

ON Semiconductor

Is Now

onsemi™

To learn more about onsemi™, please visit our website at
www.onsemi.com

onsemi and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.



Is Now Part of



ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.



SG6848x1

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

Features

- Green-Mode PWM Controller
- Low Startup Current: 5 μ A
- Low Operating Current: 3 mA
- Programmable PWM Frequency
- Peak-Current-Mode Operation
- Leading-Edge Blanking
- Built-in Synchronized Slope Compensation
- Cycle-by-Cycle Current Limiting
- Constant Output Power Limit
- Gate Output Voltage Clamped at 15 V
- Small SSOT-6 Package

Applications

General-purpose switched-mode power supplies (SMPS) and 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 auxiliary supplies, home appliances, and consumer electronics
- Replacements for linear transformers and RCC SMPS
- PC 5 V Standby Power

Description

This highly integrated PWM controller provides several enhancements to meet the low standby-power needs of low-power SMPS. To minimize standby power consumption, the proprietary Green Mode provides off-time modulation to continuously decrease PWM frequency under light-load conditions. Green Mode enables the power supply to meet even strict power conservation requirements.

The BiCMOS fabrication process enables reducing the startup current to 5 μ A and the operating current to 3 mA. As a result, 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 (90 V_{AC} to 264 V_{AC}). Cycle-by-cycle current limiting ensures safe operation during short-circuits.

To protect the external power MOSFET from damage by supply over voltage, the SG6848X1 output driver is clamped at 15 V. The SG6848X1 controllers can be used to improve the performance and reduce the production cost of power supplies. The SG6848X1 can replace linear and RCC power supplies. It is available in DIP-8 and SSOT-6 packages.

Ordering Information

| Part Number | Operating Temperature Range | Package | Packing Method |
|-------------|-----------------------------|---|----------------|
| SG6848TZ1 | -40 to +105°C | 6-Lead, SUPERSOT™-6, JEDEC MO-193, 1.6 mm Wide | Tape & Reel |
| SG6848DZ1 | -40 to +105°C | 8-Lead, MDIP, JEDEC MS-001, .300" Wide, Two Dap | Tube |
| SG6848DY1 | -40 to +105°C | 8-Lead, MDIP, JEDEC MS-001, .300" Wide, Two Dap | Tube |

