FAIRCHILD SEMICONDUCTOR®

October 2008

SG6846B
Highly Integrated Green-Mode PWM Controller

Features

- Low Startup Current: 8μA
- Low Operating Current: 3.7mA
- Peak-Current Mode Operation with Cycle-by-cycle Current Limiting
- PWM Frequency Continuously Decreasing with Burst Mode at Light Loads
- V_{DD} Over Voltage Protection (OVP)
- AC Input Brownout Protection with Hysteresis
- Constant Output Power Limit (Full AC Input Range)
- Internal Latch Circuit for OVP, OTP, and OCP (BLSY, BLSZ)
- Two-level OCP Delay with 200ms
- Programmable PWM Frequency with Frequency Hopping
- OCP Threshold is 2/3 Peak Current Limit
- Soft Startup Time: 5ms

Applications

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

- Power Adapters
- Open-frame SMPS
- SMPS with Surge-current Output, such as for Printers, Scanners, Motor Drivers

Description

The highly integrated PWM controller, SG6846B, provides several features to enhance the performance of fly-back converters. To minimize standby power consumption, a proprietary green-mode function provides off-time modulation to continuously decrease the switching frequency under light-load conditions. Under zero-load conditions, the power supply enters burst-mode. This completely shuts off PWM output. If V_{FB} is larger than around 1.6V, PWM pulses out. This green-mode function enables power supplies to meet international power conservation requirements.

The SG6846B is designed for SMPS with surge-current output. It is incorporated with a two-level OCP function. Besides, the cycle-by-cycle current limiting, if the switching current is higher than OCP threshold and lasts for 200ms, SG6846B stops gate immediately and latches itself (BLSY version) or restarts after V_{DD} charges up to 16.5V (BCSY version). SG6846B also integrates frequency-hopping function internally. The frequency hopping function helps reduce EMI emission of a power supply with minimum line filters. It has built-in synchronized slope compensation, proprietary internal compensation for constant output power limit over universal AC input range. The gate output is clamped at 18V to protect the external MOSFET from over-voltage damage.

Protection include: AC input brownout protection with hysteresis and V_{DD} over-voltage protection. For over-temperature protection, an external NTC thermistor can be applied to sense the ambient temperature. When OCP, V_{DD} OVP, or OTP are activated, an internal latch circuit is used to latch-off the controller. The latch resets when V_{DD} supply is removed.

SG6846B is available in 8-pin SOP package.

Ordering Information

Part Number	Operating Temperature Range	OCP Latch	Eco Status	Package	Packing Method
SG6846BLSY	-40 to +105°C	Yes	Green	8-Pin Small Outline Package (SOP)	Tape & Reel
SG6846BLSZ	-40 to +105°C	Yes	RoHS	8-Pin Small Outline Package (SOP)	Tape & Reel
SG6846BCSY	-40 to +105°C	No	Green	8-Pin Small Outline Package (SOP)	Tape & Reel
SG6846BCSZ	-40 to +105°C	No	RoHS	8-Pin Small Outline Package (SOP)	Tape & Reel

