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SG6846WA

Highly Integrated Green-Mode PWM Controller

Features

- Low Startup Current: 15 μ A
- Low Operating Current: 3.7mA
- Peak-Current Mode of 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
- Two-Level OCP Delay: 1700ms
- Output Short-Circuited Delay Time: 100ms
- Programmable PWM Frequency with Frequency Hopping
- OCP Threshold is Half Peak Current Limit
- Feedback Open-Loop Protection with a 1700ms Delay
- Built-in Soft-Start

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 SG6846WA is designed for SMPS with surge-current output, incorporated with a two-level OCP function. Besides the cycle-by-cycle current limiting, if the switching current is higher than two thirds the peak-current threshold for 1700ms, over-current protection is activated such that the SG6846WA is latched off.

If the switching current is higher than two thirds of the peak-current threshold for 100ms and the voltage on the V_{DD} is still higher than V_{DD-OFF} + 1V; the PWM pulses are latched off immediately until the V_{DD} voltage is lower than V_{DD-OFF} + 1V. This is useful when an output short circuit occurs.

SG6846WA also integrates a frequency-hopping function that helps reduce EMI emission of a power supply with minimum line filters. The built-in synchronized slope compensation helps achieve stable peak-current control. To keep constant output power limit over universal AC input range, the current limit and OCP threshold voltage are adjusted according to the AC line voltage detected by the VIN pin. The gate output is clamped at 18V to protect the external MOSFET from over-voltage damage. Internal soft-start is built-in to reduce stress on the MOSFET and startup current during power-on period.

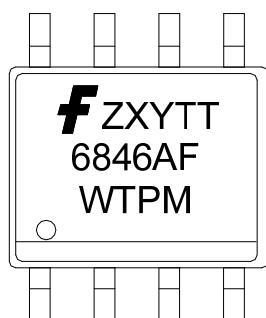
Other protection functions include AC input brownout protection with hysteresis, V_{DD} over-voltage protection, and over-temperature protection. For over-temperature protection, an external NTC thermistor can be applied to sense the ambient temperature. When OCP, V_{DD} OVP, or OTP is activated; an internal latch circuit latches off the controller. The PWM pulses stay latched off until the power supply is disconnected from the mains outlet.

SG6846WA is available in 8-pin, SOP package.

Ordering Information

Part Number	Operating Temperature Range	OCP Latch	Package	Packing Method
SG6846WALS	-40 to +105°C	Yes	8-Pin, Small-Outline Package (SOP)	Tape & Reel

Marking Information



F	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 SG6846WALSY (Green-Compound)

Figure 3. Top Mark

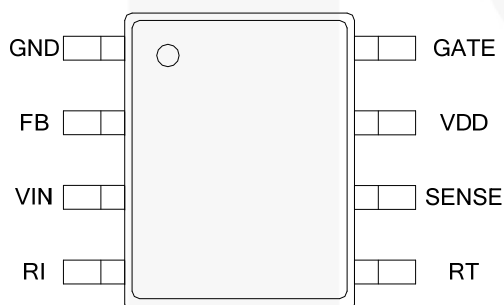


Figure 4. Pin Configuration (Top View)

Pin Definitions

Pin #	Name	Description
1	GND	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 the SENSE pin (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 on 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 1700ms, SG6846WA turns off immediately. This two-level OCP feature is especially suitable for SMPS with surge current output.
7	VDD	Supply Voltage. If an open-circuit failure occurs in the feedback loop, the internal protection circuit disables PWM output as long as V _{DD} exceeds the 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			25	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			650	mW
Θ _{JA}	Thermal Resistance (Junction-to-Ambient)			150	°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	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	5500		V
		Charge Device Model, JESD22-C101	2000		