Application Diagram

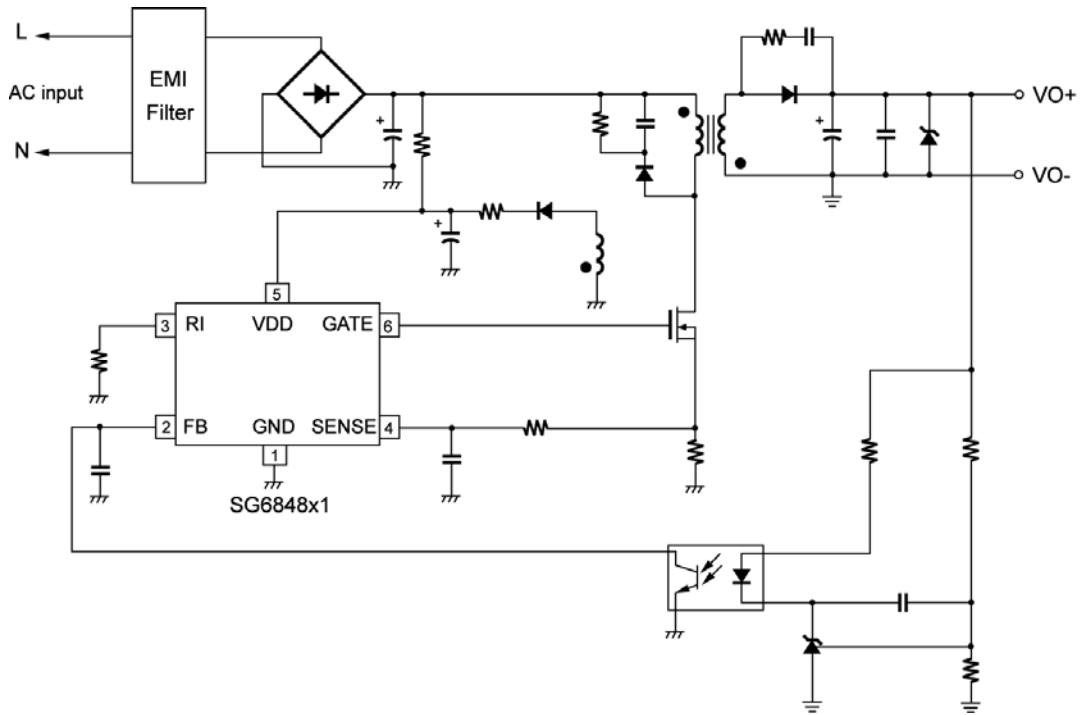


Figure 1. Typical Application

Internal Block Diagram

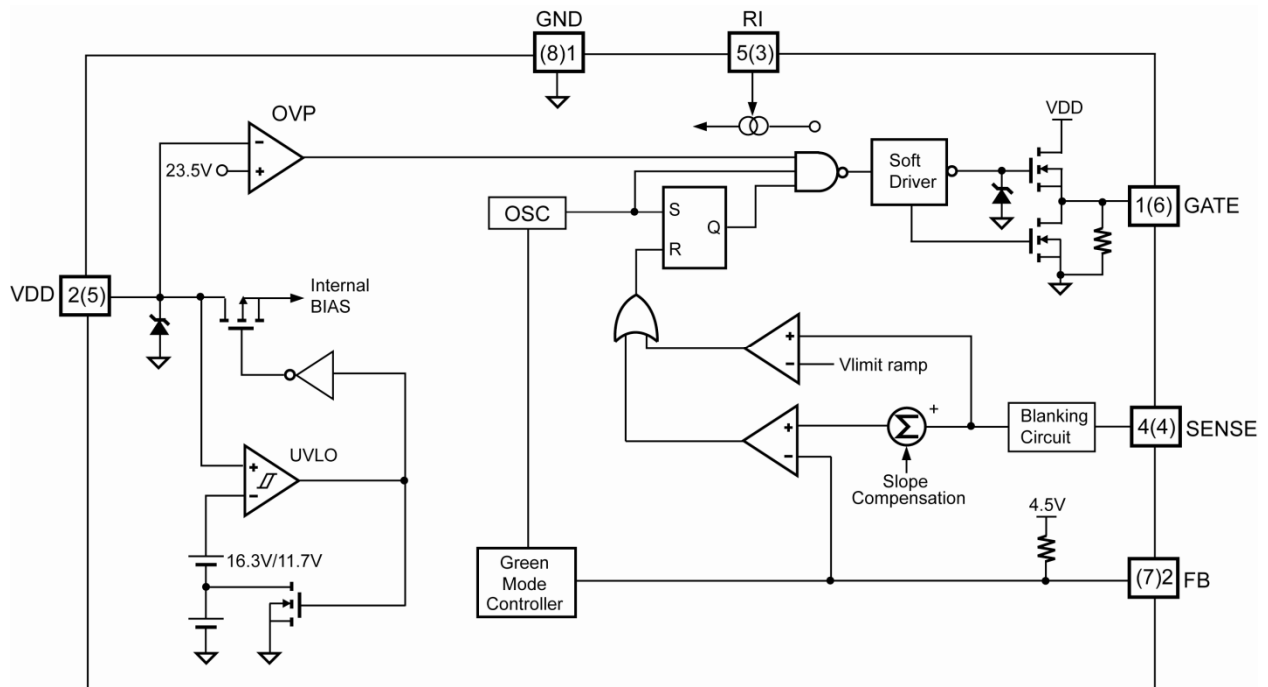
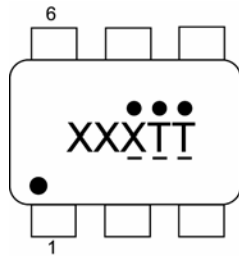


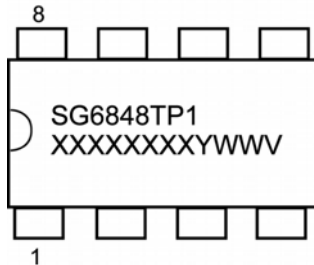
Figure 2. Functional Block Diagram

Marking Information



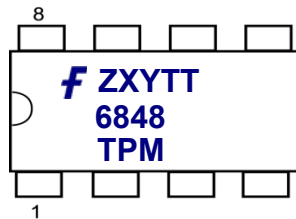
XXX: AAH=SG6848x1
 TT : Die Run Code
 . . . : Year Code
 - - - : Week Code

*Marking for SG6848TZ1 (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 SG6848DZ1 (Pb-free)