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

Typical Application

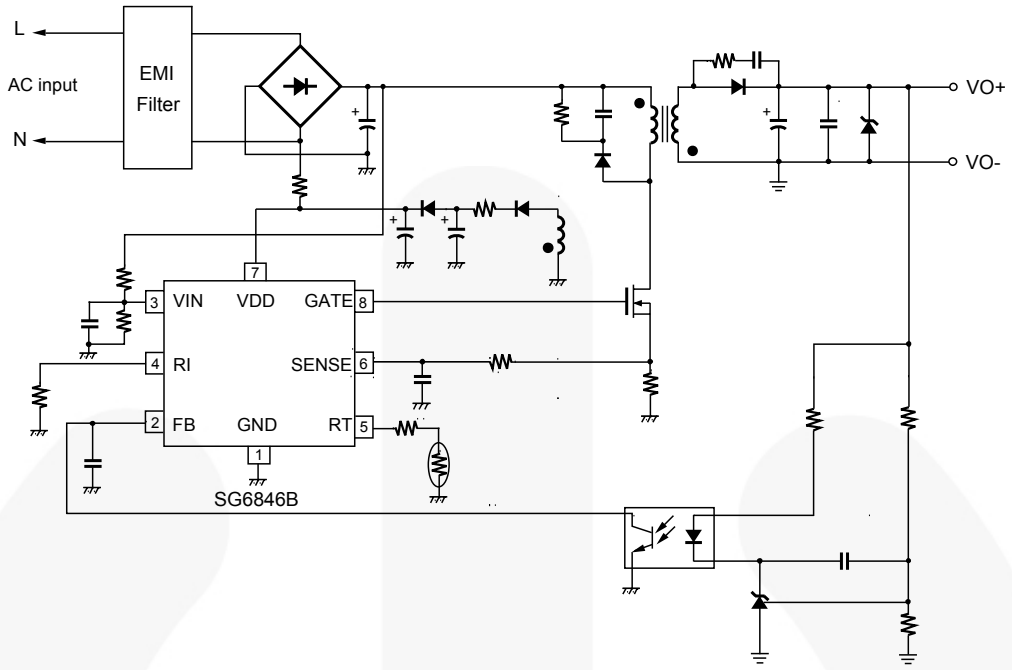


Figure 1. Typical Application

Block Diagram

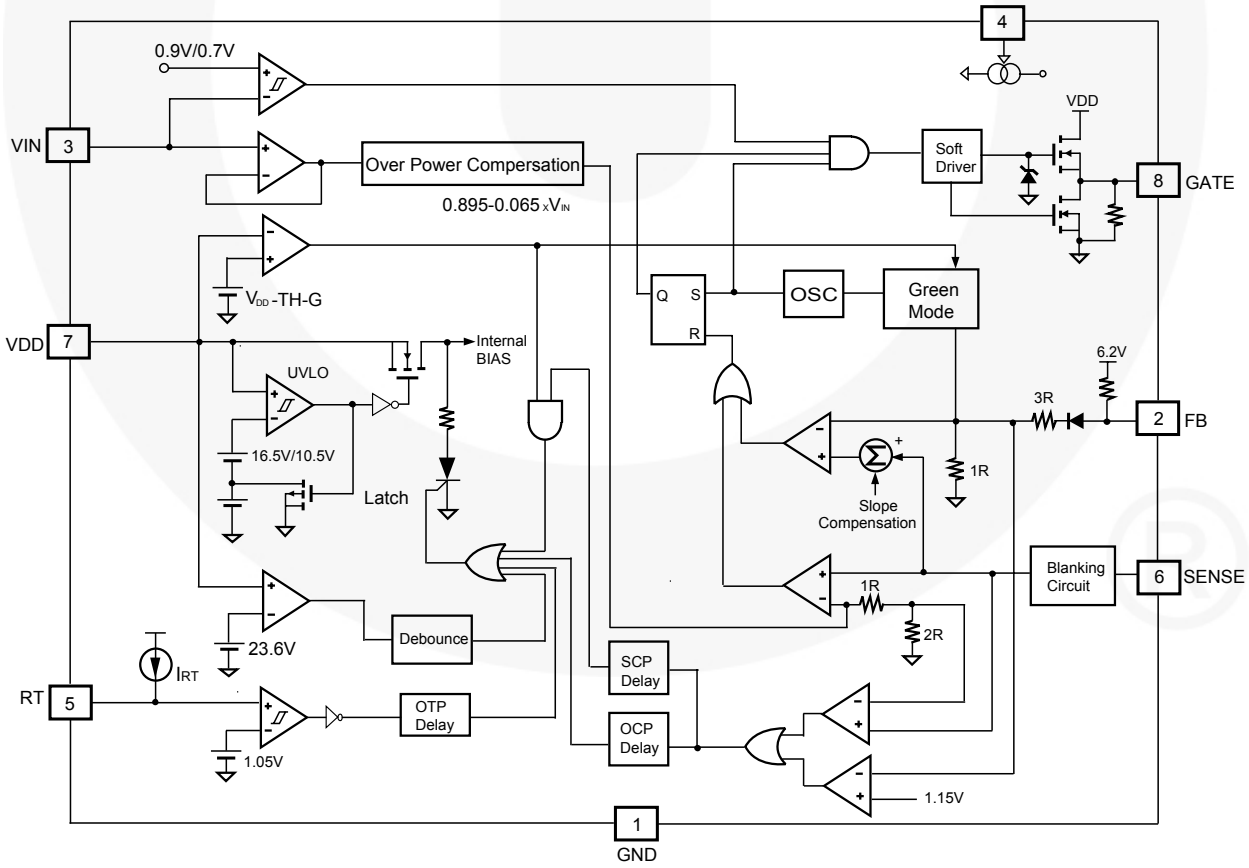
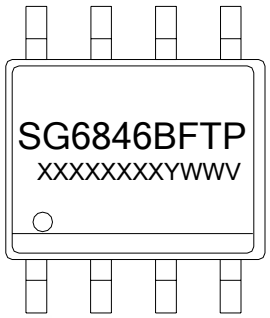


Figure 2. Block Diagram

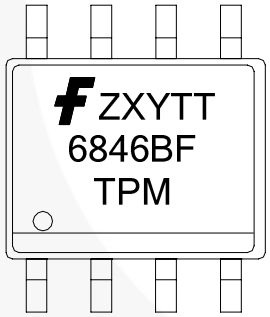
Marking Information



F: L = OCP Latch, C = OCP auto-recovery
T: S = SOP
P: Z = Lead Free + ROHS Compatible
Null = regular package
XXXXXXXX: Wafer Lot
Y: Year; WW: Week
V: Assembly Location

※ Marking for SG6846BLSZ (Pb-free)
SG6846BCSZ (Pb-free)

Figure 3. Top Mark 1



: Fairchild logo
Z: Plant Code
X: Year Code
Y: Week Code
TT: Die Run Code
F: L = OCP Latch, C = OCP auto-recovery
T: Package type, S = SOP
P: Y = Green Package
M: Manufacturing flow code

※ Marking for SG6846BLSY (Green-compound)
SG6846BCSY (Green-compound)

Figure 4. Top Mark 2

Pin Configuration

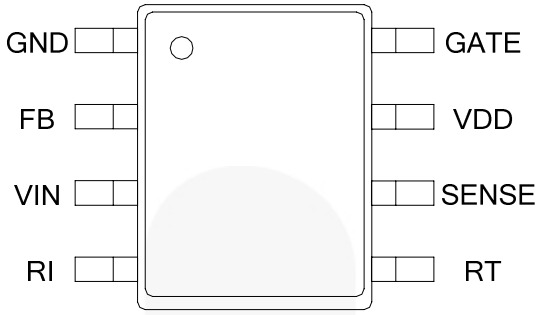


Figure 5. Pin Configuration

Pin Definitions

Pin #	Name	Function	Description
1	GND	Ground	Ground.
2	FB	Feedback	The signal from the external compensation circuit is fed into this pin. The PWM duty cycle is determined in response to the signal from this pin and the current-sense signal from pin 6.
3	VIN	Line-voltage Detection	Line-voltage detection is used for brownout protection with hysteresis. Constant output power limit over universal AC input range is achieved using this pin. Add a low-pass filter to filter out line ripple on the bulk capacitor.
4	RI	Reference Setting	A resistor from the RI pin to ground generates a reference current source that determines the switching frequency. Increasing the resistance reduces the switching frequency. A 26kΩ resistor results in a 65kHz switching frequency.
5	RT	Temperature Detection	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 threshold, PWM output is disabled.
6	SENSE	Current Sense	The sensed voltage is used for peak-current-mode control and cycle-by-cycle current limiting. If the switching current is higher than OCP threshold and lasts for 200ms, SG6846B turns off immediately. This two-level OCP feature is especially suitable for SMPS with surge current output.
7	VDD	Power Supply	If an open-circuit failure occurs in the feedback loop, the internal protection circuit disables PWM output as long as V_{DD} exceeds a threshold.
8	GATE	Driver Output	The totem-pole output driver for the power MOSFET; internally clamped below 18V.

