FAIRCHILD SEMICONDUCTOR®

September 2009

SG6858
Low-Cost, Green-Mode, PWM Controller for Flyback Converters

Features

- Green-Mode PWM
- Supports the ”Blue Angel” Standard
- Low Startup Current: 10µA (Maximum)
- Low Operating Current: 2.5mA
- Leading-Edge Blanking (LEB)
- Constant Output Power Limit
- Built-in Synchronized Slope Compensation
- Current-Mode Operation
- Cycle-by-Cycle Current Limiting
- Under-Voltage Lockout (UVLO)
- Programmable PWM Frequency
- V_{DD} Over-Voltage Protection with Auto-Restart
- Gate Output Voltage Clamped at 17V
- Few External Components Required
- SSOT-26 and DIP-8 Packages Available

Applications

- 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, PC 5V standby power, and consumer electronics
- Replacements for linear transformers and RCC SMPS
- Offline High Brightness (HB) LED drivers

Description

This highly integrated PWM controller provides several special enhancements designed to meet the low standby-power needs of low-power SMPS. To minimize standby power consumption, the proprietary green-mode function provides off-time modulation to linearly decrease the switching frequency under light-load conditions. This green-mode function enables the power supply to meet even the strictest power conservation requirements.

The BiCMOS fabrication process enables reducing the startup current to 10µA and the operating current to 2.5mA. To further improve power conservation, a large startup resistance can be used. Built-in synchronized slope compensation ensures the stability of peak-current-mode control. Proprietary internal compensation provides a constant output power limit over a universal AC input range ($90V_{AC}$ to $264V_{AC}$). Pulse-by-pulse current limiting ensures safe operation even during short circuits.

To protect the external power MOSFET from being damaged by supply over voltage, the output driver is clamped at 17V. SG6858 controllers can improve the performance and reduce the production cost of power supplies. The SG6858 replaces linear and RCC-mode power adapters. It is available in 8-pin DIP and 6-pin SSOT-26 packages.

Ordering Information

Part Number	Operating Temperature Range	Eco Status	Package	Packing Method
SG6858TZ	-40 to +125°C	RoHS	6-Pin SSOT-26	Tape & Reel
SG6858DZ	-40 to +125°C	RoHS	8-Pin DIP-8	Tube