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

*Marking for SG6848DY1 (Green Compound)

Figure 3. Top Mark

Pin Configurations

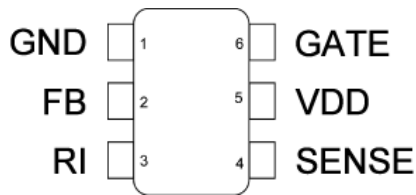


Figure 4. SSOT-6 Pin Configuration

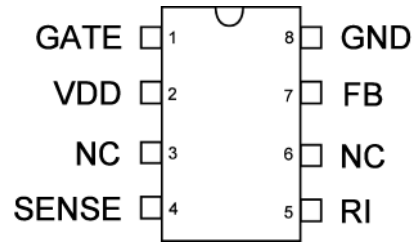


Figure 5. DIP-8 Pin Configuration

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. 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 also 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 used to charge an internal capacitor and determine the switching frequency. Increasing the resistance reduces the amplitude of the current source and the switching frequency. A 95 kΩ resistor, R _i , results in a 50 μA constant current, I _i , and a 70 kHz switching frequency. |
| 6 | | NC | No connection |
| 7 | 2 | FB | Feedback. The FB pin provides the output voltage regulation signal. It provides feedback to the internal PWM comparator, so that the PWM comparator can control the duty cycle. |
| 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 | 6.0 | V |
| V _{SENSE} | Input Voltage to Sense Pin | -0.3 | 6.0 | V |
| T _J | Operating Junction Temperature | | 150 | °C |
| Θ _{JA} | Thermal Resistance; Junction-to-Air | SSOT | 208.4 | °C/W |
| | | DIP | 82.5 | °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, JESD22-A114 | | 3.0 | kV |
| | Machine Model, JESD22-A115 | | 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, $V_{DD}=15\text{ V}$ and $T_A=25^\circ\text{C}$.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|-------------------------------|---|---|------|------|------|-------------------|
| V_{DD} Section | | | | | | |
| V_{DD-ON} | Turn-On Threshold Voltage | | 15.3 | 16.3 | 17.3 | V |
| V_{DD-OFF} | Turn-Off Threshold Voltage | | 10.9 | 11.7 | 12.5 | V |
| I_{DD-ST} | Startup Current | $V_{DD}=15\text{ V}$ | | 5 | 30 | μA |
| I_{DD-OP} | Operating Supply Current | $V_{DD}=15\text{ V}$, $C_L=1\text{ nF}$ | | 3 | 5 | mA |
| V_{DD-OVP} | Over Voltage Protection | | 22.0 | 23.5 | 25.0 | V |
| Feedback Input Section | | | | | | |
| Z_{FB} | Input Impedance | | | 2 | | k Ω |
| I_{OZ} | Zero Duty Cycle Input Current | | | 1.3 | 2.0 | mA |
| V_{OP} | Open Loop Voltage | | | 4.5 | | V |
| Current-Sense Section | | | | | | |
| Z_{CS} | Input Impedance | | | 10 | | k Ω |
| t_{PD} | Delay to Output | | | 100 | | ns |
| V_{STHFL} | Flat Threshold Voltage for Current Limit | | | 0.96 | | V |
| V_{STHVA} | Valley Threshold Voltage for Current Limit | | | 0.81 | | V |
| t_{LEB} | Leading-Edge Blanking Time | | | 200 | | ns |
| DC_{SAW} | Duty Cycle of SAW Limit | | | 45 | | % |
| Oscillator Section | | | | | | |
| f_{OSC} | Frequency | $R_I=95\text{ k}\Omega$ | 65 | 70 | 75 | kHz |
| f_{OSC-G} | Green-Mode Frequency | $R_I=95\text{ k}\Omega$ | | 15 | | kHz |
| I_N | Green-Mode Start Threshold FB Input Current | | | 1 | | mA |
| I_G | Green-Mode Minimum Frequency FB Input Current | | | 1.16 | | mA |
| S_G | Green-Mode Modulation Slope | $R_I=95\text{ k}\Omega$ | | 300 | | Hz/ μA |
| f_{DV} | Frequency Variation vs. V_{DD} Deviation | $V_{DD}=14\text{ to }20\text{ V}$ | | | 2 | % |
| f_{DT} | Frequency Variation vs. Temperature Deviation | $T_A=-30\text{ to }105^\circ\text{C}$ | | | 2 | % |
| Output Section | | | | | | |
| DCY_{MAX} | Maximum Duty Cycle | | 70 | 75 | 80 | % |
| DCY_{Min} | Minimum Duty Cycle | | | 0 | | % |
| V_{GATE-L} | Output Voltage Low | $V_{DD}=15\text{ V}$, $I_O=20\text{ mA}$ | | | 1.5 | V |
| V_{GATE-H} | Output Voltage High | $V_{DD}=13.5\text{ V}$, $I_O=20\text{ mA}$ | 8 | | | V |
| t_r | Rising Time | $V_{DD}=15\text{ V}$, $C_L=1\text{ nF}$ | | 250 | | ns |
| t_f | Falling Time | $V_{DD}=15\text{ V}$, $C_L=1\text{ nF}$ | | 80 | | ns |
| $V_{GATE-CLAMP}$ | Output Clamp Voltage | $V_{DD}=20\text{ V}$ | | 15 | 17 | V |