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	$^{\circ}\text{C}$

Electrical Characteristics

$V_{DD} = 15V$ and $T_A = 25^\circ C$ 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 VDD for Short-Circuit Protection			$V_{DD-OFF} + 1.0V$		V
V_{DD-LH}	Threshold Voltage for Latch-Off Release			4		V
I_{DD-ST}	Startup Current	$V_{DD-ON} - 0.16V$		15	30	μA
I_{DD-OP}	Operating Supply Current	GATE Open		3.7	5.0	mA
V_{DD-OVP}	VDD Over-Voltage Protection (Latch-Off)		22.8	24.0	25.2	V
$t_{D-VDDOVP}$	VDD OVP Debounce Time	$R_I = 26k\Omega$	80	180	280	μs
I_{DD-OVP}	VDD 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			$V_{IN-OFF} + 0.20$		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	k Ω
V_{FBO}	FB Pin Open Voltage		5.6	6.0	6.4	V
V_{FB-OLP}	Threshold Voltage of Open-Loop Protection		4.1	4.6	5.1	V
t_{D-OLP}	Open-Loop Protection Delay	$R_I = 26k\Omega$		1700		ms
Current Sense Section						
Z_{SENSE}	Input Impedance			12		k Ω
t_{PD}	Delay to Output		60	95	130	ns
t_{LEB}	Leading-Edge Blanking Time		220	310	400	ns
V_{SLOPE}	Slope Compensation	Duty = DCY_{MAX}		0.33		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	$V_{IN} = 1V$	0.53	0.58	0.63	V
$V_{STH3V-2/3}$	OCP Threshold Voltage for Current Limit	$V_{IN} = 3V$	0.44	0.49	0.54	V
t_{D-OCP}	Delay for Over-Current Protection	$R_I = 26k\Omega$	1600	1700	1800	ms
t_{D-SCP}	Delay for Output Short-Circuited Protection	$R_I = 26k\Omega$; $V_{DD} < V_{DD-SCP}$		100		ms
$t_{SS-65KHz}$	Period During Startup Time	$R_I = 26k\Omega$	4.3	5.1	5.9	ms
$t_{SS-130KHz}$		$R_I = 13k\Omega$	1.0	2.2	3.4	ms

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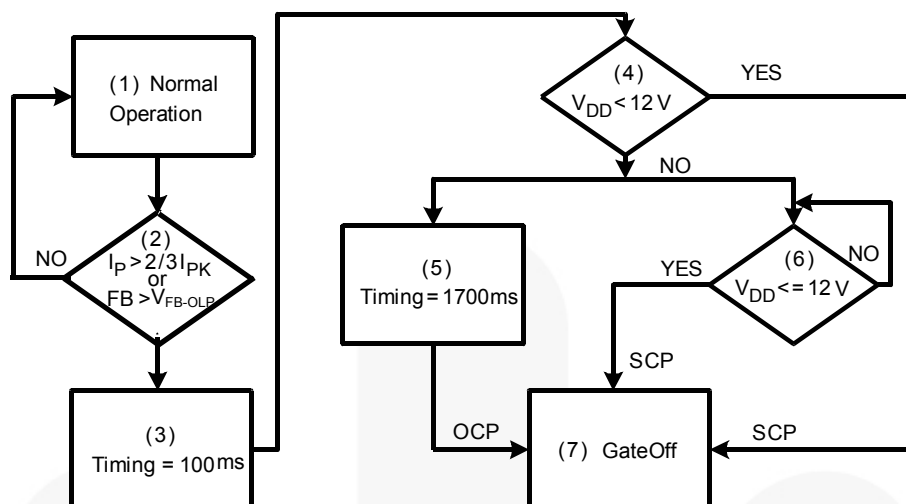


Figure 5. OCP/SCP Logic Flow Diagram

Electrical Characteristics (Continued)

$V_{DD} = 15V$ and $T_A = 25^\circ C$ 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
		Hopping Range			±4.4		
f _{OSC,MAX}	Maximum PWM Frequency	Center Frequency	R _I = 13kΩ, V _{FB} >V _N		130		kHz
		Hopping Range			±8.4		
f _{OSC,MIN}	Minimum PWM Frequency	Center Frequency	R _I = 36kΩ, V _{FB} >V _N		47.00		kHz
		Hopping Range			±2.90		
t _{hop}	Hopping Period		R _I = 26kΩ	11.5			ms
f _{OSC-G}	Green-Mode Minimum Frequency		R _I = 26kΩ	17.50	21.00	24.50	kHz
V _{FB-N}	FB Pin Frequency Reduction Threshold	FB Pin Voltage	R _I = 26kΩ, V _{FB} = V _N	1.90	2.10	2.30	V
		Hopping Range			±4.40		KHz
V _{FB-G}	FB Voltage at f _{OSC-G}	FB Pin Voltage	R _I = 26kΩ, V _{FB} = V _G	1.40	1.60	1.80	V
		Hopping Range			±1.45		KHz
S _G	Slope for Green-Mode Modulation		R _I = 26kΩ		85		Hz/mV
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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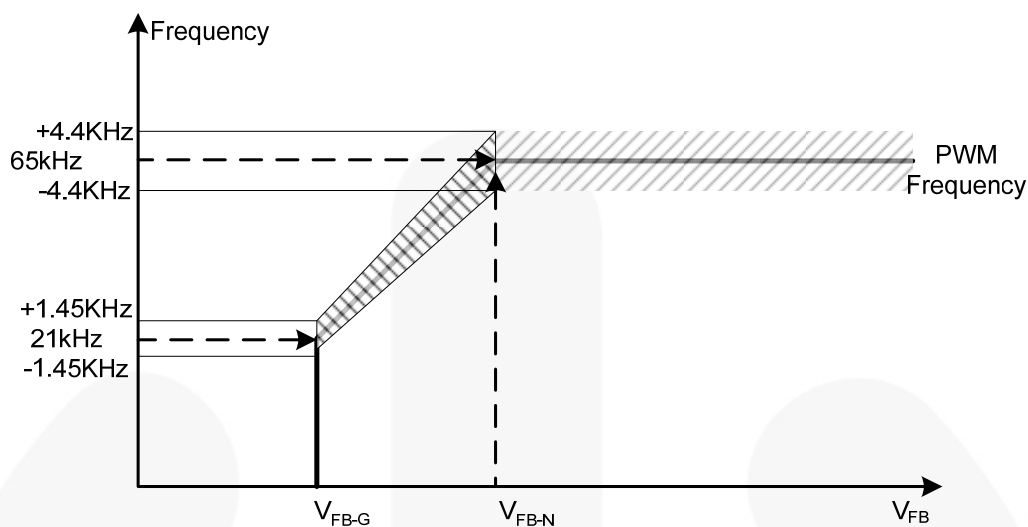


Figure 6. PWM Frequency

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		70	75	80	%
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	Rise Time	GATE = 1nF	170	260	350	ns
t _F	Fall Time	GATE = 1nF	30	50	70	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			1.065		V
t _{DOTP-LATCH}	Over-Temperature Latch-Off Debounce	R _I = 26kΩ	80	100	120	ms
R _{RT-OFF}	Equivalent Impedance of RT for OTP ⁽¹⁾	R _I = 26kΩ		15		kΩ
R_I Section						
R _I NOR	R _I Operating Range		13		36	kΩ
R _I MAX	Maximum R _I Value for Protection		10			MΩ
R _I MIN	Minimum R _I Value for Protection				6	kΩ

Note:

1. The relationship between R_{RT-OFF} and R_I is:

$$R_{RT-OFF} = V_{OTP-LATCH-OFF} / I_{RT} = V_{RT} / (70\mu A \times 26 / R_I (K\Omega)) \quad (1)$$