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_L	Input Voltage to FB, SENSE, VIN, RT, RI Pins		-0.3	7.0	V
P_D	Power Dissipation at T_A<50°C	SOP		400	mW
Θ_{JC}	Thermal Resistance (Junction-to-Case)	SOP		54.4	°C/W
T_J	Operating Junction Temperature		-40	+150	°C
T_{STG}	Storage Temperature Range		-65	+150	°C
T_L	Lead Temperature, Wave Soldering, 10 Seconds			+260	°C
ESD	Human Body Model, JESD22-A114			5.0	kV
	Charge Device Model, JESD22-C101			1.5	

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
T_A	Operating Ambient Temperature	-40	+105	°C

Electrical Characteristics

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{DD} Section						
V_{DD-OP}	Continuously Operating Voltage				20	V
V_{DD-ON}	Turn-on Threshold Voltage		15.5	16.5	17.5	V
V_{DD-OFF}	Turn-off Voltage		9.5	10.5	11.5	V
V_{DD-SCP}	Threshold Voltage on V_{DD} for Short-Circuit Protection		V_{DD-OFF} +0.5V	V_{DD-OFF} +1.0V	V_{DD-OFF} +1.5V	V
V_{DD-LH}	Threshold Voltage for Latch-off Release		3	4	5	V
I_{DD-ST}	Startup Current	V_{DD-ON} – 0.16V		8	30	µA
I_{DD-OP}	Operating Supply Current	GATE Open		3.7	5.0	mA
V_{DD-OVP}	V_{DD} Over-Voltage Protection (Latch off)		23	24	25	V
$t_{D-VDDOVP}$	V_{DD} OVP Debounce Time	R_I = 26kΩ		150		µs
I_{DD-OVP}	V_{DD} OVP Latch-off Holding Current	V_{DD} = 5V	30	50	70	µA
V_{IN} Section						
V_{IN-OFF}	PWM Turn-off Threshold Voltage		0.65	0.70	0.75	V
V_{IN-ON}	PWM Turn-on Threshold Voltage		V_{IN-OFF} +0.18	V_{IN-OFF} +0.20	V_{IN-OFF} +0.22	V
Feedback Input Section						
A_V	Input-Voltage to Current-Sense Attenuation		1/3.5	1/4.0	1/4.5	V/V
Z_{FB}	Input Impedance		4.0	5.5	7.0	kΩ
V_{FBO}	FB Pin Open Voltage		5.2	6.2	6.6	V
Current Sense Section						
Z_{SENSE}	Input Impedance			12		kΩ
t_{PD}	Delay to Output			100	250	ns
t_{LEB}	Leading-edge Blanking Time		270	360		ns
V_{SLOPE}	Slope Compensation	Duty = DCY_{MAX}	0.30	0.33	0.36	V
V_{STH1V}	Threshold Voltage for Current Limit	V_{IN} = 1V	0.80	0.83	0.86	V
V_{STH3V}	Threshold Voltage for Current Limit	V_{IN} = 3V	0.67	0.70	0.73	V
$V_{STH1V-2/3}$	OCP Threshold Voltage for Current Limit	V_{IN} = 1V	0.58	0.61	0.64	V
$V_{STH3V-2/3}$	OCP Threshold Voltage for Current Limit	V_{IN} = 3V	0.48	0.51	0.54	V
t_{D-OCP}	Delay Time for Over-Current Protection	R_I = 26kΩ	175	200	225	ms
$t_{D-Short}$	Output Short Circuit Protection delay time	$V_{CS} > V_{STH}$, R_I = 26kΩ, $V_{DD} < V_{DD-SCP}$	6	7	8	ms
$t_{SS-65KHz}$	Period During Soft Start Time	R_I = 26kΩ	4.5	5.0	5.5	ms
$t_{SS-130KHz}$		R_I = 13kΩ	2.25	2.50	2.75	ms

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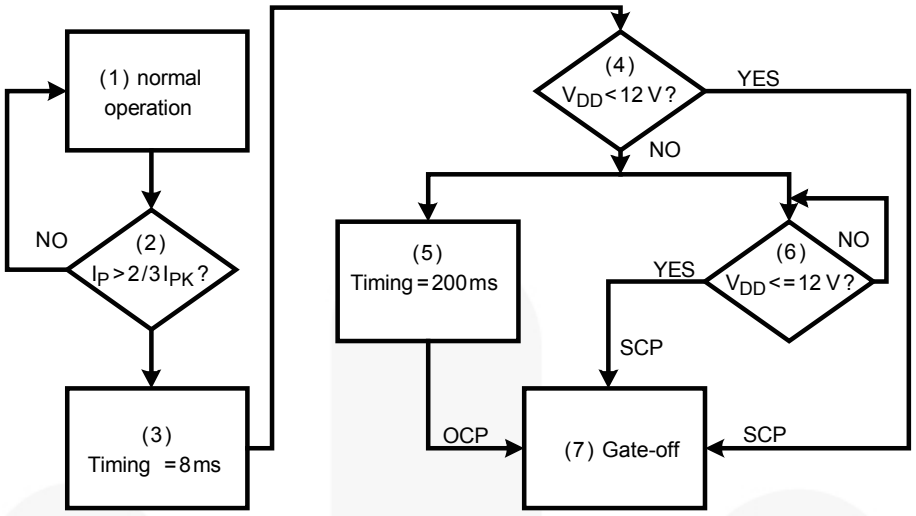

Figure 6. SG6846B OCP/SCP Logic Flow Diagram

Electrical Characteristics (Continued)

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

Symbol	Parameter		Test Condition	Min.	Typ.	Max.	Unit
Oscillator Section							
f_{OSC}	Normal PWM Frequency	Center Frequency	R_I = 26kΩ, V_{FB}>V_N	62	65	68	kHz
		Jitter Range		±3.7	±4.2	±4.7	
$f_{OSC,MAX}$	Maximum PWM Frequency	Center Frequency	R_I = 13kΩ, V_{FB}>V_N	124	130	136	kHz
		Jitter Range		±7.4	±8.4	±9.4	
$f_{OSC,MIN}$	Minimum PWM Frequency	Center Frequency	R_I = 36kΩ, V_{FB}>V_N	44.8	47.0	49.2	kHz
		Jitter Range		±2.54	±2.90	±3.26	
t_{hop-1}	Jitter Period		R_I = 26kΩ, $V_{FB} \geq V_N$	3.9	4.4	4.9	ms
f_{OSC-G}	Green-Mode Minimum Frequency		R_I = 26kΩ	18.0	22.5	25.0	kHz
S_G	Slope for Green-Mode Modulation		R_I = 26kΩ		85		Hz/mV
V_{FB-N}	FB Pin Frequency Reduction Threshold	Pin, FB voltage	R_I = 26kΩ, V_{FB} = V_N	1.9	2.1	2.3	V
		Jitter Range		3.7	4.2	4.7	KHz
V_{FB-G}	FB Voltage at f_{OSC-G}	Pin, FB voltage	R_I = 26kΩ, V_{FB} = V_G	1.4	1.6	1.8	V
f_{DV}	Frequency Variation vs. V_{DD} Deviation		V_{DD} = 11.5V to 20V			5	%
f_{DT}	Frequency Variation vs. Temperature Deviation		T_A = -30 to 85°C		1.5	5.0	%

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Electrical Characteristics (Continued)

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
PWM Output Section						
DCY_{MAX}	Maximum Duty Cycle		80	85	90	%
V_{OL}	Output Voltage Low	V_{DD} = 15V, I_O = 50mA			1.5	V
V_{OH}	Output Voltage High	V_{DD} = 12V, I_O = 50mA	8			V
t_R	Rising Time	GATE = 1nF		350		ns
t_F	Falling Time	GATE = 1nF		50		ns
V_{CLAMP}	Gate Output Clamping Voltage	V_{DD} = 20V			18	V
Over-Temperature Protection (OTP) Section(1)						
I_{RT}	Output Current of RT Pin	R_I = 26kΩ	64	70	76	μA
V_{RTTH}	Threshold Voltage for OTP		1.00	1.05	1.10	V
$t_{DOTP-LATCH}$	Over-Temperature Latch-off Debounce	SG6846BLSY or SG6846BCSY, R_I = 26kΩ, $V_{FB}>V_N$		100		ms
		SG6846BLSZ or SG6846BCSZ, R_I = 26kΩ, $V_{FB}>V_N$		100		μs
R_{RT-OFF}	Equivalent Impedance of RT for OTP(1)	R_I = 26kΩ	14	15	16	kΩ
R_I Section						
RI_{NOR}	R_I Operating Range		13		36	kΩ
RI_{MAX}	Maximum R_I Value for Protection		10			MΩ
RI_{MIN}	Minimum R_I Value for Protection				6	kΩ

Note:

1. The relationship between R_{RT-OFF} and R_I is: $R_{RT-OFF} = V_{OTP-LATCH-OFF} / I_{RT} = V_{RT} / (70\mu A \times 26 / R_I\,(K\Omega))$ (1)