Typical Performance Characteristics

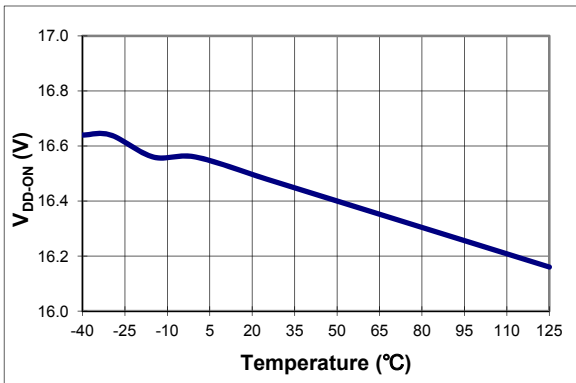


Figure 6. Turn-On Threshold Voltage (V_{DD-ON}) vs. Temperature

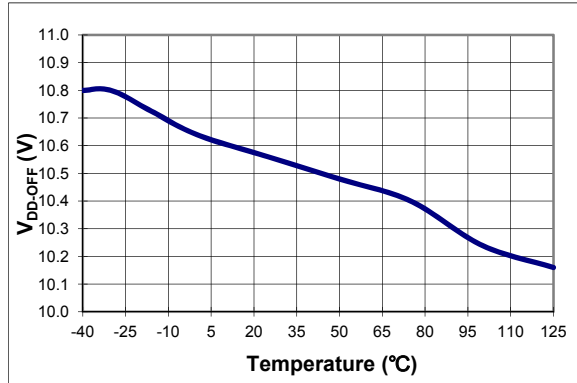


Figure 7. Turn-Off Threshold Voltage (V_{DD-OFF}) vs. Temperature

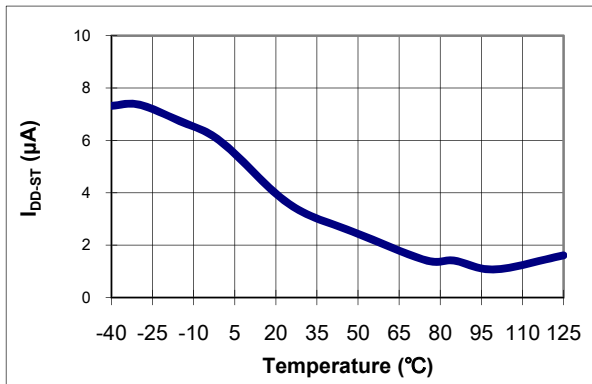


Figure 8. Startup Current (I_{DD-ST}) vs. Temperature

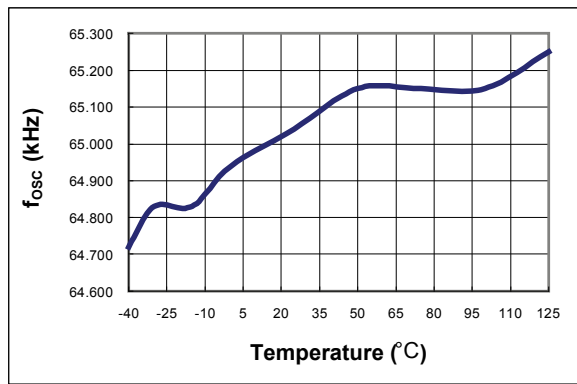


Figure 9. Center Frequency (f_{OSC}) vs. Temperature

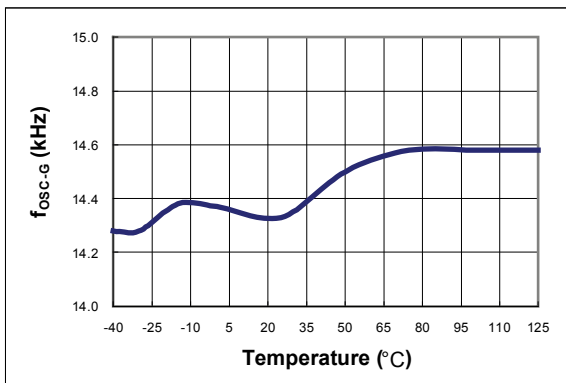


Figure 10. Green-Mode Frequency (f_{OSC-G}) vs. Temperature

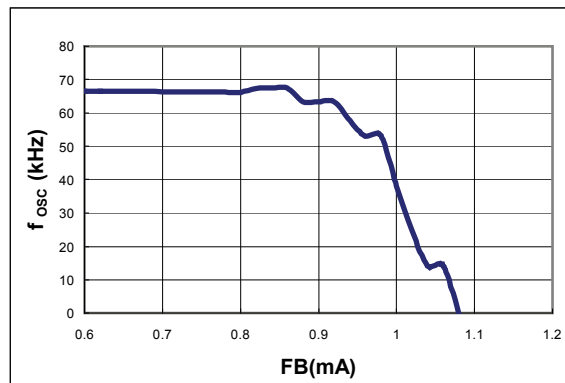


Figure 11. PWM Oscillator Frequency (f_{OSC}) vs. FB

Operation Description

The SG6848x1 devices integrate many useful functions into one controller for low-power switching mode power supplies. The following descriptions highlight some of the features.

Startup Current

The startup current is only 5 μ A. Low startup current allows a startup resistor with a high resistance and a low-wattage to supply the startup power for the controller. A 1.5 M Ω , 0.25 W, startup resistor and a 10 μ F/25 V V_{DD} hold-up capacitor are sufficient for an AC-to-DC power adapter with a wide input range (100 V_{AC} to 240 V_{AC}).

Operating Current

The operating current is reduced to 3 mA. The low operating current results in higher efficiency and reduces the V_{CC} hold-up capacitance requirement.

Green-Mode Operation

The proprietary Green Mode 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. Green Mode dramatically reduces power consumption under light-load and zero-load conditions. Power supplies using the SG6848X1 can meet even strict regulations regarding standby power consumption.

