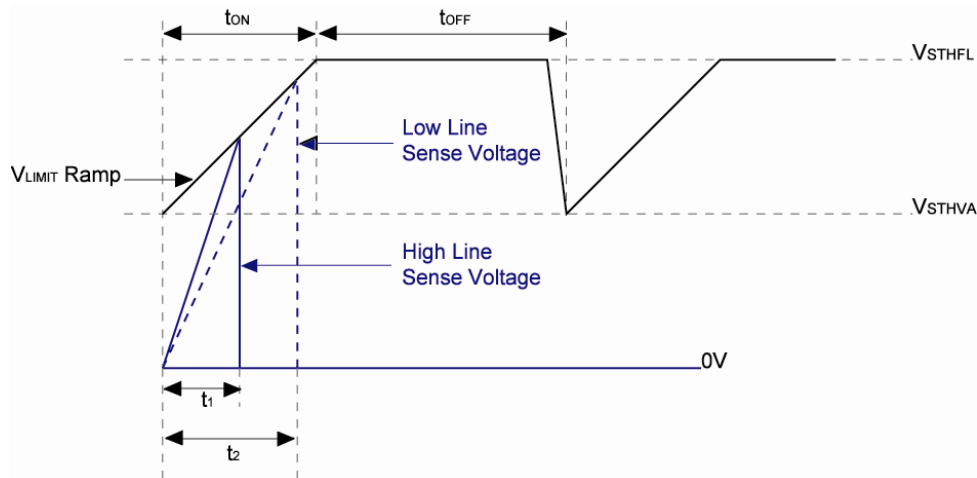| Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{DD} Section						
V_{DD-ON}	Turn-on Threshold Voltage		16	17	18	V
V_{DD-OFF}	Turn-off Threshold Voltage		7.5	8.0	8.5	V
I_{DD-ST}	Startup Current	V_{DD}=15V		5	20	µA
I_{DD-OP}	Operating Supply Current	V_{DD}=15V, C_L=1nF		3.6	4.6	mA
$V_{DD-CLAMP}$	Zener Diode Breakdown Voltage	I_{DD}=10mA		28	30	V
$V_{DD-TH-G}$	V_{DD}-Low Threshold Voltage for Exiting Green-Mode OFF		V_{DD-OFF}+1.0	V_{DD-OFF}+1.5	V_{DD-OFF}+2.0	V
Feedback Input Section						
I_{FB-ZDC}	Zero Duty Cycle FB Input Current			1.15	1.40	mA
$V_{FB-OPEN}$	Open-Loop Voltage		4.5			V
Z_{FB}	Input Impedance	I_{FB}=0.1mA to 0.2mA		2.4		kΩ
V_{DD-FB}	V_{DD} Feedback Threshold Voltage*	FB is Open	20.0	22.7	25.0	V
		I_{FB}=0.4mA	18	20	22	V
Current-Sense Section						
t_{PD}	Delay to Output			100		ns
V_{STHVA}	Valley Threshold Voltage for Current Limit	V_{DD}=20V	0.84	0.89	0.94	V
		V_{DD}=15V	0.72	0.77	0.82	V
		V_{DD}=10V	0.58	0.63	0.68	V
t_{LEB}	Leading-Edge Blanking Time			310		ns

Figure 6.   Saw Limit

Electrical Characteristics (Continued)

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Oscillator Section						
f_{OSC}	Frequency		60	65	70	kHz
f_{OSC-G}	Green-Mode Frequency		20	25	30	kHz
I_{FB-G}	Green-Mode Ending FB Current		0.90	1.15	1.40	mA
f_{DV}	Frequency Variation vs. V_{DD} Deviation	V_{DD}=10 to 20V			2.00	%
Output Section						
DCY_{MAX}	Maximum Duty Cycle		70	75	80	%
V_{GATE-L}	Output Voltage Low	V_{DD}=15V, I_o=10mA			1.5	V
V_{GATE-H}	Output Voltage High	V_{DD}=15V, I_o=10mA	8			V
t_r	Rising Time	V_{DD}=15V, C_L=1nF		200		ns
t_f	Falling Time	V_{DD}=15V, C_L=1nF		80		ns
$V_{GATE-CLAMP}$	Output Clamp Voltage	V_{DD}=20V		16.7	18.0	V
Over-Temperature Protection (OTP)						
T_{OTP}	Protection Junction Temperature			+150		°C
$T_{OTP-RESTART}$	Restart Junction Temperature			+130		°C

Typical Performance Characteristics
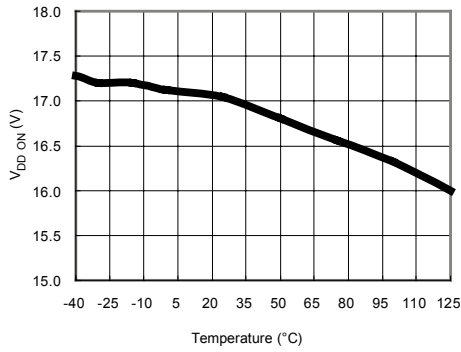
Figure 7. Turn-on Threshold Voltage (V_{DD-ON}) vs. Temperature
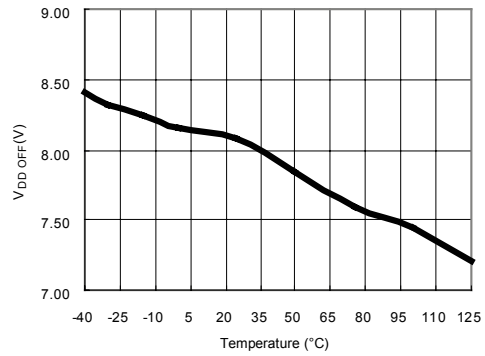

Figure 8. Turn-off Threshold Voltage (V_{DD-OFF}) vs. Temperature

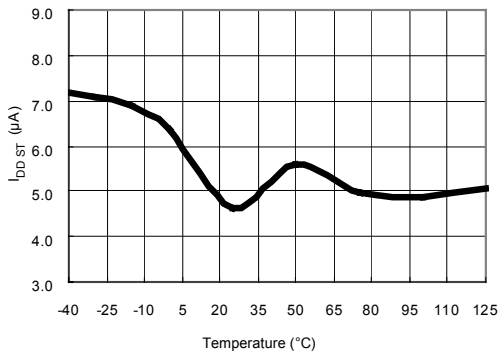
Figure 9. Startup Current (I_{DD-ST}) vs. Temperature
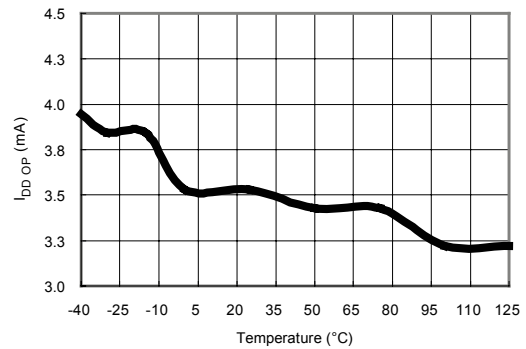

Figure 10. Center Frequency (f_{OSC}) vs. Temperature
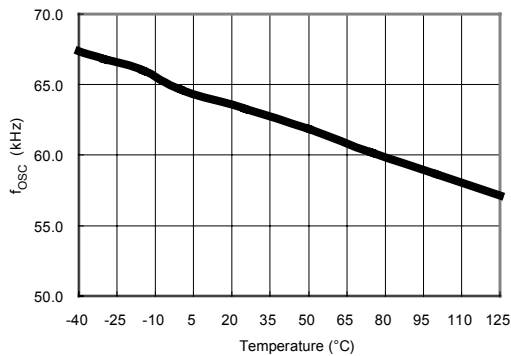
Figure 11. Center Frequency (f_{OSC}) vs. Temperature
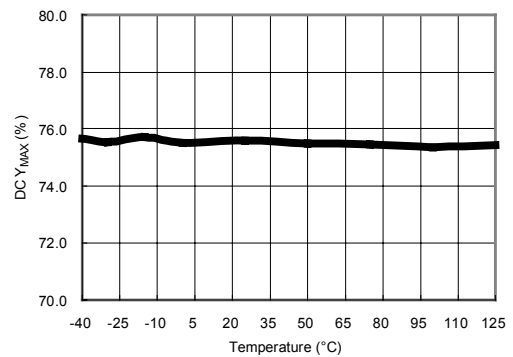
Figure 12. Maximum Duty Cycle (DCY_{MAX}) vs. Temperature

Typical Performance Characteristics (Continued)
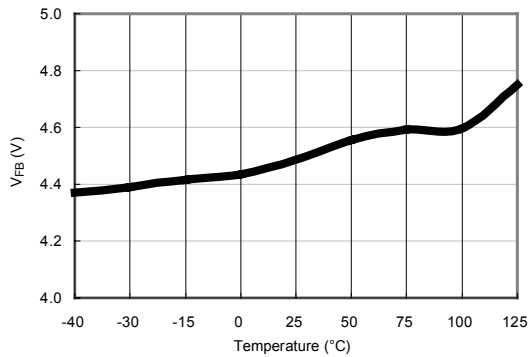
Figure 13. FB Open-Loop Voltage (V$_{FB}$) vs. Temperature
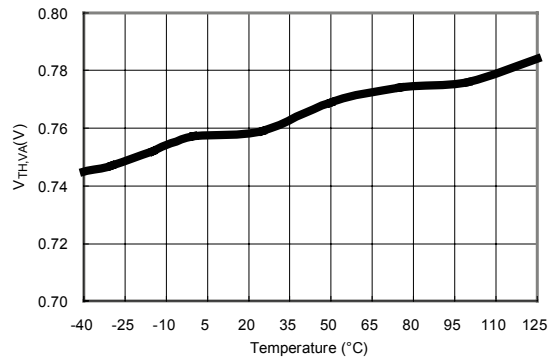
Figure 14. Valley Threshold Voltage (V$_{STHVA}$) vs. Temperature

Figure 15. Output Voltage Low (V$_{GATE-L}$) vs. Temperature

Figure 16. Green-Mode Burst Back and Green-Mode Off Frequency vs. V$_{DD}$

Figure 17. Valley Threshold Voltage (V$_{STHVA}$) vs. V$_{DD}$

Figure 18. V$_{LIMIT}$ Ramp vs. Duty Cycle

Figure 19. V$_{DD}$ Zener Current vs. Zener Clamp Voltage

Operation Description

SG6849 devices integrate many useful functions for low-power switch-mode power supplies. The following descriptions highlight the key features of the SG6849.

Startup Current

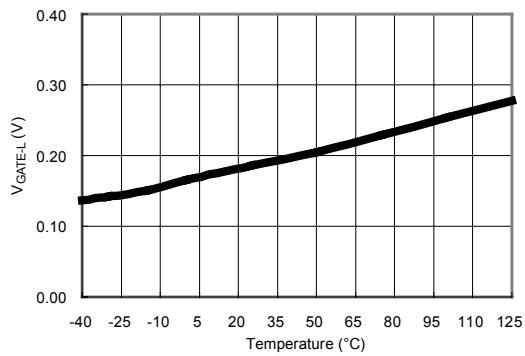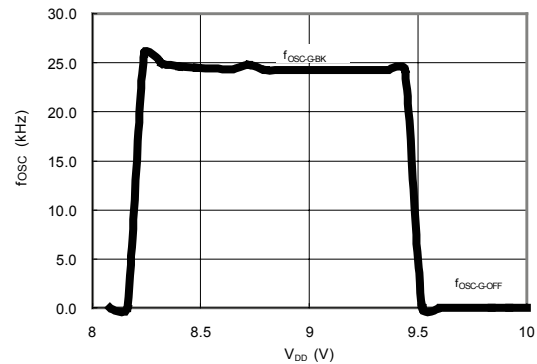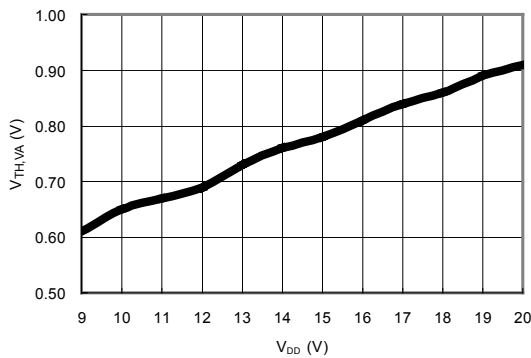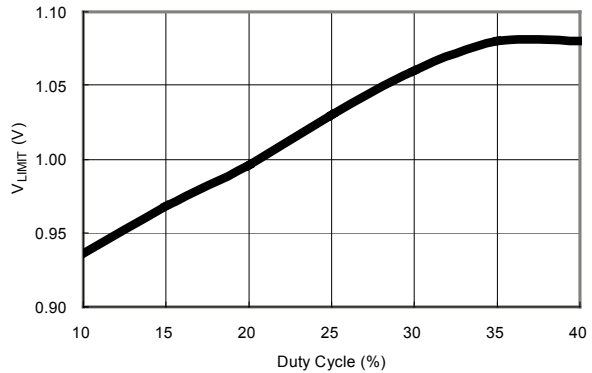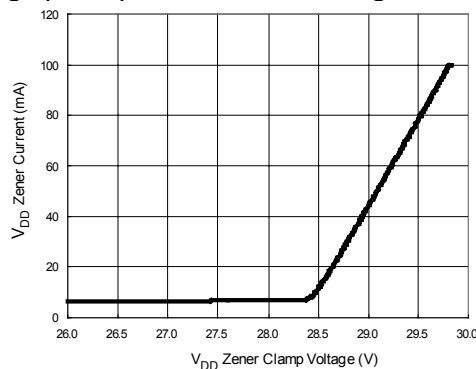The required startup current is only 5μA. This allows a high-resistance, low-wattage startup resistor to be used to supply the controller's startup power. A 1.5MΩ/0.25W startup resistor can be used over a wide input range ($90V_{AC}$-$264V_{AC}$) with very little power loss.

Operating Current

The operating current is normally 3.6mA. The low operating current results in higher efficiency and reduces the required V_{DD} hold-up capacitance. A 10μF/25V V_{DD} hold-up capacitor can be used over a wide input range ($90V_{AC}$ -$264V_{AC}$) with little power loss.

Green-Mode Operation

The proprietary green-mode function provides off-time modulation to linearly decrease the switching frequency under light-load and zero-load conditions. The on-time is limited to provide better protection against brownouts and other abnormal conditions.

This green-mode function dramatically reduces power consumption under light-load and zero-load conditions. Power supplies using SG6849 can meet international restrictions regarding standby power-consumption.

Constant Voltage (CV) and Constant Current (CC) without Feedback

The SG6849 tightly regulates the output voltage and provide over-current protection without requiring secondary-side feedback signals. For improved CV and CC accuracy, the transformer leakage inductance should be reduced as much as possible.

Over-Temperature Protection (OTP)

The SG6849 has a built-in temperature sensing circuit to shut down PWM output once the junction temperature exceeds 150°C. While PWM output is shut down, the V_{DD} voltage gradually drops to the UVLO voltage. Some of the SG6849's internal circuits are shut down and V_{DD} gradually starts increasing again. When V_{DD} reaches 17V, all the internal circuits, including the temperature sensing circuit, starts operating normally. If the junction temperature is still higher than 150°C, the PWM controller is shut down immediately. This situation continues until the temperature drops below 130°C. The PWM output then turns back on. The temperature hysteresis window for the OTP circuit is 20°C.

V_{DD} Over-Voltage Clamping

V_{DD} over-voltage clamping is built in to prevent damage from over-voltage conditions. When V_{DD} exceeds 22.7V, PWM output is shut down. Over-voltage conditions may be caused by an open photo-coupler loop or a short circuit in the output.

Oscillator Operation

The oscillation frequency is fixed at 65kHz.

Leading-Edge Blanking (LEB)

Each time the power MOSFET is switched on, a turn-on spike occurs at the sense resistor. To avoid premature termination of the switching pulse, a 310ns leading-edge blanking time is built in. Conventional RC filtering is not necessary. During this blanking period, the current-limit comparator is disabled and it cannot switch off the gate drive.

Constant Output Power Limit

When the SENSE voltage across the sense resistor R_S reaches the threshold voltage (around 1.0V), the output GATE drive is turned off following a small propagation delay t_{PD}. This propagation delay introduces an additional current proportional to $t_{PD} \cdot V_{IN}/L_P$. The propagation delay is nearly constant regardless of the input line voltage V_{IN}. Higher input line voltages result in larger additional currents. Under high input-line voltages, the output power limit is higher than under low input-line voltages.

Over a wide range of AC input voltages, the variation can be significant. To compensate for this, the threshold voltage is adjusted by adding a positive ramp ($V_{LIMIT-ramp}$). This ramp signal varies from 0.77V to 1.05V for SG6849 and it flattens out at 1.05V. A smaller threshold voltage forces the output GATE drive to terminate earlier, reducing total PWM turn-on time and making the output power equal to that of the low line input. This proprietary internal compensation feature ensures a constant output power limit over a wide range of AC input voltages ($90V_{AC}$-$264V_{AC}$).

Under-Voltage Lockout (UVLO)

The turn-on / turn-off thresholds of the SG6849 are fixed internally at 17V/8V. To enable the SG6849 during startup, the hold-up capacitor must first be charged to 17V through the startup resistor.

The hold-up capacitor continues to supply V_{DD} before energy can be delivered from the auxiliary winding of the main transformer. V_{DD} must not drop below 8V during this startup process. This UVLO hysteresis window ensures that the hold-up capacitor can adequately supply V_{DD} during startup.

Gate Output

The SG6849 BiCMOS output stage is a fast totem-pole gate driver. Cross-conduction is avoided to minimize heat dissipation, increase efficiency, and enhance reliability. The output driver is clamped by an internal 16.7V Zener diode to protect the power MOSFET transistors against harmful over-voltage gate signals.

Slope Compensation

The sensed voltage across the current sense resistor is used for current-mode control and pulse-by-pulse current limiting. The built-in slope compensation function improves power supply stability. Furthermore, it prevents sub-harmonic oscillations that normally would occur because of peak current mode control. A positively sloped, synchronized ramp is activated by the SG6849 with every switching cycle. The slope of the ramp is:

$$\frac{0.36 \times Duty}{Duty(max.)} \qquad (1)$$

Noise Immunity

Noise from the current sense or the 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. Avoid long PCB traces and component leads. Compensation and filter components should be located near the SG6849. Increasing the power-MOS gate resistance is advised.
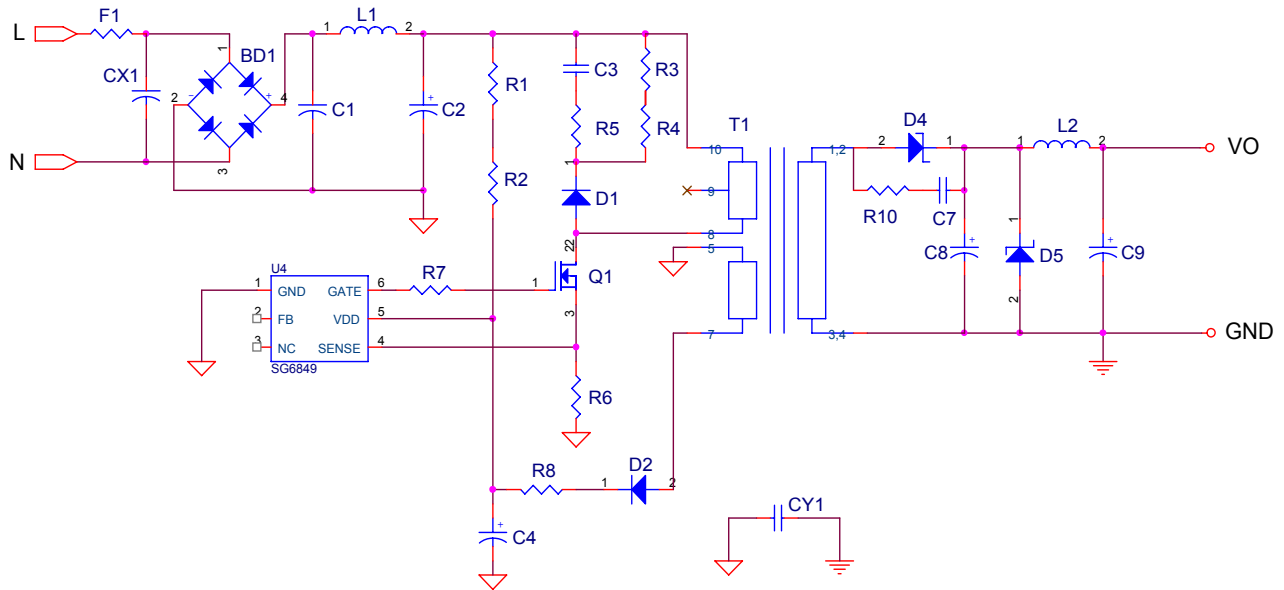
Applications Information

Figure 20. Reference Circuit (without Secondary-Side Feedback)

BOM

Reference	Component	Reference	Component
BD1	BD DI106 1A/600V	F1	R 1Ω/0.5W
CX1 (Option)	YC 472pF/400V (Y1)	L1	Inductor 20mH 6*8mm
CY1 (Option)	YC 102pF/400V (Y1)	L2	Inductor 10µH 6mm
C1	CC 0.01µF/500V	Q1	MOSFET 1A/600V
C2	EC 10µF/400V 105ºC	R1,R2	R 750kΩ/1206
C3	CC 1000pF/500V	R3,R4	R 47kΩ/1206
C4	EC 10µF/50V	R5	R 47Ω/1206
C7 (Option)	CC 102pF/100V 1206	R6	R 4.7Ω/0.5W
C8	EC 470µF/10V 105ºC	R7	R 100Ω/0805
C9	EC 220µF/10V 105ºC	R8	R 10Ω/1206
D1	Diode FRI07	R10(Option)	R 10Ω/1206
D2	Diode FR102	T1	Transformer EE-16
D4	Diode SB360	U4	IC SG6849 (Green PWM IC)
D5 (Option)	ZD 6.8V/0.5W		

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Applications Information (Continued)
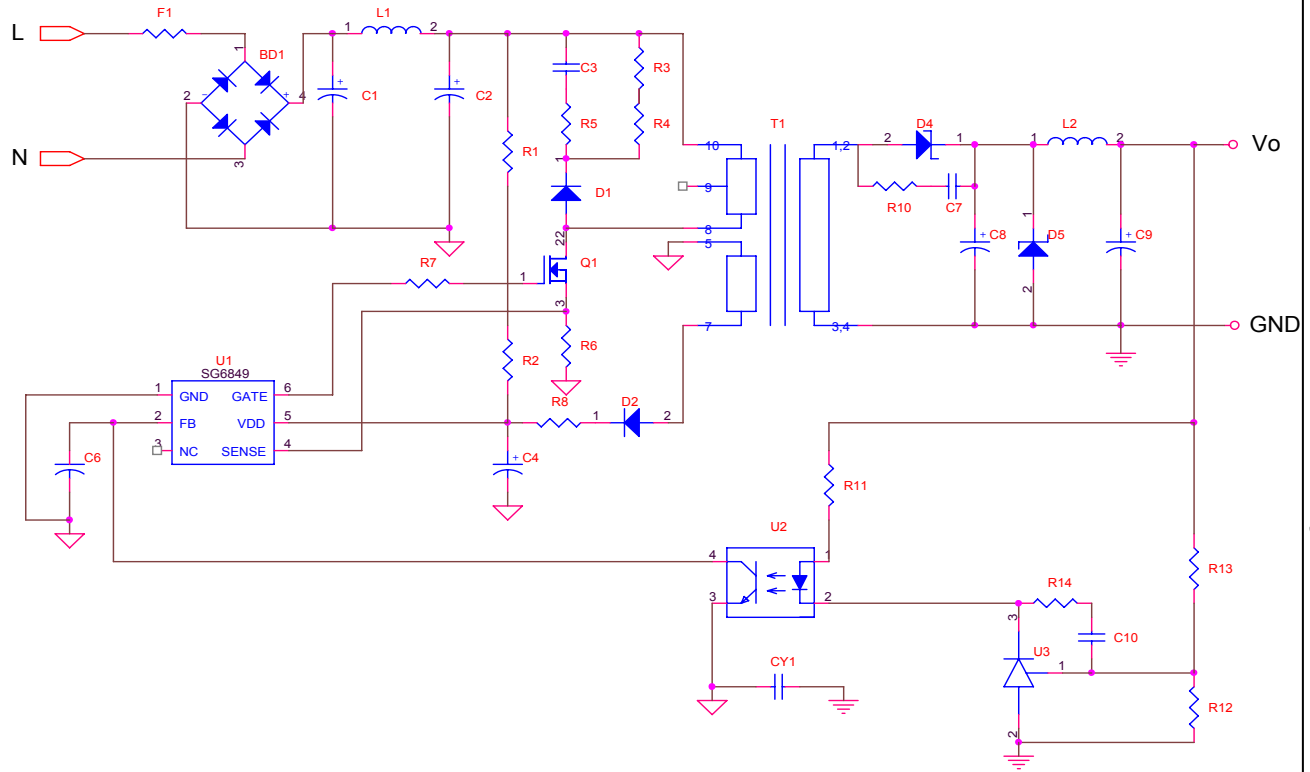
Figure 21. Reference Circuit (with Secondary-Side Feedback)

BOM

Reference	Component	Reference	Component
BD1	BD DI106 1A/600V	L2	Inductor 10µH 6mm
CY1 (Option)	YC 102p/400V	Q1	MOSFET 1A/600V
C1	CC 0.01µF/500V	R1,R2	R 750kΩ/1206
C2	EC 10µF/400V 105ºC	R4,R3	R 47kΩ/1206
C3	CC 1000p/500V	R5	R 47Ω/1206
C4	EC 10µF50V	R6	R 4.7Ω/0.5W
C6	CC 472p/0805	R7	R 100Ω/0805
C7	CC 102p/100V 1206	R10	R 10Ω/1206
C8	EC 470µF10V 105ºC	R8	R 10Ω/1206
C9	EC 470µF10V 105ºC	R11	R 100Ω/1/8W
C10	CC 222p/0805	R12	R 33kΩ/0805
D1	Diode FR107	R13	R 33kΩ/1/8W
D2	Diode FR102	R14	R 4.7kΩ/0805
D4	Diode SB360	T1	Transformer EE-16
D5 (Option)	ZD 6.8V/0.5W	U1	IC SG6849 (Green PWM IC)
F1	R 1Ω/0.5W Resistor	U2	IC PC817
L1	Inductor 20mH 6*8mm	U3	IC TL431

Physical Dimensions
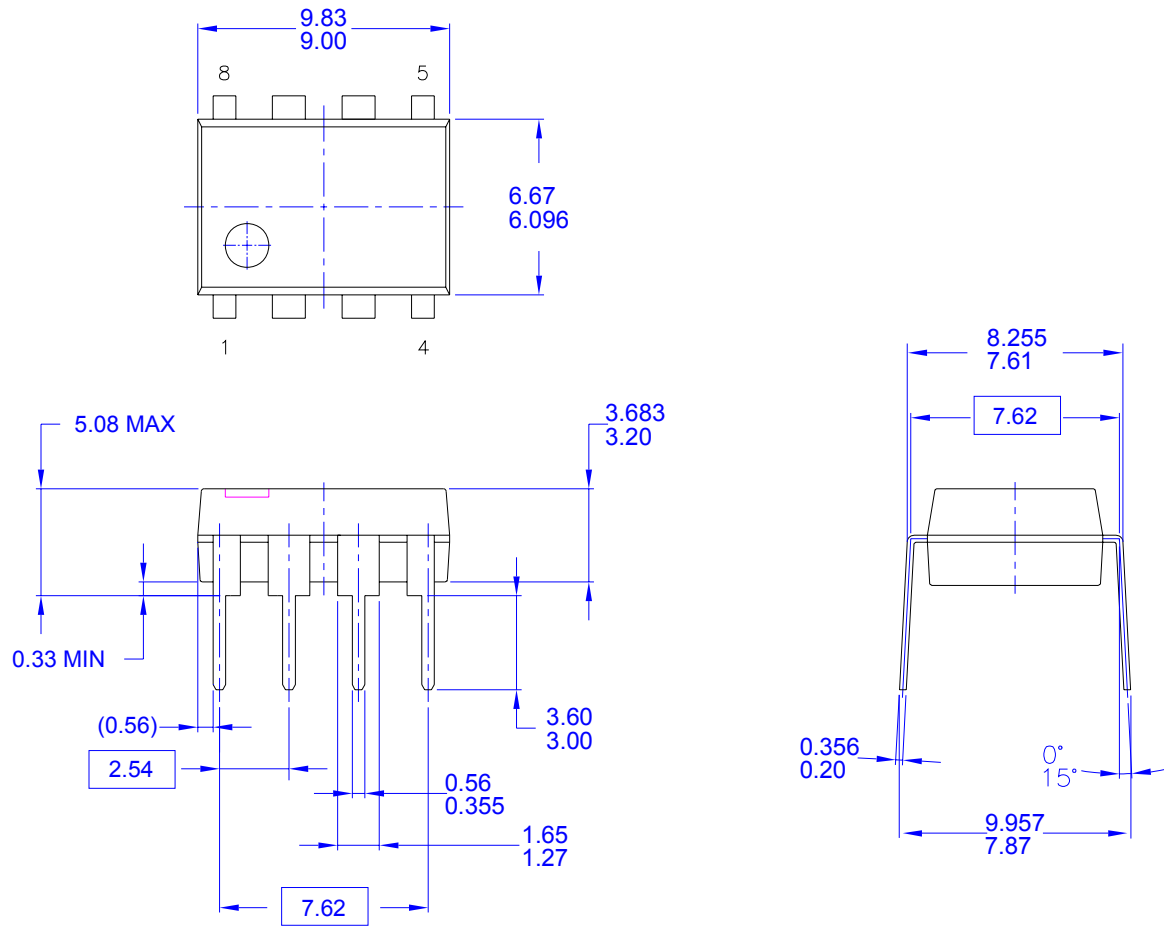
NOTES: UNLESS OTHERWISE SPECIFIED
 A) THIS PACKAGE CONFORMS TO
    JEDEC MS-001 VARIATION BA
 B) ALL DIMENSIONS ARE IN MILLIMETERS.
 C) DIMENSIONS ARE EXCLUSIVE OF BURRS,
    MOLD FLASH, AND TIE BAR EXTRUSIONS.
 D) DIMENSIONS AND TOLERANCES PER
    ASME Y14.5M-1994
 E) DRAWING FILENAME AND REVSION: MKT-N08FREV2.

Figure 22. 8-Pin Dual Inline (DIP) Package

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Physical Dimensions (Continued)

3.00
2.80

A

6   4

B

3.00
2.60

1.70
1.50

1   3

0.95

0.50
0.30

1.90

⊕ 0.20 Ⓜ A B

(0.30)

SYMM
C̵L

0.95   0.95

1.00 MIN

2.60

0.70 MIN

LAND PATTERN RECOMMENDATION

SEE DETAIL A

1.10 MAX

1.00
0.70

C

0.10
0.00

▽ 0.10 C

0.20
0.08

GAGE PLANE

0.25

8°
0°

0.55
0.35

SEATING PLANE

0.60 REF

DETAIL A
SCALE: 50X

MA06AREVD

NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE CONFORMS TO JEDEC MO-193,
    VAR. AA, ISSUE C, DATED JANUARY 2000.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
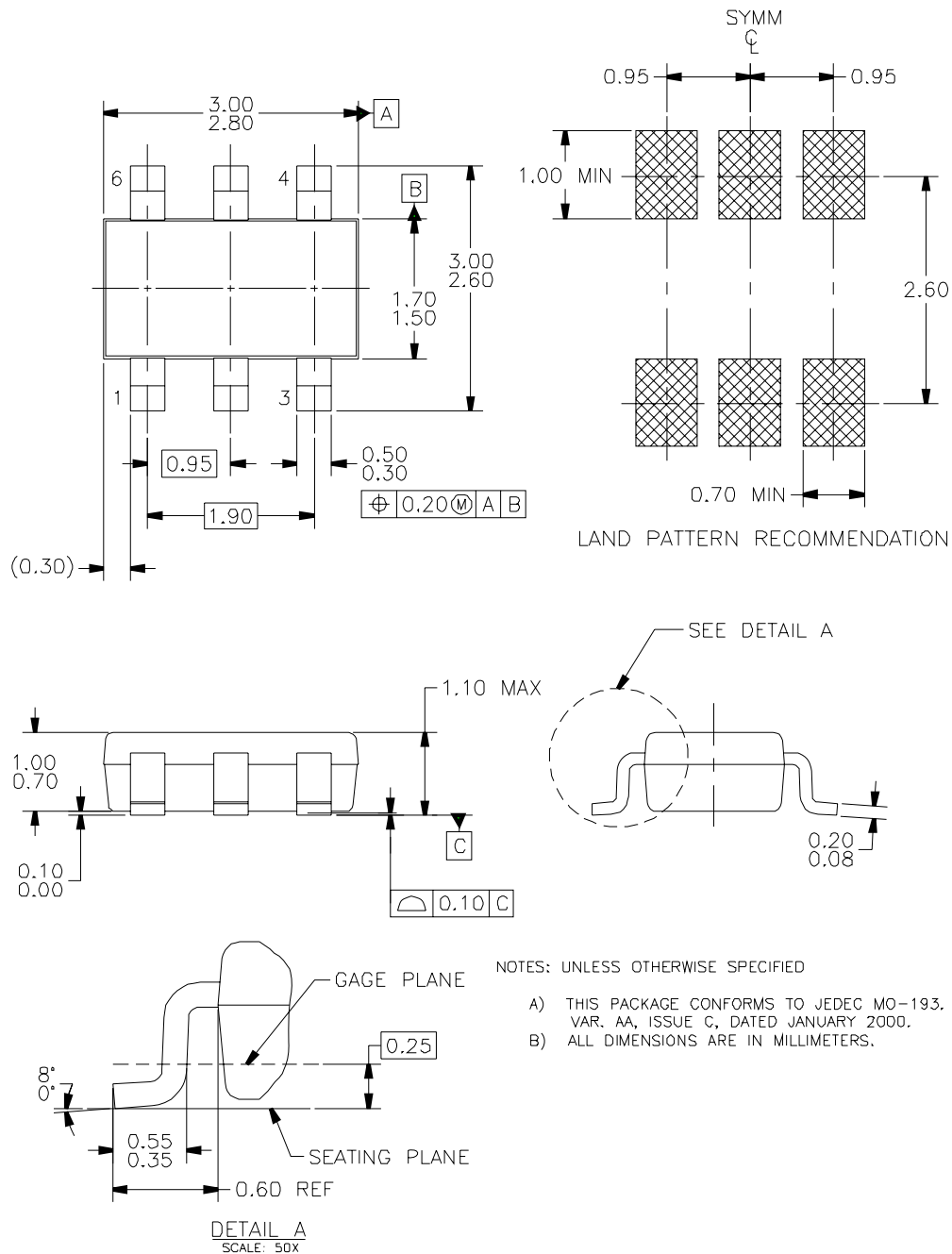
Figure 23. 6-Pin SSOT-6 Package

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

PUBLICATION ORDERING INFORMATION

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