Typical Performance Characteristics

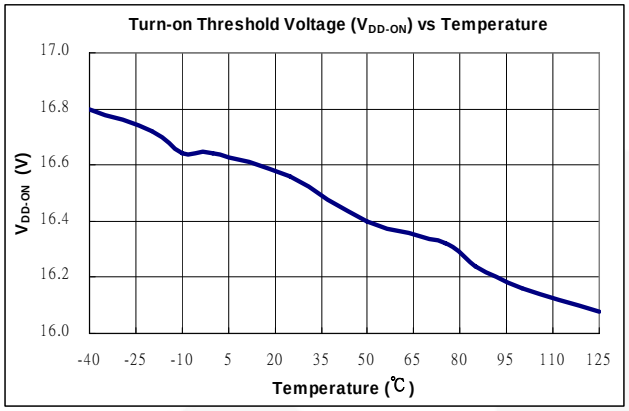

Figure 7. Turn-on Threshold Voltage (V_{DD-ON}) vs. Temperature

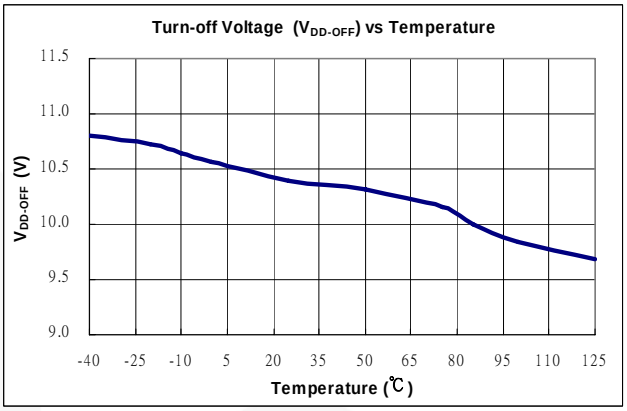

Figure 8. Turn-off Threshold Voltage (V_{DD-OFF}) vs. Temperature

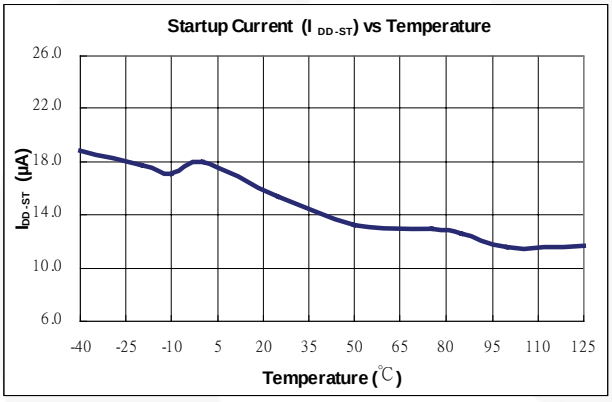

Figure 9. Startup Current (I_{DD-ST}) vs. Temperature

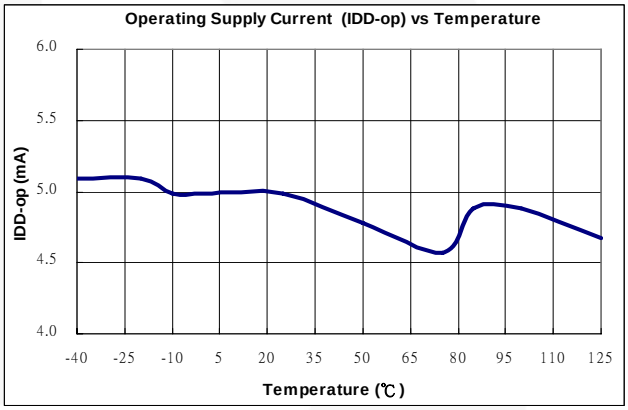

Figure 10. Operating Supply Current (I_{DD-op}) vs. Temperature

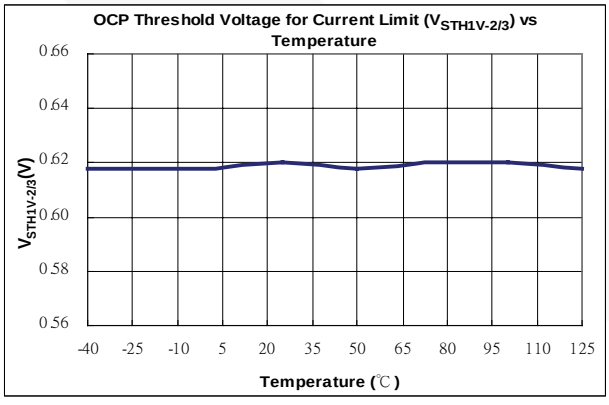

Figure 11. OCP Threshold Voltage for Current Limit ($V_{STH1V-2/3}$) vs. Temperature

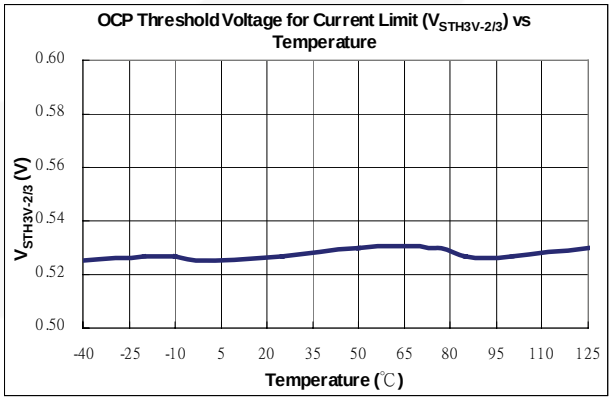

Figure 12. OCP Threshold Voltage for Current Limit ($V_{STH3V-2/3}$) vs. Temperature

Typical Performance Characteristics (Continued)

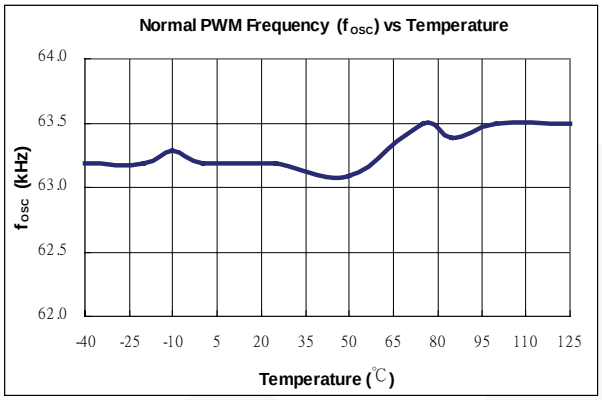

Figure 13. Normal PWM Frequency (f_{OSC}) vs. Temperature

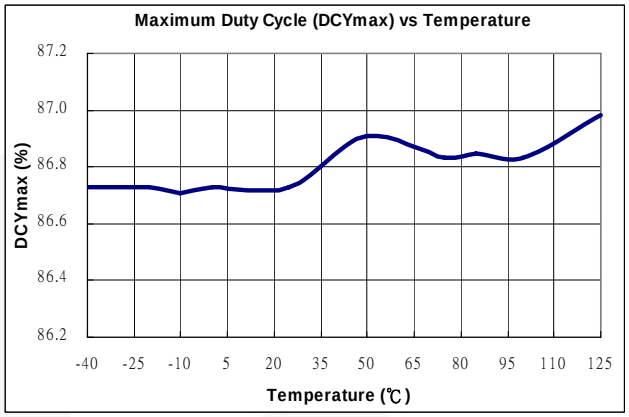

Figure 14. Maximum Duty Cycle (D_{CYmax}) vs. Temperature

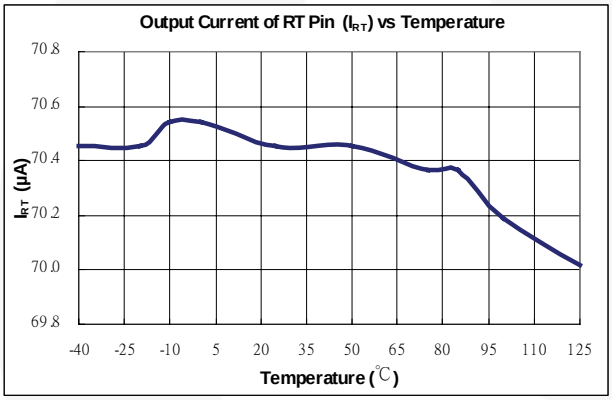

Figure 15. Output Current of RT pin (I_{RT}) vs. Temperature

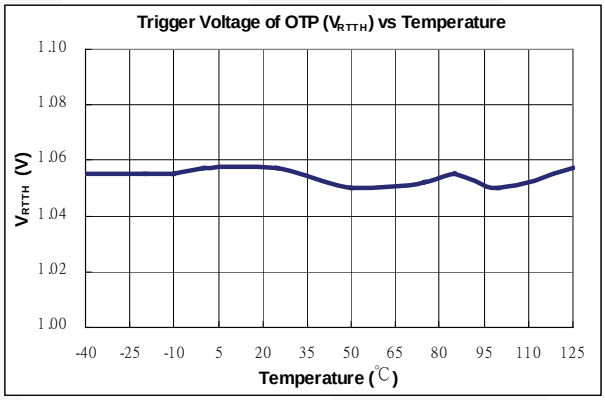

Figure 16. Trigger Voltage of OTP(V_{RTTH}) vs. Temperature

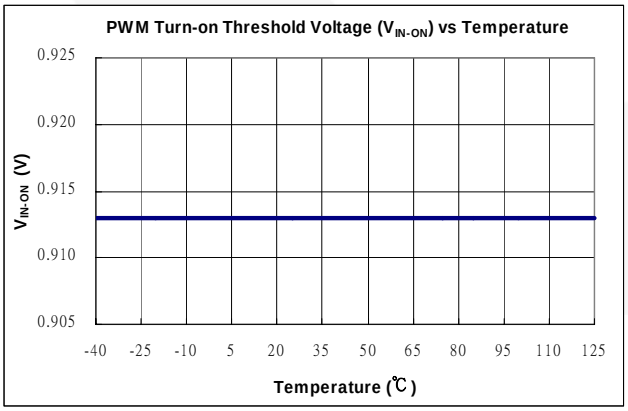

Figure 17. PWM Turn-on Threshold Voltage (V_{IN-ON}) vs. Temperature

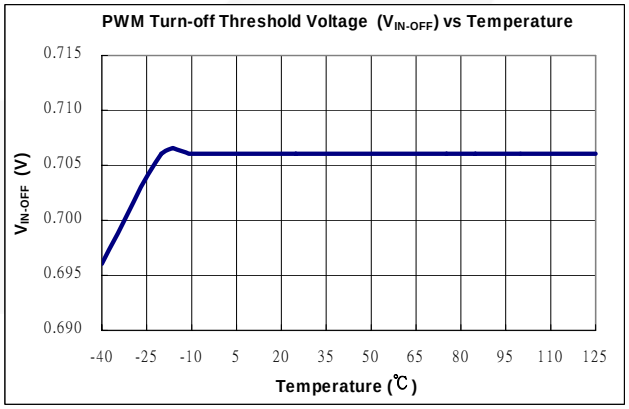

Figure 18. PWM Turn-off Threshold Voltage (V_{IN-OFF}) vs. Temperature

Operation Description

Startup Operation

The turn-on/turn-off thresholds are fixed internally at 16.5V and 10.5V. To enable the SG6846B during startup, the hold-up capacitor must first be charged to 16.5V through the startup resistor.

If an open-circuit or short-circuit to ground occurs at the RI pin, the internal protection circuit immediately shuts down the controller.

The hold-up capacitor continues to supply V_{DD} before energy can be delivered from the auxiliary winding of the main transformer. The V_{DD} must not drop below 10.5V during this startup process. This UVLO hysteresis window ensures that the hold-up capacitor can adequately supply V_{DD} during startup.

The typical startup current is only 8μA, which allows a high-resistance, low-wattage startup resistor to be used. For constant output power limit over a universal input-voltage range, the peak-current threshold is adjusted by the voltage of the VIN pin. Since the VIN pin is connected to the rectified AC input line voltage through the resistive divider, a higher line voltage generates a higher V_{IN} voltage. The threshold voltage decreases as the V_{IN} increases, making the maximum output power at high line input voltage equal to that at low line input. The value of R-C network should not be so large it affects the power limit (shown in Figure 19). R and C should put on less than 300Ω and 1000pF, respectively, to minimize power loss. A 1.5MΩ/0.25W startup resistor and a 10μF/25V V_{DD} hold-up capacitor are sufficient for a universal input range.

The required operating current has been reduced to 3.7mA, which enables higher efficiency and reduces the V_{DD} hold-up capacitance requirement.

Green-Mode Operation

The proprietary green-mode function provides off-time modulation to continuously decrease the switching frequency under light-load conditions. Maximum on-time is limited to provide protection against abnormal conditions. To further reduce power consumption under zero-load condition, the PWM oscillator is completely turned off and the power supply enters burst-mode. Green mode dramatically reduces power consumption under light-load and zero-load conditions. Power supplies using SG6846B can meet restrictive international regulations regarding standby power consumption.

Oscillator Operation

A resistor connected from the RI pin to GND generates a internal reference current source used to determine the PWM frequency. Increasing the resistance decreases the amplitude of the current source and reduces the PWM frequency. Using a 26kΩ resistor results in a corresponding 65kHz switching frequency. The relationship between R_I and the switching frequency is:

$$f_{PWM}(kHz) = \frac{1690}{R_I\ (k\Omega)} \quad (2)$$

If an open-circuit or short-circuit to ground occurs at the RI pin, the internal protection circuit immediately shuts down the controller.

Two-level Over-current Protection (OCP)

The cycle-by-cycle current limiting shuts down the PWM immediately when the switching current is over the peak-current threshold. Additionally, when the switching current is higher than over-current threshold, the internal counter counts down. When the total accumulated counting time is more than ~200ms (R_I = 26kΩ), the controller is latched off and the internal counter counts up. When the switching current is lower than over-current threshold, the internal counter counts down. When the total accumulated counting time is more than ~200ms (R_I = 26kΩ), the controller is latched off.

This two-level OCP protection and up/down counter are especially designed for SMPS with surge current output, such as those for printers, scanners, and motor drivers.

Constant Output Power Limit

For constant output power limit over universal input-voltage range, the peak-current threshold is adjusted by the voltage of the VIN pin. Since the VIN pin is connected to the rectified AC input line voltage through the resistive divider, a higher line voltage generates a higher V_{IN} voltage. The threshold voltage decreases as V_{IN} increases, making the maximum output power at high-line input voltage equal to that at low-line input.

Brownout Protection

Since the VIN pin is connected through a resistive divider to the rectified AC input line voltage, it can also be used for brownout protection. If the V_{IN} voltage is less than 0.7V, the PWM output is shut off. If the V_{IN} is over 0.9V, the PWM output is turned on again. The hysteresis window for on/off is ~0.2V.

V_{DD} Over-voltage Protection (OVP)

V_{DD} over-voltage protection is built in to prevent damage. If V_{DD} is over 24V, SG6846B is latched off.

Over-Temperature Protection (OTP)

An external NTC thermistor can be connected from the RT pin to GND. The impedance of the NTC decreases at high temperatures. When the voltage of the RT pin drops below 1.05V, the SG6846B is turned off. *For protection-mode options, see Ordering Information.*

Operation Description (Continued)

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 SG6846B.

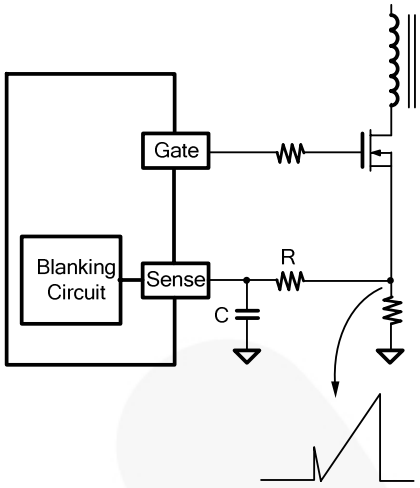

Figure 19. Current Sense R-C Filter

Reference Circuit

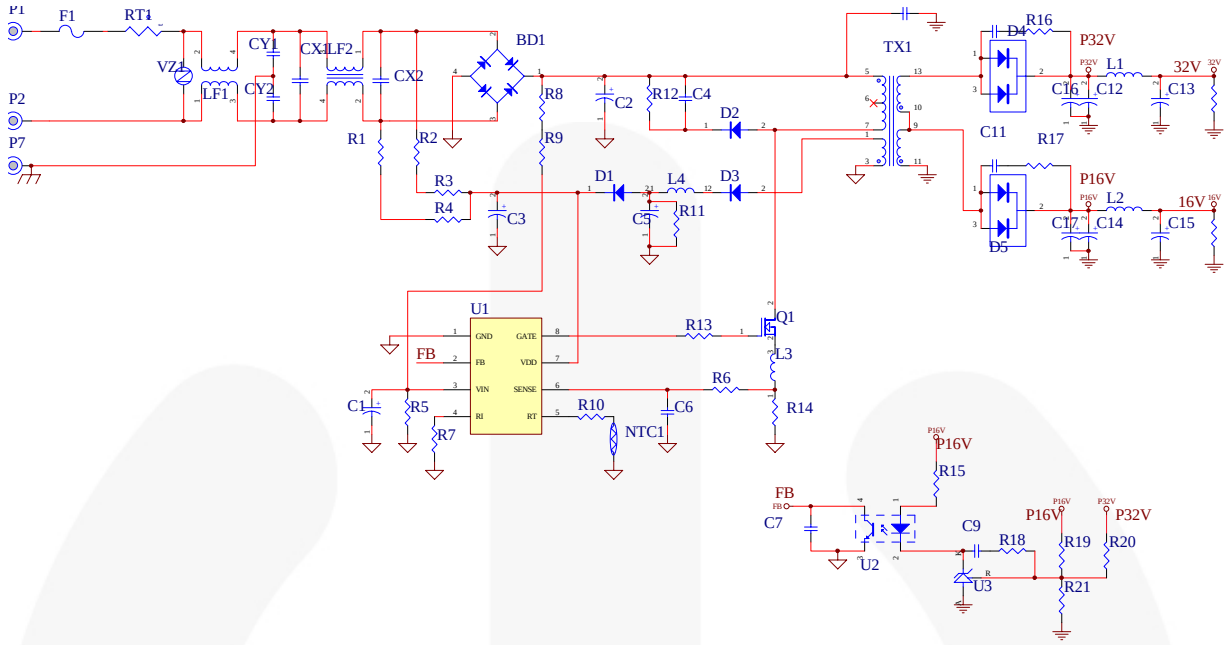

Figure 20. Application Circuit for 32V / 16V Output

BOM

Part No.	Value	Part No.	Value	Part No.	Value
R1, R2, R3, R4	470KΩ +/-5%	C4	103P 630V	D3	FR103 1.0A 200V
R8, R9	S1MΩ +/-1%	C10,C11	102P 1KV	BD1	DBL406G
R5	16K2Ω +/-1%	C6,C7	102P 50V	D4	BYT28-300
R15	1K5Ω +/-5%	C9	222P 50V	D5	BYV32-150
R13	10Ω +/-5%	C14,C17	470μ 25V	F1	250V4A QUICK
R18	4K7Ω +/-5%	C15	220μ 25V	L1,L2	1.8μH
R21	15KΩ +/-1%	C13,C16	220μ 50V	L4	10μH
R7	27KΩ +/-5%	C2	150μ 400V	U3	TL431 +/-1%
R6	330Ω +/-1%	C1	4.7μ 50V	U1	SG6846
R19	102KΩ +/-1%	C3	10μ 50V	U2	PC817
R14	0Ω22 +/-5%	CX1	X1 0.47μ 275V	Q1	7NB60
R16, R17	1W 20Ω +/-5%	C8	Y2 222P 250V	TX1	EI-33
R11	20KΩ +/-5%	C5	100μ 50V	RT1	SCK053
R12	100KΩ +/-5%	CX2	X2 0.1μF 275V	VZ1	14φ 470V
R20	887KΩ +/-1%	D1	1N4148		
R22	10KΩ +/-1%	D2	BYV95C		

Physical Dimensions

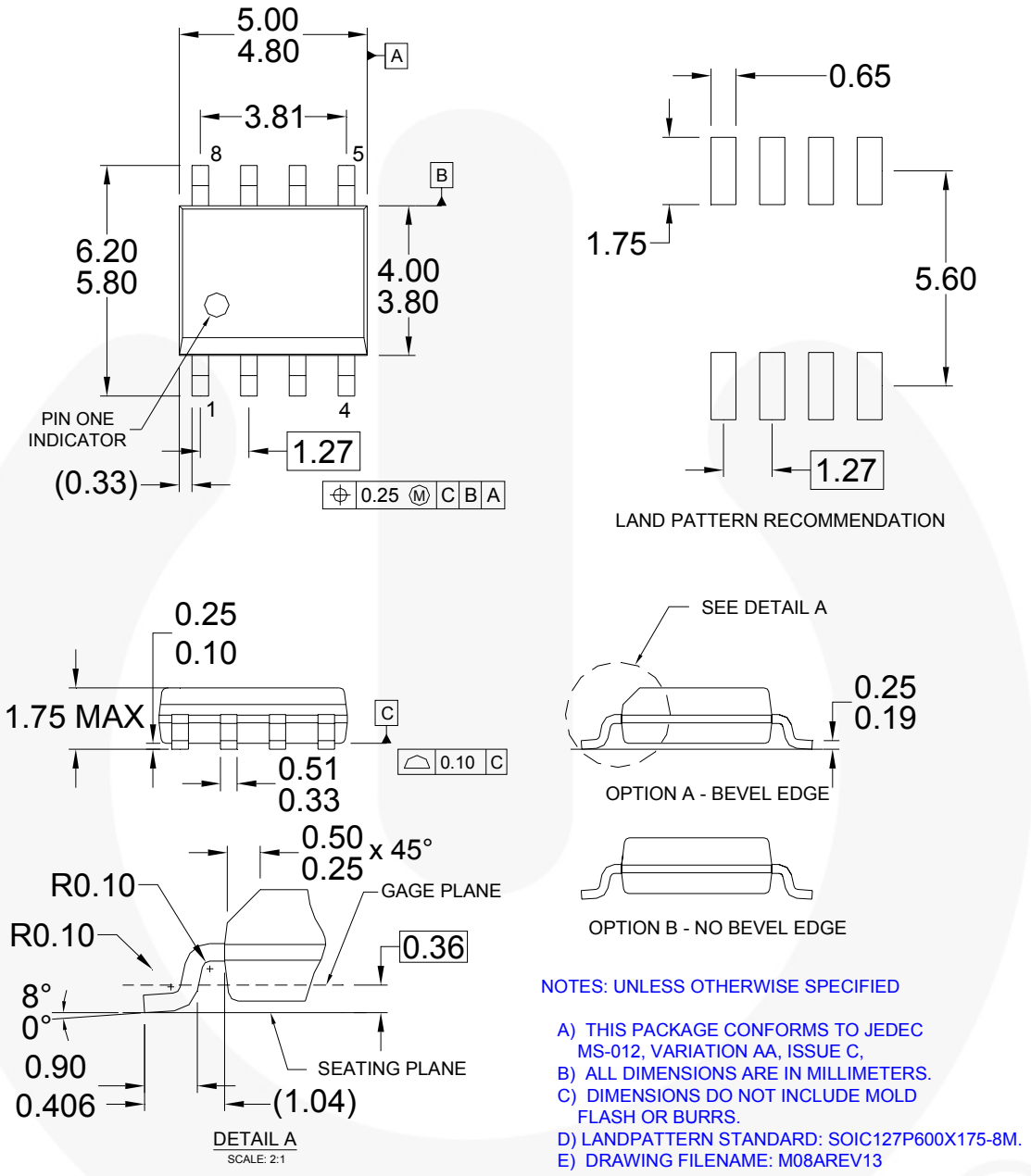

Figure 21. 8-Pin Small Outline Package (SOP)

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.

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