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

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Typical Application

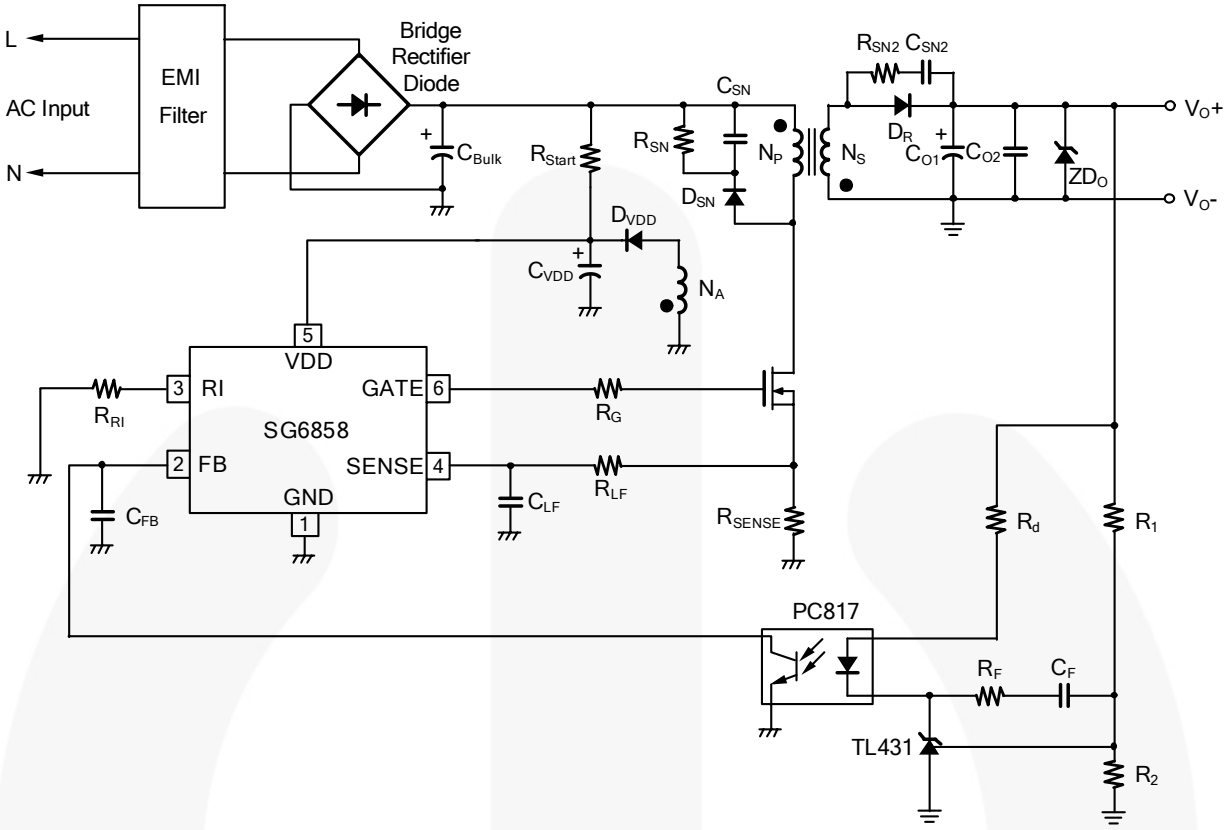


Figure 1. Typical Application

Block Diagram

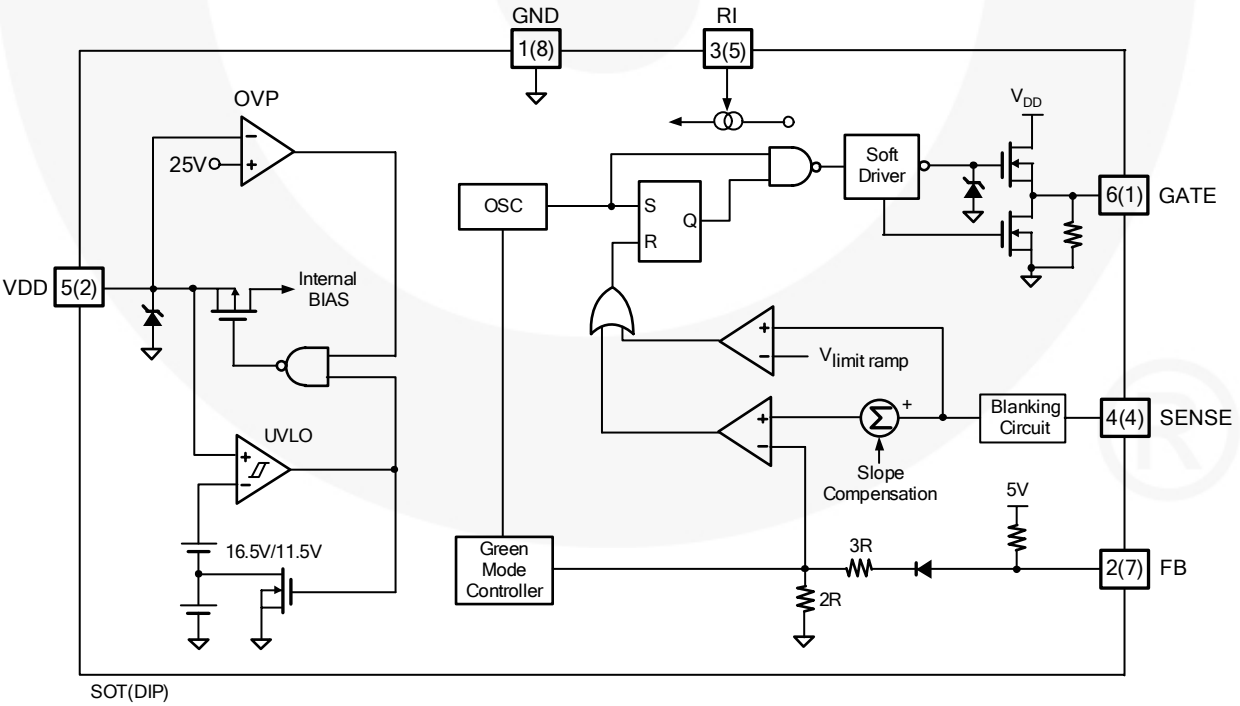
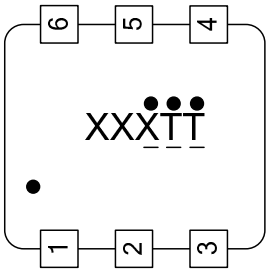


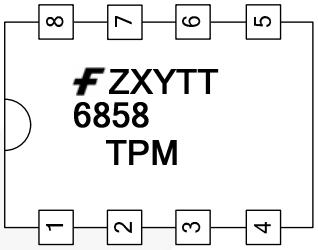
Figure 2. Block Diagram

Marking Information



XXX:AAI=SG6858
TT: Die run code
●: Year code
— : Week code

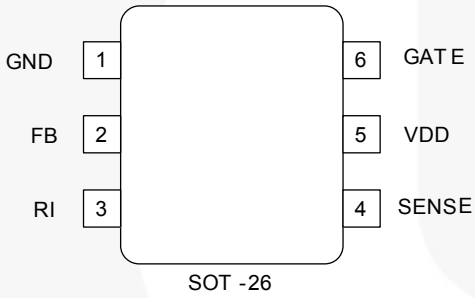
Figure 3. SSOT-26



F: Fairchild Logo
Z: Assembly Plant Code
X: Year Code
Y: Week Code
TT: Die Run Code
T: N=DIP
P: Y=Green Package
M: Manufacture flow code

Figure 4. DIP-8

Pin Configuration



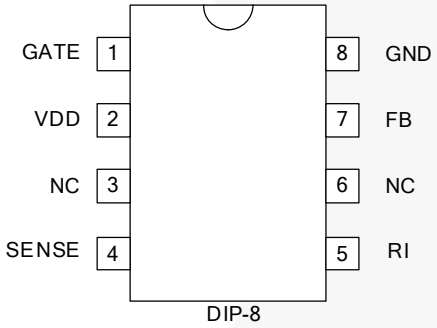


Figure 5. Pin Configurations

Pin Definitions

Pin #		Name	Description
DIP-8	SSOT-26		
1	6	GATE	Totem-pole output driver for the power MOSFET.
2	5	VDD	Power supply.
3		NC	No connection.
4	4	SENSE	Current sense. This pin senses the voltage across a resistor. When the voltage reaches the internal threshold, PWM output is disabled. This activates over-current protection. This pin provides current amplitude information for current-mode control.
5	3	RI	A resistor connected from the RI pin to ground generates a constant current source. This current is used to charge an internal capacitor to determine the switching frequency. Increasing the resistance reduces the amplitude of the current source and reduces the switching frequency. A 95kΩ resistor, R_I, results in a 50μA constant current, I_I, and a 70kHz switching frequency.
6		NC	No connection.
7	2	FB	Feedback. The FB pin provides the output voltage regulation signal, and feedback to the internal PWM comparator, so the PWM comparator can control the duty cycle.
8	1	GND	Ground.

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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. All voltage values, except differential voltages, are given with respect to GND pin.

Symbol	Parameter		Min.	Max.	Unit
V_{DD}	Supply Voltage			30	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
$R_{\Theta JC}$	Thermal Resistance (Junction-to-Case)	SSOT		208.4	°C/W
		DIP		82.5	
T_J	Operating Junction Temperature		-40	+125	°C
T_{STG}	Storage Temperature Range		-55	+150	°C
T_L	Lead Temperature, Wave Soldering, 10 Seconds			260	°C
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114		3.0	kV
		Machine Model, JESD22-A115		0.2	

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Max.	Unit
V_{DD}	DC Supply Voltage		22	V
T_A	Operating Ambient Temperature	-40	+125	°C

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Electrical Characteristics

V_{DD}=15V, T_A=-40°C ~+125°C (T_A= T_J), unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{DD} Section						
V_{DD-OP}	Continuously Operating Voltage				22	V
V_{DD-ON}	Turn-On Threshold Voltage		15.5	16.5	17.5	V
V_{DD-OFF}	Turn-Off Voltage		10.5	11.5	12.5	V
I_{DD-ST}	Startup Current	V_{DD}=V_{DD-ON} – 0.1V		10	15	µA
I_{DD-OP}	Operating Supply Current	V_{DD}=15V, GATE with 1nF to GND		2.5	3.5	mA
V_{DD-OVP}	V_{DD} Over-Voltage Protection Level		23	25	26	V
$t_{D-VDDOVP}$	V_{DD} OVP Debounce Time		50	125	200	µsec
$V_{DD-G\ OFF}$	V_{DD} Low Threshold Voltage to Exit Green Off Mode		V_{DD-OFF} + 0.95	V_{DD-OFF} + 1.10	V_{DD-OFF} + 1.25	V
Feedback Input Section						
A_V	FB Input to Current Comparator Attenuation			2/5		V/V
Z_{FB}	Input Impedance			5		kΩ
$V_{FB-OPEN}$	FB Pin Open High Voltage		4.5	5.0	5.5	V
V_{FB-N}	Green Mode Entry FB Voltage			2.85		V
V_{FB-G}	Green Mode Ending FB Voltage			2.20		V
S_G	Green Mode Modulation Slope	R_I=95kΩ		75		Hz/mV
Current Sense Section						
Z_{SENSE}	Input Impedance		10			kΩ
t_{PD}	Delay to Output			60	110	ns
V_{STHFL}	Flat Threshold Voltage for Current Limit			0.96		V
V_{STHVA}	Valley Threshold Voltage for Current Limit		0.75	0.80	0.85	V
t_{LEB}	Leading-Edge Blanking Time		240	300	360	ns
DCY_{SAW}	Duty Cycle of SAW Limit	Maximum Duty Cycle		45		%
Oscillator Section						
f_{OSC}	Frequency	R_I=95kΩ	65	70	75	kHz
f_{OSC-G}	Green Mode Frequency	R_I=95kΩ		22		kHz
f_{DV}	Frequency Variation vs. V_{DD} Deviation	V_{DD}=13.5V to 22V	0	0.02	2.00	%
f_{DT}	Frequency Variation vs. Temperature Deviation	T_A=-40°C ~+125°C			2	%
Output Section						
DCY_{MAX}	Maximum Duty Cycle		70	75	80	%
V_{GATE-L}	Output Voltage Low	V_{DD}=15V, I_O=20mA			1.5	V
V_{GATE-H}	Output Voltage High	V_{DD}=13.5V, I_O=20mA	8			V
t_R	Rising Time	V_{DD}=13.5V, C_L=1nF	100	170	240	ns
t_F	Falling Time	V_{DD}=13.5V, C_L=1nF	35	55	75	ns
$V_{GATE-CLAMP}$	Output Clamp Voltage	V_{DD}=13.5V, T_A=25°C	16	17	18	V

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Typical Performance Characteristics

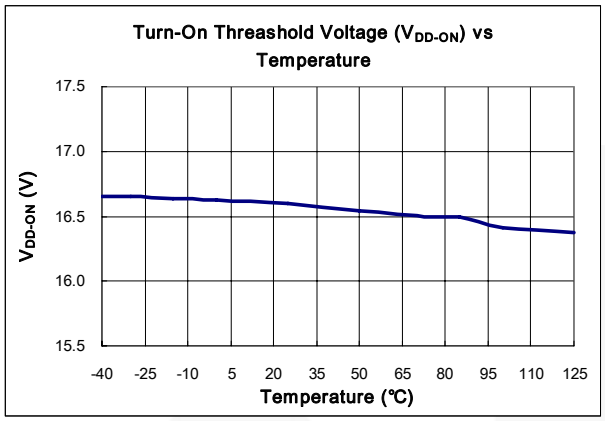


Figure 6. Turn-On Threshold Voltage (V_{DD-ON}) vs. Temperature

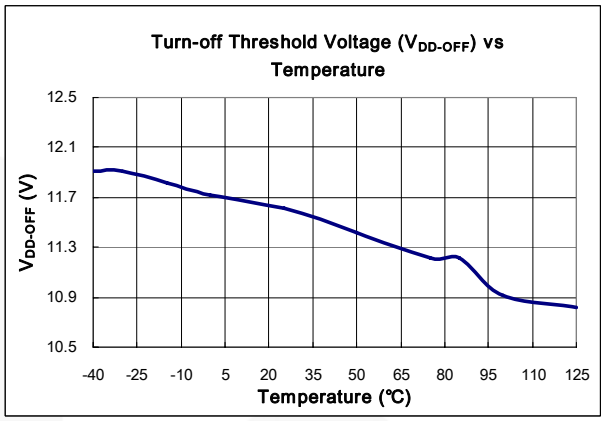


Figure 7. Turn-Off Threshold Voltage (V_{DD-OFF}) vs. Temperature

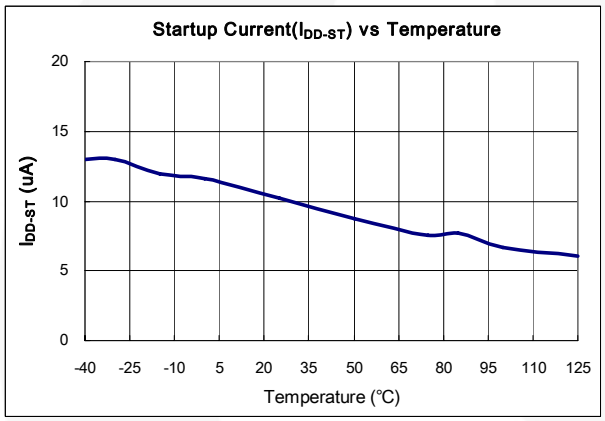


Figure 8. Startup Current (I_{DD-ST}) vs. Temperature

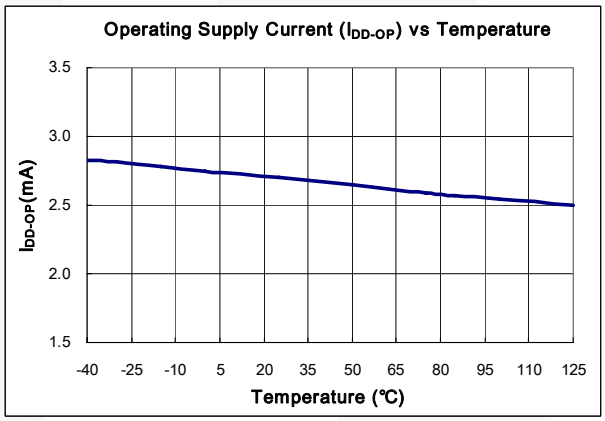


Figure 9. Operating Supply Current (I_{DD-OP}) vs. Temperature

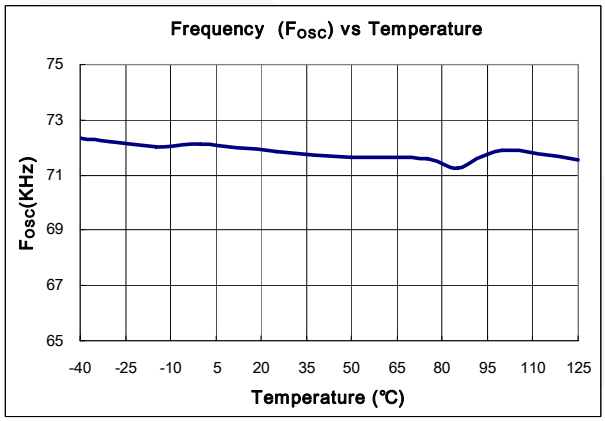


Figure 10. Frequency (f_{OSC}) vs. Temperature

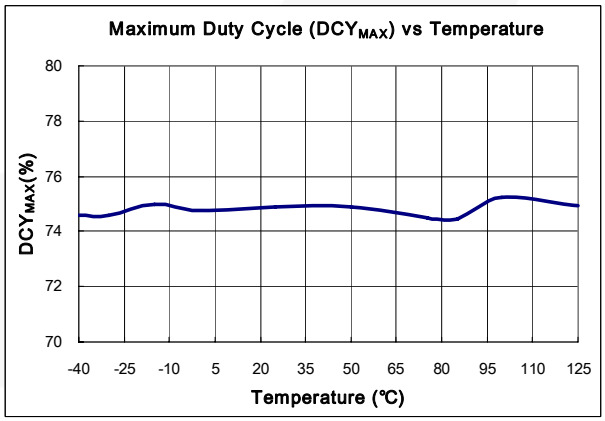


Figure 11. Maximum Duty Cycle (DCY_{MAX}) vs. Temperature

Typical Performance Characteristics (Continued)

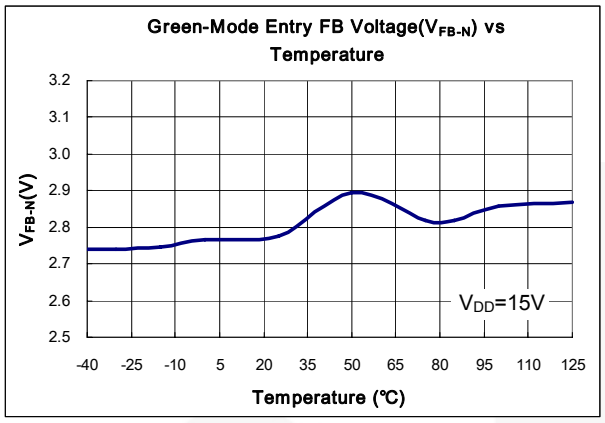


Figure 12. Green Mode Entry FB Voltage (V_{FB-N}) vs. Temperature

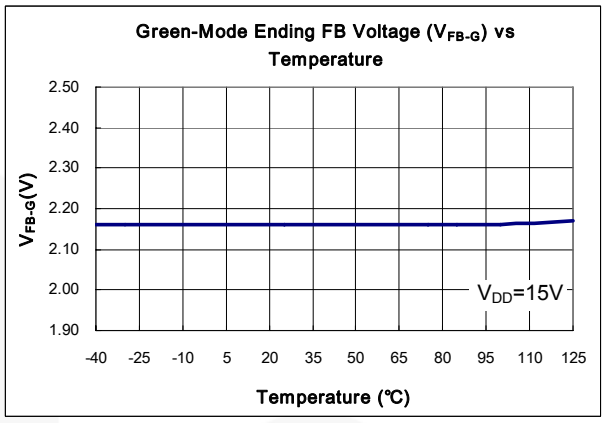


Figure 13. Green Mode Ending FB Voltage (V_{FB-G}) vs. Temperature

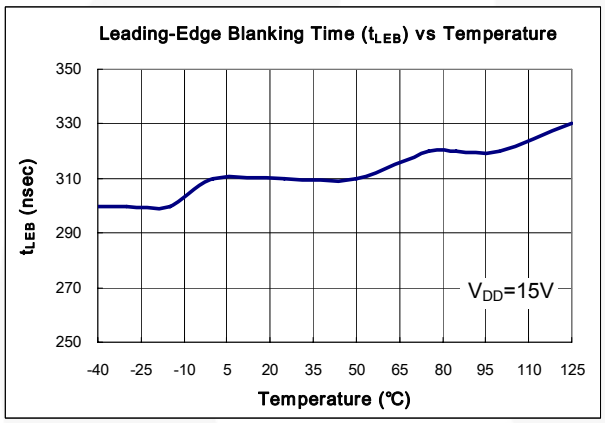


Figure 14. Leading-Edge Blanking Time (t_{LEB}) vs. Temperature

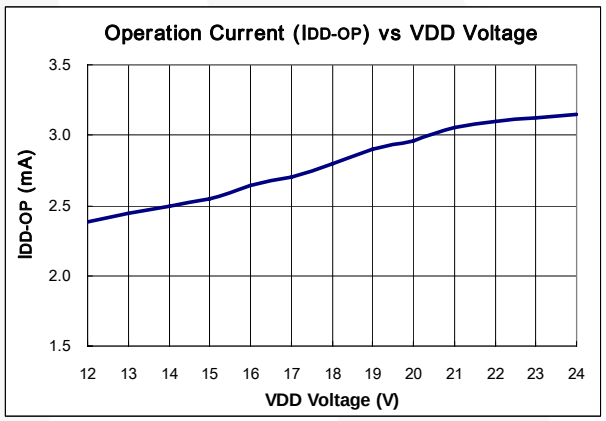


Figure 15. Operating Current (I_{DD-OP}) vs. Temperature

Operation Description

SG6858 devices integrate many useful designs into one controller for low-power switch-mode power supplies. The following descriptions highlight some of the features of the SG6858 series.

Startup Operation

The startup current is only 10μA. Low startup current allows a startup resistor with a high resistance and low wattage to supply the startup power for the controller. A 1.5MΩ, 0.25W, startup resistor and a 10μF/25V V_{DD} hold-up capacitor would be sufficient for an AC-to-DC power adapter with a wide input range ($100V_{AC}$ to $240V_{AC}$).

Operating Current

The operating current has been reduced to 2.5mA. The low operating current results in higher efficiency and reduces the V_{DD} hold-up capacitance requirement.

Green-Mode Operation

The proprietary green-mode function provides off-time modulation to linearly decrease the switching frequency under light-load conditions. On-time is limited to provide stronger protection against brownouts and other abnormal conditions. The feedback current, which is sampled from the voltage feedback loop, is taken as the reference. Once the feedback current exceeds the threshold current, the switching frequency starts to decrease. This green-mode function dramatically reduces power consumption under light-load and zero-load conditions. Power supplies using the SG6858 meet the strictest regulations regarding standby power consumption.

Oscillator Operation

A resistor connected from the RI pin to ground generates a constant current source for the SG6858. This current is used to charge an internal capacitor. The charge-time determines the internal clock speed and the switching frequency. Increasing the resistance reduces the amplitude of the input current and reduces the switching frequency. A 95kΩ resistor R_I results in a 50μA constant current I_I and a 70kHz switching frequency. The relationship between R_I and the switching frequency is:

$$f_{PWM} = \frac{6650}{R_I\ (k\Omega)}(kHz) \quad (1)$$

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 300ns leading-edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current-limit comparator is disabled and it cannot switch off the gate driver.

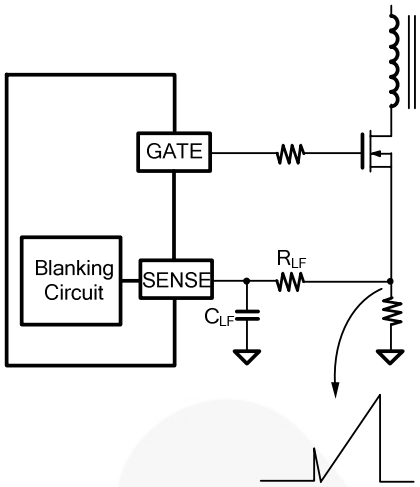


Figure 16. Current Sense R-C Filter

Constant Output Power Limit

When the SENSE voltage across the sense resistor R_S reaches the threshold voltage (around 0.96V), the output GATE drive is turned off following a short propagation delay t_{PD}.

This propagation delay introduces an additional current proportional to $t_{PD} \bullet V_{IN}/L_P$. The propagation delay is nearly constant regardless of the input line voltage V_{IN}. Higher input line voltages result in larger additional currents. At high input line voltages, the output power limit is higher than at low input line voltages.

To compensate for this output power limit variation across a wide AC input range, the threshold voltage is adjusted by adding a positive ramp (V_{LIMIT_RAMP}).

This ramp signal rises from 0.80V to 0.96V, then flattens out at 0.96V. A smaller threshold voltage forces the output GATE drive to terminate earlier. This reduces the total PWM turn-on time and makes the output power equal to that of low line input. This proprietary internal compensation ensures a constant output power limit for a wide AC input voltage range ($90V_{AC}$ to $264V_{AC}$).

Under-Voltage Lockout (UVLO)

The turn-on and turn-off thresholds are fixed internally at 16.5V/11.5V. During startup, the hold-up capacitor must be charged to 16.5V through the startup resistor, so that the SG6858 is enabled. The hold-up capacitor continues to supply V_{DD} until power can be delivered from the auxiliary winding of the main transformer. V_{DD} must not drop below 11.5V during this startup process. This UVLO hysteresis window ensures that the hold-up capacitor is adequate to supply V_{DD} during startup.

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V_{DD} Over-Voltage Protection (OVP)

Integrated V_{DD} over-voltage protection prevents damage due to over-voltage conditions. When the V_{DD} exceeds the internal threshold due to abnormal conditions, PWM output is turned off until the V_{DD} voltage drops below the UVLO, then starts again. Over-voltage conditions are usually caused by open feedback loops.

Gate Output

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 17V Zener diode to protect power MOSFET transistors against undesired over-voltage gate signals.

Built-in Slope Compensation

The sensed voltage across the current sense resistor is used for current mode control and pulse-by-pulse current limiting. Built-in slope compensation improves stability and prevents sub-harmonic oscillations due to peak-current mode control. The SG6858 has a synchronized, positively-sloped ramp built-in at each switching cycle. The slope of the ramp is:

$$\frac{0.36 \times Duty}{Duty(\max.)} \quad (2)$$

Noise Immunity

Noise from the current sense or the control signal can cause significant pulsewidth jitter, particularly in continuous-conduction mode. While slope compensation helps alleviate this problem, further precautions should be taken. Good placement and layout practices should be followed. Avoiding long PCB traces and component leads, locating compensation and filter components near the SG6858, and increasing the power MOS gate resistance are advised.

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Typical Application Circuit (Flyback Converter for Printer Application)

Application	Fairchild Devices	Input Voltage Range	Output
Adapter	SG6858	90~264V_{AC}	12V/1.25A (15W)

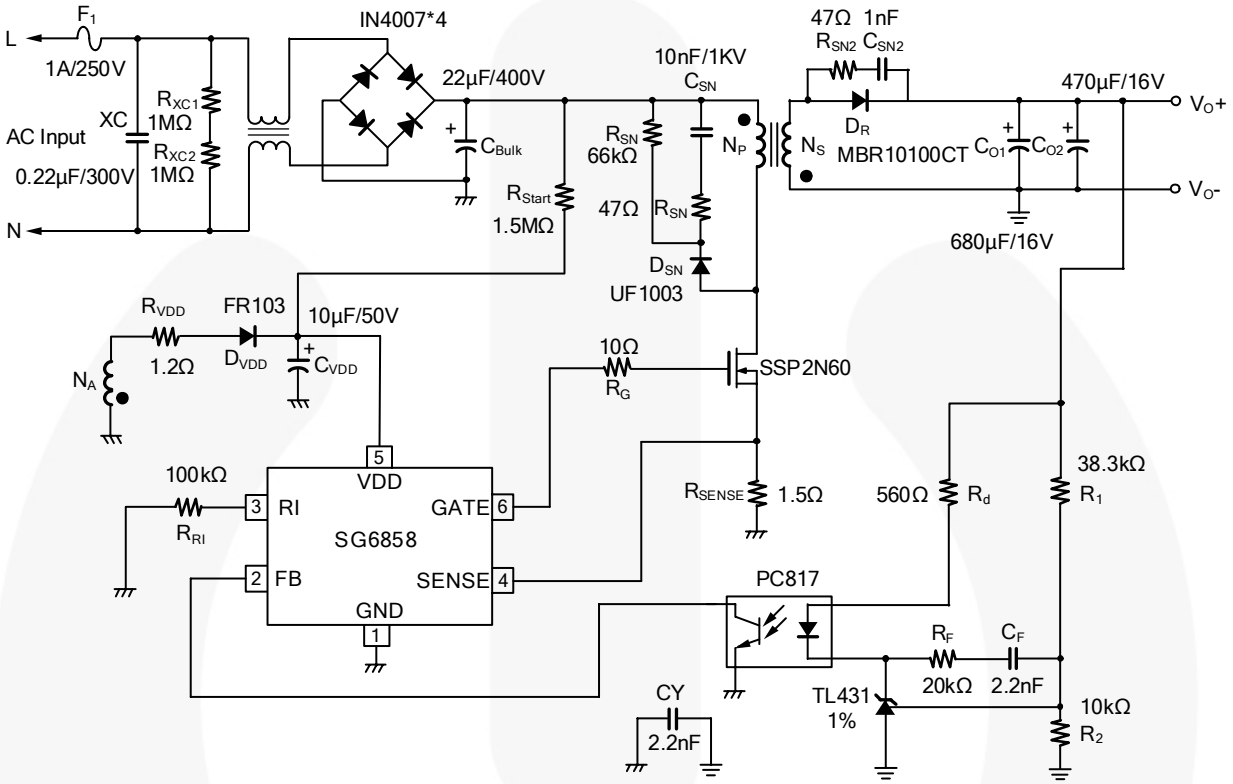


Figure 17. Schematic of Application Circuit

Transformer

- Core: EF-20
- Primary-Side Inductance: 2mH (Pin1 to Pin3)

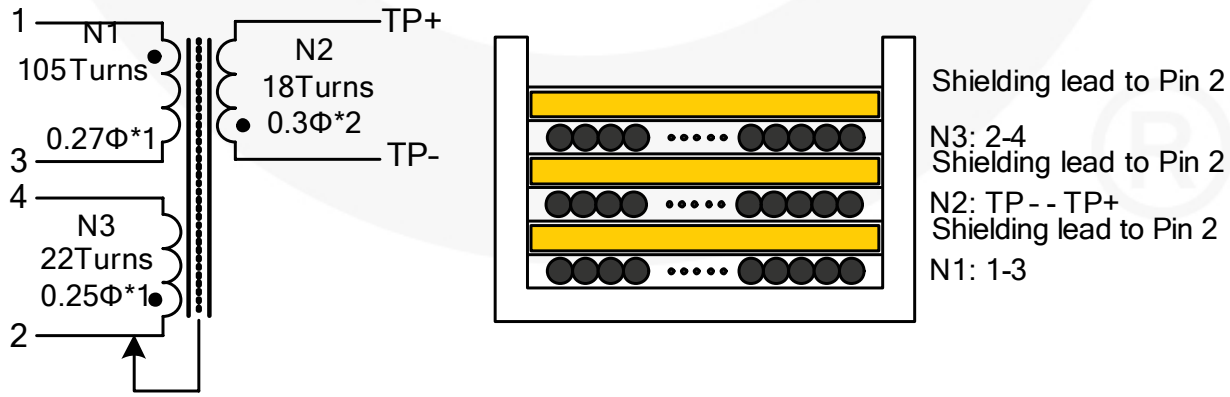


Figure 18. Transformer Structure

Physical Dimensions

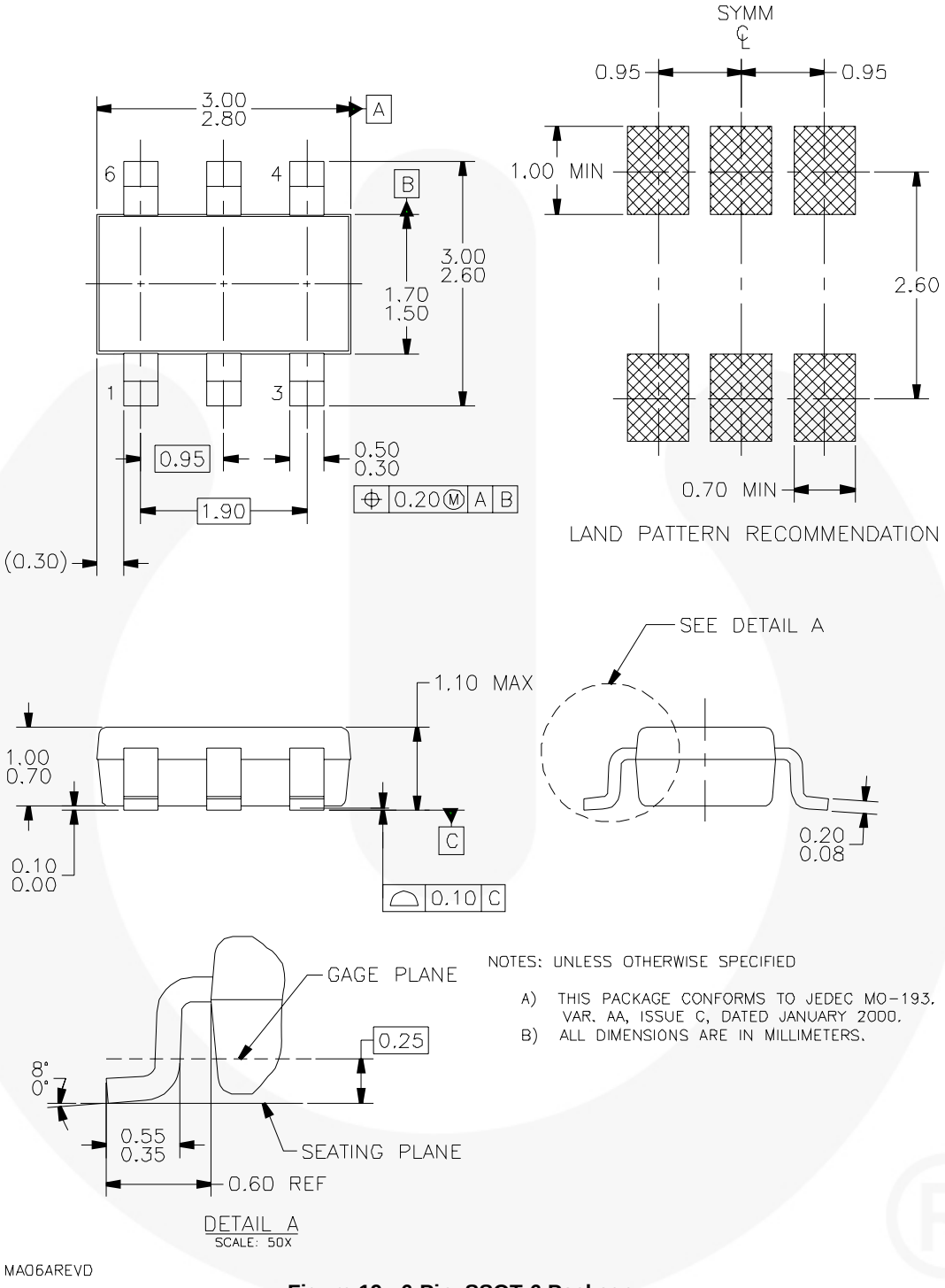
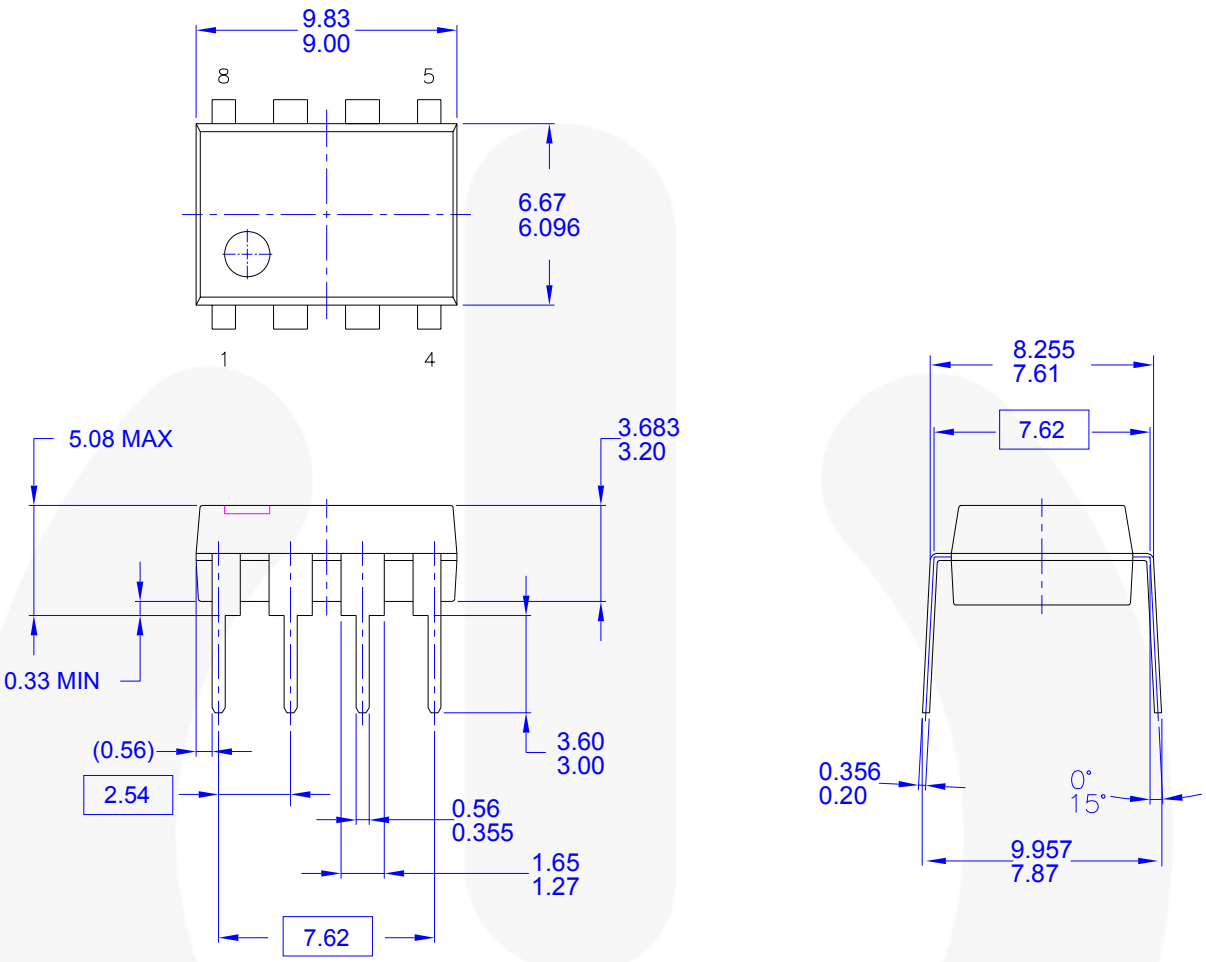


Figure 19. 6-Pin, SSOT-6 Package

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Physical Dimensions (Continued)



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 20. 8-Pin, Dual-Inline Package (DIP-8)

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TinyLogic®
TINYOPTO™
TinyPower™
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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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