Oscillator Operation

A resistor connected from the RI pin to ground generates a constant current source for the SG6848X1. 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 95 k Ω R_i resistor results in a 50 μ A constant current I_i and a 70 kHz switching frequency. The relationship between R_i and the switching frequency is:

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

The range of the oscillation frequency is designed to be within 50 kHz ~ 100 kHz.

Leading-Edge Blanking

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

Constant Output Power Limit

When the SENSE voltage across the sense resistor R_S reaches the threshold voltage (around 0.96 V), the output GATE drive is turned off after a short propagation delay, t_D . This delay introduces an additional current, proportional to $t_D \cdot V_{IN}/L_p$. The propagation delay is nearly constant regardless of the input line voltage V_{IN} . Higher input line voltages result in larger additional currents. 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. This ramp signal rises from 0.81 V to 0.96 V, then flattens out at 0.96 V. 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 (90 V_{AC} to 264 V_{AC}).

Under-Voltage Lockout (UVLO)

The turn-on and turn-off thresholds are fixed internally at 16.3 V and 11.7 V. During startup, the hold-up capacitor must be charged to 16.3 V through the startup resistor to enable the SG6848X1. 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 11.7 V during this startup process. This UVLO hysteresis window ensures that hold-up capacitor is adequate to supply V_{DD} during startup.