Typical Performance Characteristics

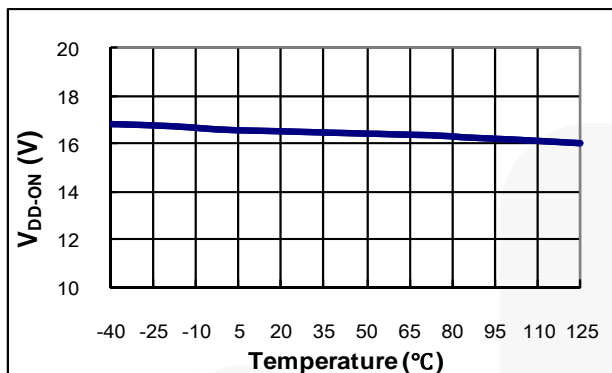


Figure 7. Turn-on Threshold Voltage (V_{DD-ON}) vs. Temperature

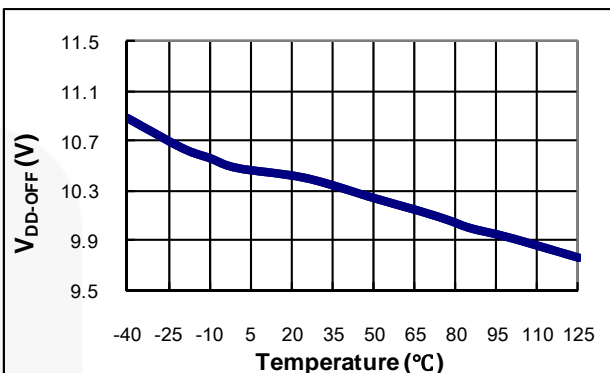


Figure 8. Turn-off Threshold Voltage (V_{DD-OFF}) vs. Temperature

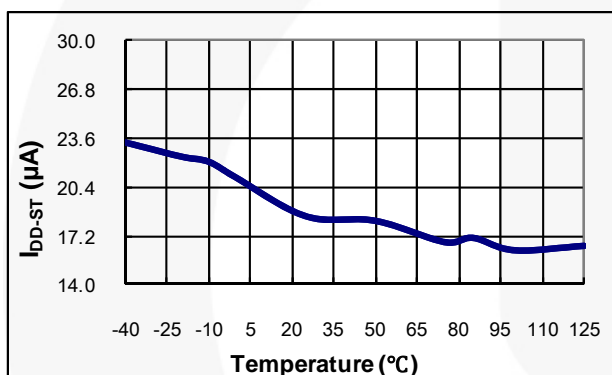


Figure 9. Startup Current (I_{DD-ST}) vs. Temperature

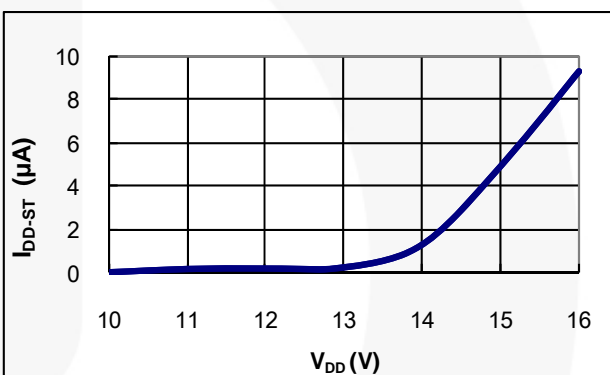


Figure 10. Startup Current vs. V_{DD} Voltage

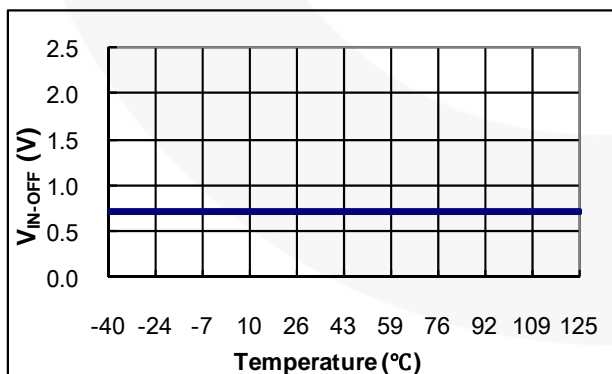


Figure 11. PWM Turn-off Threshold Voltage (V_{IN-OFF}) vs. Temperature

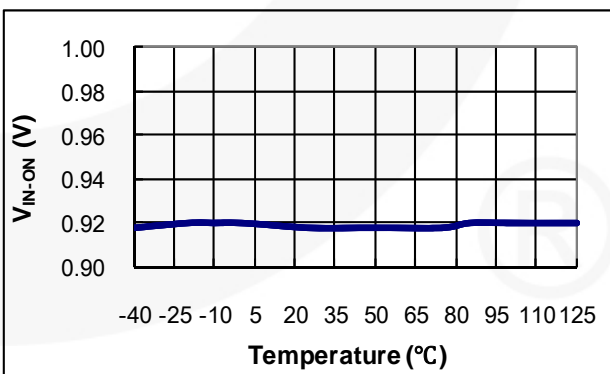


Figure 12. PWM Turn-on Threshold Voltage (V_{IN-ON}) vs. Temperature

Typical Performance Characteristics (Continued)

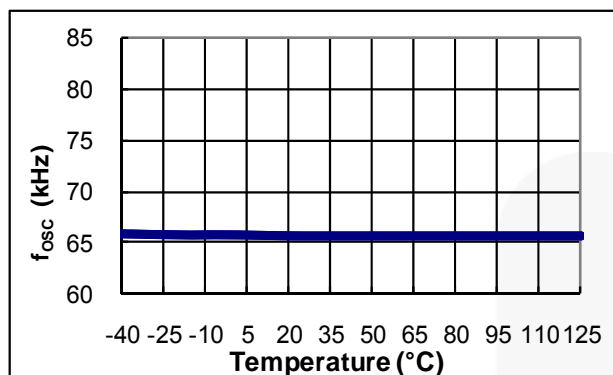


Figure 13. Normal PWM Frequency (f_{osc}) vs. Temperature

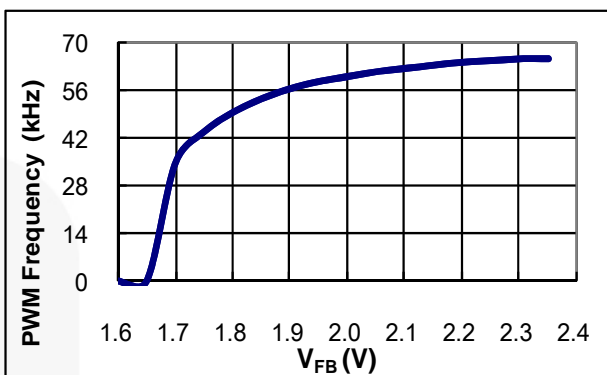


Figure 14. PWM Frequency vs. FB Voltage

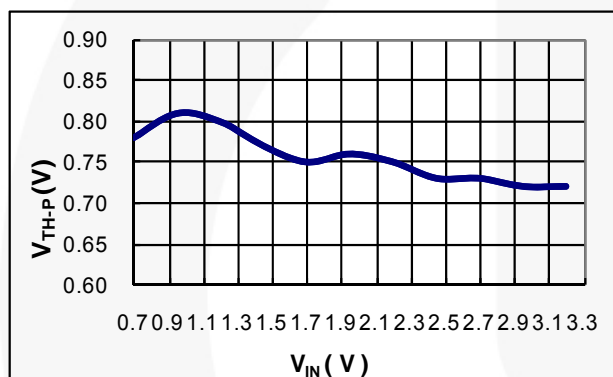


Figure 15. Current-Limit Threshold vs. V_{IN} Voltage

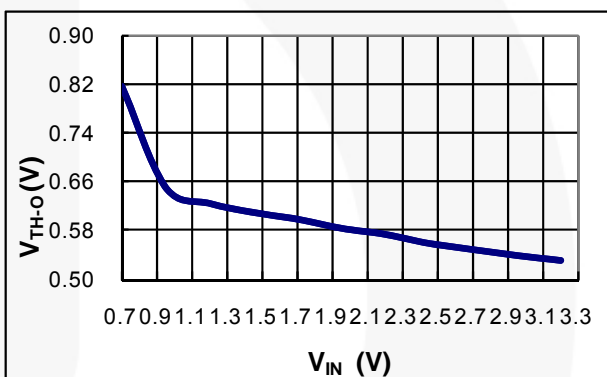


Figure 16. 2/3 Current-Limit Threshold vs. V_{IN} Voltage

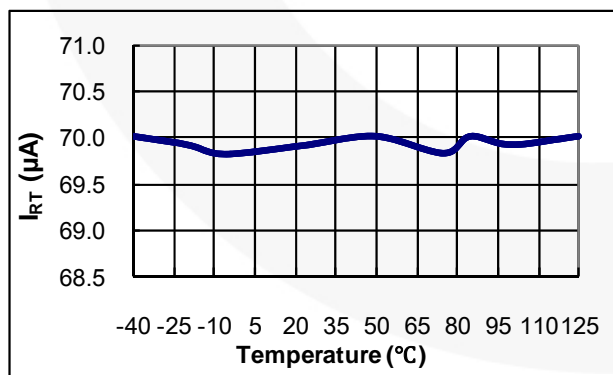


Figure 17. Output Current of RT Pin (I_{RT}) vs. Temperature

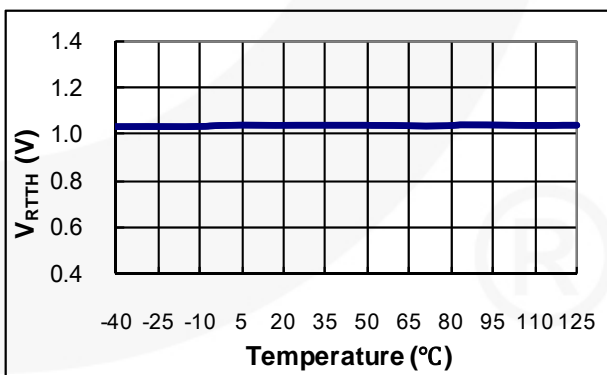


Figure 18. FB Output High Voltage (V_{RTTH}) vs. Temperature

Operation Description

Startup Operation

The turn-on and turn-off thresholds are fixed internally at 16.5V and 10.5V, respectively. To enable the SG6846WA during startup, the hold-up capacitor must first be charged to 16.5V 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. The V_{DD} must not drop below 10.5V during this startup process. The hold-up capacitor must supply V_{DD} sufficient energy that avoid voltage drop to UVLO during startup.

A typical startup current is only 15 μ A; which allows use of a high-resistance, low-wattage startup resistor. A 1.5M Ω /0.25W startup resistor and a 10 μ F/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. This green mode dramatically reduces power consumption under light-load and zero-load conditions.

Oscillator Operation

A resistor connected from the RI pin to GND pin generates a reference current source inside the SG6846WA, which is used to determine the PWM frequency. Increasing the resistance decreases the amplitude of the current source and reduces the PWM frequency. Using a 26k Ω resistor results in a corresponding 65kHz switching frequency. The relationship between R_I and the switching frequency is:

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

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 the over-current threshold, the internal counter counts down. When the total accumulated counting time is more than around 1700ms ($R_I = 26\text{k}\Omega$), the controller is latched off and the internal counter counts up. When the switching current is lower than the over-current threshold, the internal counter counts down. When the total accumulated counting time is more than ~1700ms ($R_I = 26\text{k}\Omega$), 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 (shown in Figure 19), making the maximum output power at high-line input voltage equal to that at low-line input.

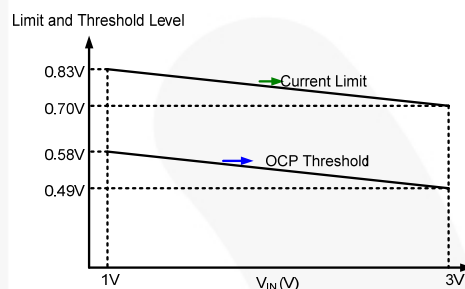


Figure 19. Linearly Current Limit Curve

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, SG6846WA 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 1.065V, the SG6846WA is turned off after $t_{\text{DTP-LATCH}}$. If RT pin is not connected to NTC resistor to do Over-Temperature Protection (OTP), it is recommended to place one 100K Ω resistor to ground to prevent from noise interference. This pin is limited by internal clamping circuit.

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 SG6846W.

Reference Circuit

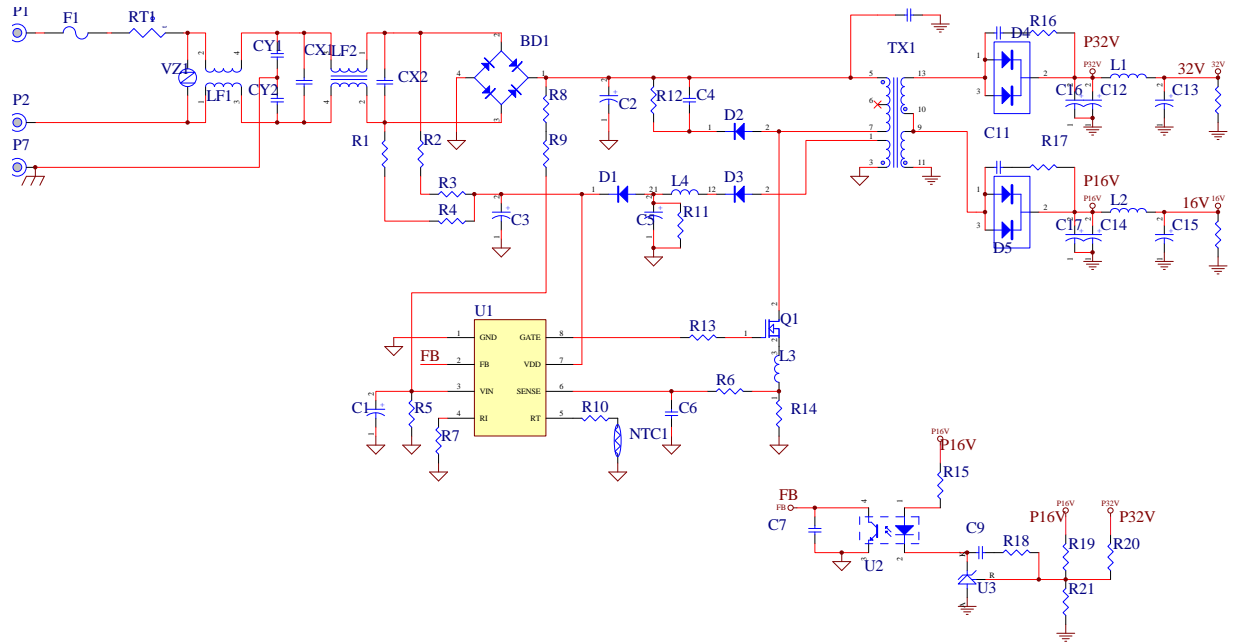


Figure 20. Application Circuit for 32V / 16V Output

Table 1. Bill of Materials

Part No.	Value	Part No.	Value	Part No.	Value
R1, R2, R3, R4	470K Ω \pm 5%	C4	103P 630V	D3	FR103 1.0A 200V
R8, R9	51M Ω \pm 1%	C10,C11	102P 1KV	BD1	DBL406G
R5	16K2 Ω \pm 1%	C6,C7	102P 50V	D4	BYT28-300
R15	1K5 Ω \pm 5%	C9	222P 50V	D5	BYV32-150
R13	10 Ω \pm 5%	C14,C17	470 μ F 25V	F1	250V4A QUICK
R18	4K7 Ω \pm 5%	C15	220 μ F 25V	L1,L2	1.8 μ H
R21	15K Ω \pm 1%	C13,C16	220 μ F 50V	L4	10 μ H
R7	27K Ω \pm 5%	C2	150 μ F 400V	U3	TL431 \pm 1%
R6	330 Ω \pm 1%	C1	4.7 μ F 50V	U1	SG 6846
R19	102K Ω \pm 1%	C3	10 μ F 50V	U2	PC817
R14	0 Ω 22 \pm 5%	CX1	X1 0.47 μ F 275V	Q1	7NB60
R16, R17	1W 20 Ω \pm 5%	C8	Y2 222P 250V	TX1	EI-33
R11	20K Ω \pm 5%	C5	100 μ F 50V	RT1	SCK053
R12	100K Ω \pm 5%	CX2	X2 0.1 μ F 275V	VZ1	14 ψ 470V
R20	887K Ω \pm 1%	D1	1N4148		
R22	10K Ω \pm 1%	D2	BYV95C		

Physical Dimensions

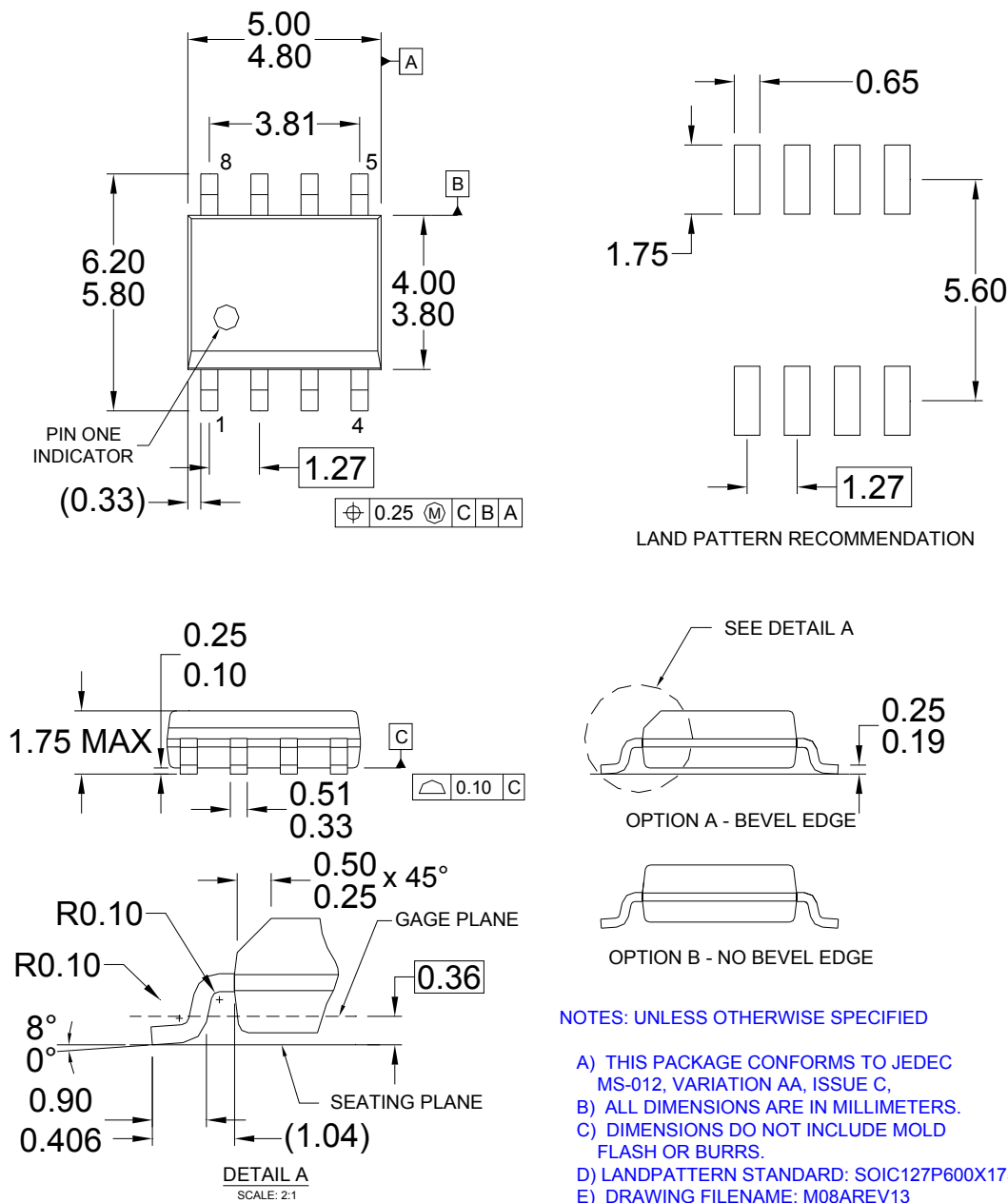


Figure 21. 8-Pin, SOIC, JEDEC MS-012, .150-inch Narrow Body

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