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

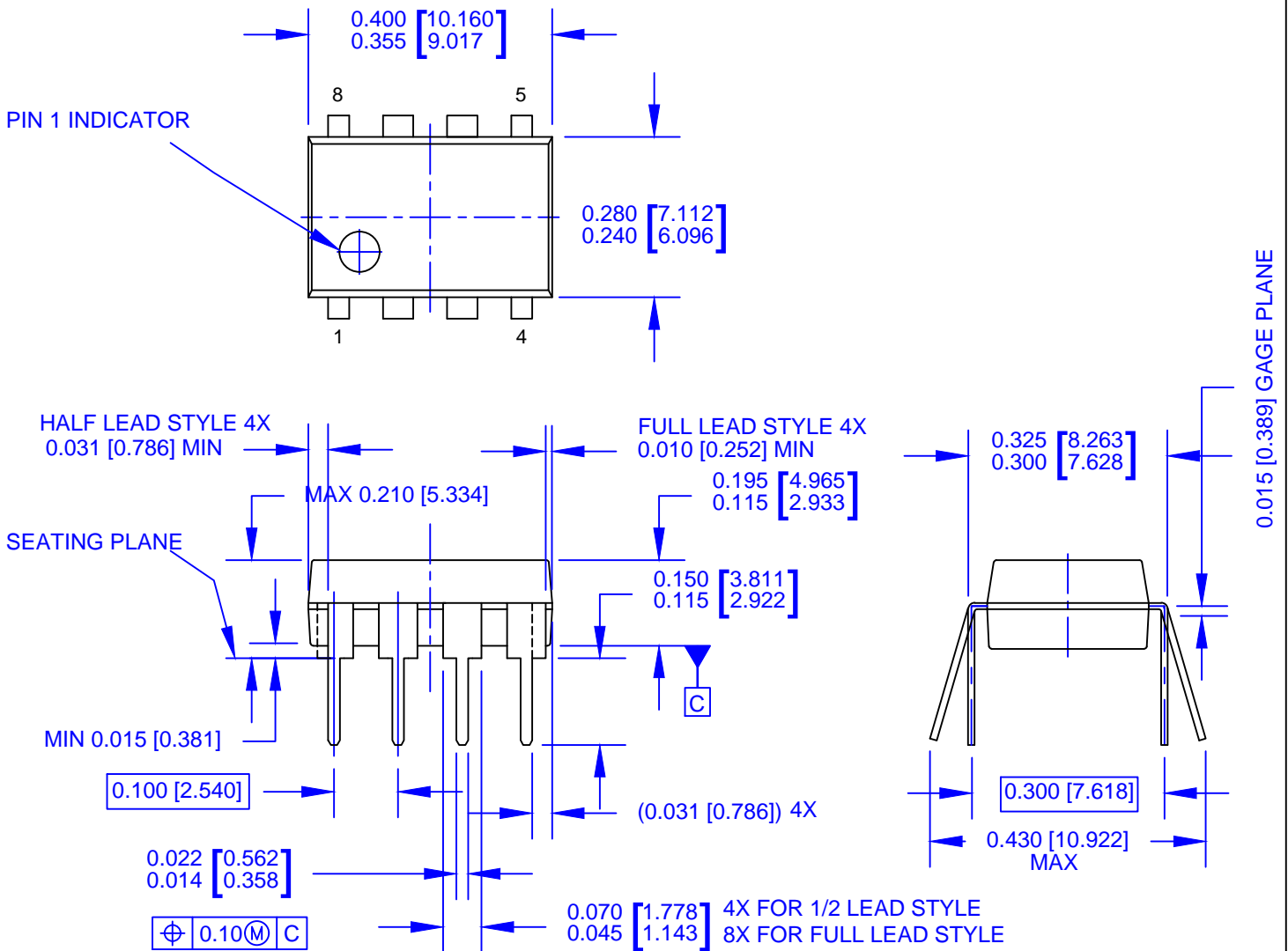
Built-In Slope Compensation

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. A synchronized, positively-sloped ramp in each switching cycle is calculated as:

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

Noise Immunity

Noise from the current sense or control signal can cause significant pulse-width jitter, particularly in continuous-conduction mode. Slope compensation helps, but 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 SG6848x1, and increasing the power MOS gate resistance are advised.



NOTES:

- A) THIS PACKAGE CONFORMS TO JEDEC MS-001 VARIATION BA WHICH DEFINES 2 VERSIONS OF THE PACKAGE TERMINAL STYLE WHICH ARE SHOWN HERE.
- B) CONTROLLING DIMS ARE IN INCHES
- C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- D) DIMENSIONS AND TOLERANCES PER ASME Y14.5M-2009
- E) DRAWING FILENAME AND REVISION: MKT-N08MREV2.



ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Email Requests to: orderlit@onsemi.com

ON Semiconductor Website: www.onsemi.com

TECHNICAL SUPPORT

North American Technical Support:
Voice Mail: 1 800-282-9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative