



**Is Now Part of**



**ON Semiconductor®**

**To learn more about ON Semiconductor, please visit our website at**  
**[www.onsemi.com](http://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](http://www.onsemi.com). Please email any questions regarding the system integration to [Fairchild\\_questions@onsemi.com](mailto: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](http://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.



January 2014

*Fairchild Power Supply WebDesigner — Flyback Design & Simulation - In Minutes at No Expense*

## FSEZ1307

# Primary-Side-Regulation PWM with Power MOSFET Integrated

### Features

- Low Standby Power: Under 30 mW
- High-Voltage Startup
- Few External Components
- Constant-Voltage (CV) and Constant-Current (CC) Control without Secondary-Feedback Circuitry
- Green Mode: Linearly Decreasing PWM Frequency
- Fixed PWM Frequency at 50 kHz with Frequency Hopping to Solve EMI Problem
- Cable Compensation in CV Mode
- Peak-Current-Mode Control in CV Mode
- Cycle-by-Cycle Current Limiting
- $V_{DD}$  Over-Voltage Protection with Auto Restart
- $V_{DD}$  Under-Voltage Lockout (UVLO)
- Gate Output Maximum Voltage Clamped at 15 V
- Fixed Over-Temperature Protection with Auto Restart
- Available in 7-Lead SOP Package

### Applications

- Battery chargers for cellular phones, cordless phones, PDA, digital cameras, power tools, etc.
- Replaces linear transformers and RCC SMPS

### Description

This third-generation Primary Side Regulation (PSR) PWM controller combination power MOSFET, FSEZ1307, provides several features to enhance the performance of low-power flyback converters. The proprietary topology, TRUECURRENT®, enables precise CC regulation and simplified circuit design for battery-charger applications. Compared to a conventional design or a linear transformer, a low-cost, smaller, and lighter charger results.

To minimize standby power consumption, the proprietary green mode provides off-time modulation to linearly decrease PWM frequency under light-load conditions. Green mode assists the power supply in meeting power conservation requirements.

By using the FSEZ1307, a charger can be implemented with few external components and minimized cost. A typical output CV/CC characteristic envelope is shown in Figure 1.

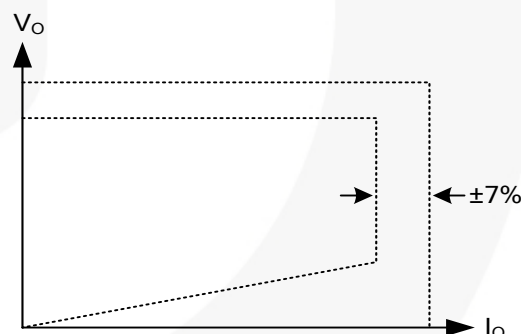


Figure 1. Typical Output V-I Characteristic

### Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
FSEZ1307MY	-40°C to +105°C	7-Lead, Small Outline Package (SOP-7)	Tape & Reel

 For Fairchild's definition of Eco Status, please visit: [http://www.fairchildsemi.com/company/green/rohs\\_green.html](http://www.fairchildsemi.com/company/green/rohs_green.html).

## Application Diagram

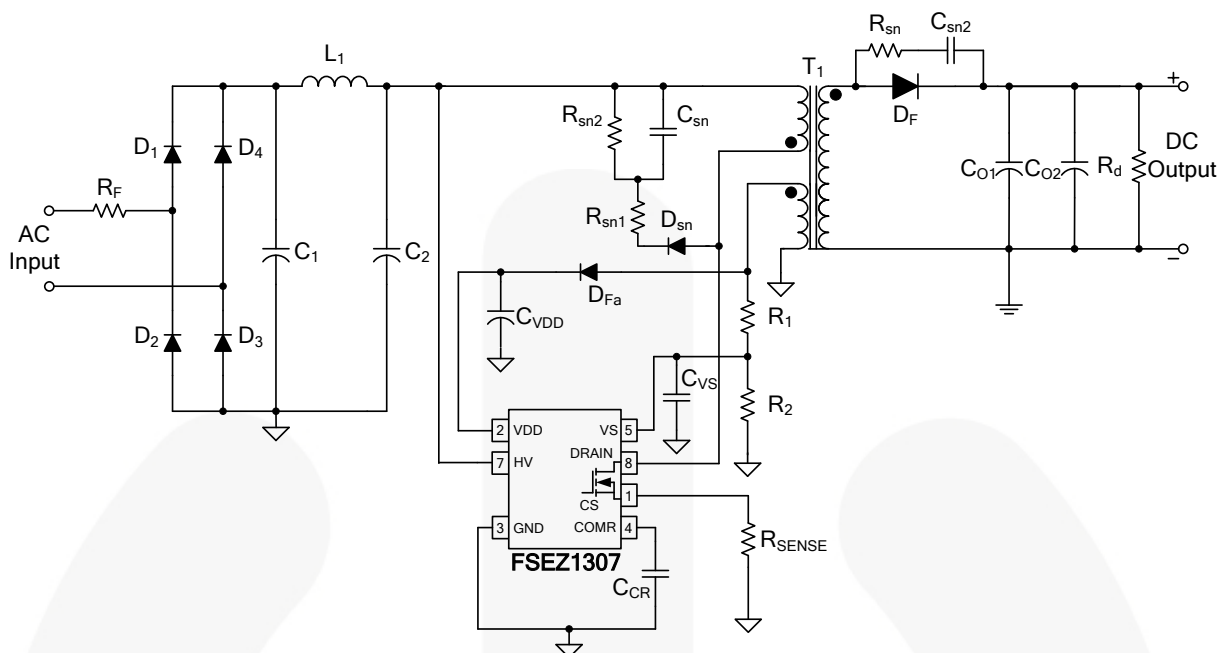


Figure 2. Typical Application

## Internal Block Diagram

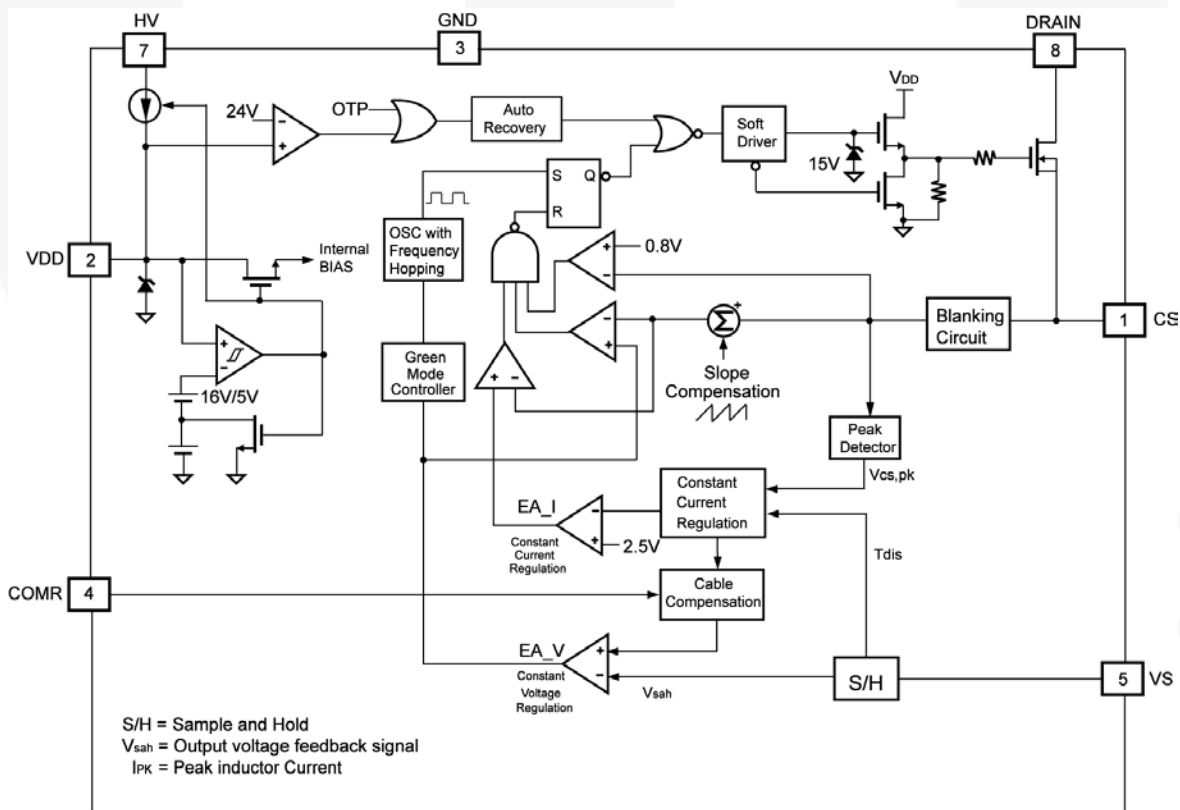
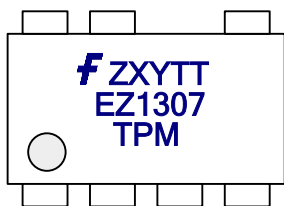


Figure 3. Functional Block Diagram

## Marking Information



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 (M=SOP)  
 P: Y=Green Package  
 M: Manufacture Flow Code

Figure 4. Top Mark

## Pin Configuration

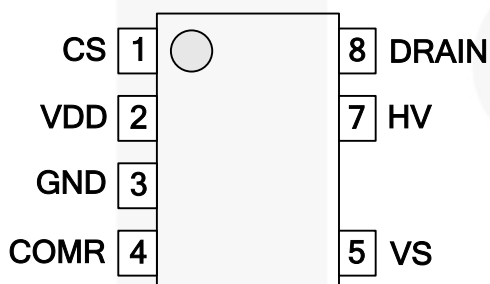


Figure 5. Pin Configuration

## Pin Definitions

Pin #	Name	Description
1	CS	<b>Current Sense.</b> This pin connects a current-sense resistor to detect the MOSFET current for peak-current-mode control in CV mode and provides the output-current regulation in CC mode.
2	VDD	<b>Power Supply.</b> IC operating current and MOSFET driving current are supplied using this pin. This pin is connected to an external $V_{DD}$ capacitor of typically 10 $\mu\text{F}$ . The threshold voltages for startup and turn-off are 16 V and 5 V, respectively. The operating current is lower than 5 mA.
3	GND	<b>Ground</b>
4	COMR	<b>Cable Compensation.</b> This pin connects a 1 $\mu\text{F}$ capacitor between the COMR and GND pins for compensation voltage drop due to output cable loss in CV mode.
5	VS	<b>Voltage Sense.</b> This pin detects the output voltage information and discharge time based on voltage of auxiliary winding.
7	HV	<b>High Voltage.</b> This pin connects to a bulk capacitor for high-voltage startup.
8	DRAIN	<b>Driver Output.</b> Power MOSFET drain. This pin is the high-voltage power MOSFET drain.

## 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.	Units
$V_{HV}$	HV Pin Input Voltage			500	V
$V_{VDD}$	DC Supply Voltage <sup>(1,2)</sup>			30	V
$V_{VS}$	VS Pin Input Voltage		-0.3	7.0	V
$V_{CS}$	CS Pin Input Voltage		-0.3	7.0	V
$V_{COMV}$	Voltage Error Amplifier Output Voltage		-0.3	7.0	V
$V_{COMI}$	Current Error Amplifier Output Voltage		-0.3	7.0	V
$V_{DS}$	Drain-Source Voltage			700	V
$I_D$	Continuous Drain Current	$T_A=25^\circ\text{C}$		0.5	A
		$T_A=100^\circ\text{C}$		0.35	A
$I_{DM}$	Pulsed Drain Current			3.5	A
$E_{AS}$	Single Pulse Avalanche Energy			35	mJ
$I_{AR}$	Avalanche Current			1	A
$P_D$	Power Dissipation ( $T_A < 50^\circ\text{C}$ )			660	mW
$\theta_{JA}$	Thermal Resistance (Junction to Air)			150	$^\circ\text{C/W}$
$\theta_{JC}$	Thermal Resistance (Junction to Case)			39	$^\circ\text{C/W}$
$T_J$	Operating Junction Temperature		-40	+150	$^\circ\text{C}$
$T_{STG}$	Storage Temperature Range		-55	+150	$^\circ\text{C}$
$T_L$	Lead Temperature (Wave Soldering or IR, 10 Seconds)			+260	$^\circ\text{C}$
ESD	Electrostatic Discharge Capability	Human Body Model (Except HV Pin), JEDEC-JESD22_A114		2500	V
		Charged Device Model (Except HV Pin), JEDEC-JESD22_C101		1250	

### Notes:

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device.
2. All voltage values, except differential voltages, are given with respect to the GND pin.

## 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.	Units
$T_A$	Operating Ambient Temperature	-40	+105	$^\circ\text{C}$

## Electrical Characteristics

Unless otherwise specified,  $V_{DD}=15\text{ V}$  and  $T_A=25^\circ\text{C}$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
<b>V<sub>DD</sub> Section</b>						
$V_{OP}$	Continuously Operating Voltage				23	V
$V_{DD-ON}$	Turn-On Threshold Voltage		15	16	17	V
$V_{DD-OFF}$	Turn-Off Threshold Voltage		4.5	5.0	5.5	V
$I_{DD-OP}$	Operating Current			2.5	5.0	mA
$I_{DD-GREEN}$	Green-Mode Operating Supply Current			0.95	1.20	mA
$V_{DD-OVP}$	$V_{DD}$ Over-Voltage-Protection Level (OVP)			24		V
$V_{DD-OVP-HYS}$	Hysteresis Voltage for $V_{DD}$ OVP		1.5	2.0	2.5	V
$t_{D-VDDOVP}$	$V_{DD}$ Over-Voltage-Protection Debounce Time		50	200	300	$\mu\text{s}$
<b>HV Startup Current Source Section</b>						
$V_{HV-MIN}$	Minimum Startup Voltage on HV Pin				50	V
$I_{HV}$	Supply Current Drawn from HV Pin	$V_{DC}=100\text{ V}$		1.5	3.0	mA
$I_{HV-LC}$	Leakage Current after Startup	HV=500 V, $V_{DD}=V_{DD-OFF}+1\text{ V}$		0.96	3.00	$\mu\text{A}$
<b>Oscillator Section</b>						
$f_{OSC}$	Frequency	Center Frequency	47	50	53	kHz
		Frequency Hopping Range	$\pm 1.5$	$\pm 2.0$	$\pm 2.5$	
$f_{OSC-N-MIN}$	Minimum Frequency at No-Load			370		Hz
$f_{OSC-CM-MIN}$	Minimum Frequency at CCM			13		kHz
$f_{DV}$	Frequency Variation vs. $V_{DD}$ Deviation	$V_{DD}=10\sim 25\text{ V}$ ,		1	2	%
$f_{DT}$	Frequency Variation vs. Temperature Deviation	$T_A=-40^\circ\text{C}$ to $105^\circ\text{C}$			15	%
<b>Voltage-Sense Section</b>						
$I_{IC}$	IC Bias Current			10		$\mu\text{A}$
$V_{BIAS-COMV}$	Adaptive Bias Voltage Dominated by $V_{COMV}$	$R_{VS}=20\text{ k}\Omega$		1.4		V
<b>Current-Sense Section</b>						
$t_{PD}$	Propagation Delay to GATE Output			90	200	ns
$t_{MIN-N}$	Minimum On Time at No-Load		700	850	1050	ns
$V_{TH}$	Threshold Voltage for Current Limit			0.8		V
<b>Voltage-Error-Amplifier Section</b>						
$V_{VR}$	Reference Voltage		2.475	2.500	2.525	V
$V_N$	Green-Mode Starting Voltage on EA_V	$f_{OSC}=2\text{ kHz}$		2.5		V
$V_G$	Green-Mode Ending Voltage on EA_V	$f_{OSC}=1\text{ kHz}$		0.4		V
<b>Current-Error-Amplifier Section</b>						
$V_{IR}$	Reference Voltage		2.475	2.500	2.525	V
<b>Cable Compensation Section</b>						
$V_{COMR}$	COMR Pin for Cable Compensation			0.75		V

Continued on the following page...

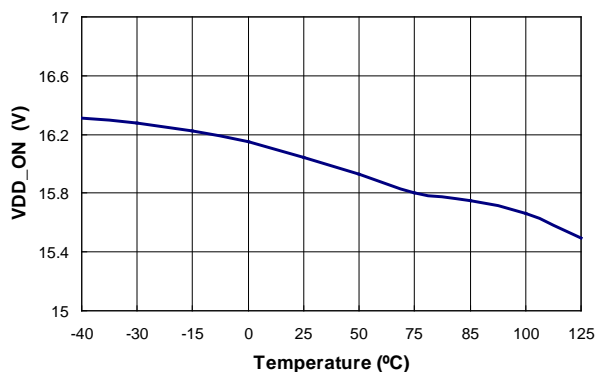
**Electrical Characteristics** (Continued)Unless otherwise specified,  $V_{DD}=15\text{ V}$  and  $T_A=25^\circ\text{C}$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
<b>Internal MOSFET Section<sup>(3)</sup></b>						
$DCY_{MAX}$	Maximum Duty Cycle		70	75	80	%
$BV_{DSS}$	Drain-Source Breakdown Voltage	$I_D=250\text{ }\mu\text{A}$ , $V_{GS}=0\text{ V}$	700			V
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D=250\text{ }\mu\text{A}$ , Referenced to $T_A=25^\circ\text{C}$		0.53		V/°C
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$I_D=0.5\text{ A}$ , $V_{GS}=10\text{ V}$		17	20	$\Omega$
$I_S$	Maximum Continuous Drain-Source Diode Forward Current				0.5	A
$I_{DSS}$	Drain-Source Leakage Current	$V_{DS}=700\text{ V}$ , $T_A=25^\circ\text{C}$			10	$\mu\text{A}$
		$V_{DS}=560\text{ V}$ , $T_A=100^\circ\text{C}$			100	$\mu\text{A}$
$t_{D-ON}$	Turn-On Delay Time	$V_{DS}=350\text{ V}$ , $I_D=1\text{ A}$ , $R_G=25\Omega^{(4)}$		10	30	ns
$t_{D-OFF}$	Turn-Off Delay Time			20	50	ns
$C_{ISS}$	Input Capacitance	$V_{GS}=0\text{ V}$ , $V_{DS}=25\text{ V}$ , $f_S=1\text{ MHz}$		125	150	pF
$C_{OSS}$	Output Capacitance			15	18	pF
<b>Over-Temperature-Protection Section</b>						
$T_{OTP}$	Threshold Temperature for OTP <sup>(5)</sup>			140		°C

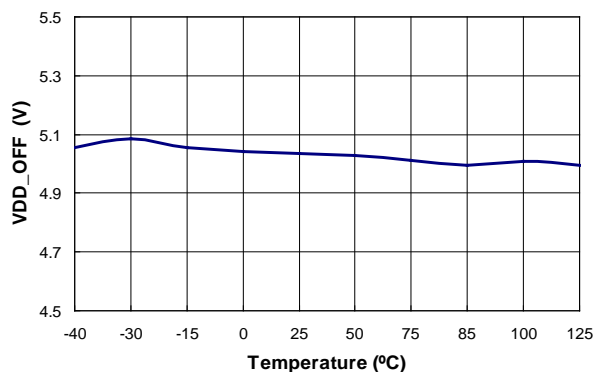
**Notes:**

3. These parameters, although guaranteed, are not 100% tested in production.
4. Pulse test: pulsewidth  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .
5. When the Over-temperature protection is activated, the power system enter latch mode and output is disabled.

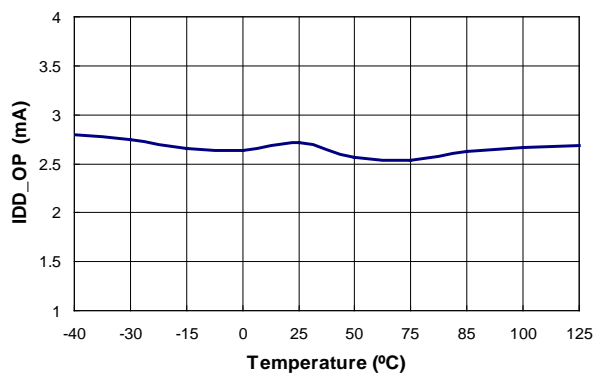
## Typical Performance Characteristics



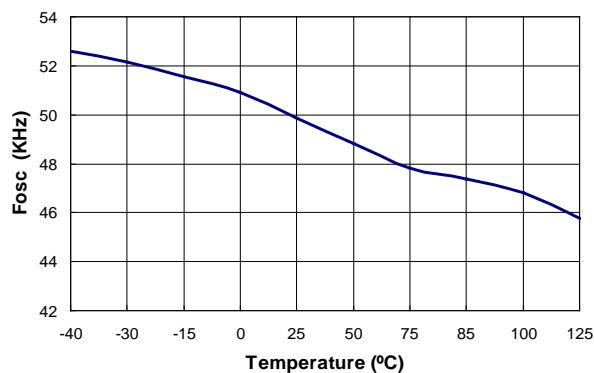
**Figure 6. Turn-On Threshold Voltage ( $V_{DD-ON}$ ) vs. Temperature**



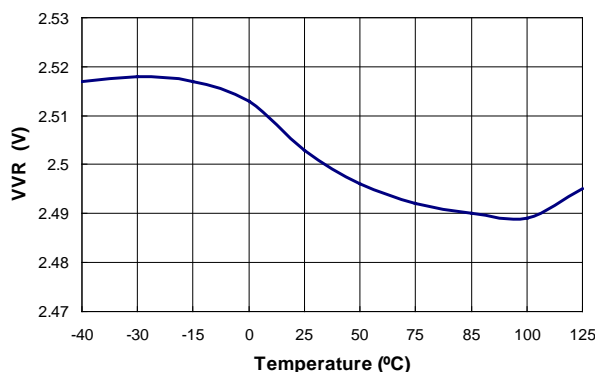
**Figure 7. Turn-Off Threshold Voltage ( $V_{DD-OFF}$ ) vs. Temperature**



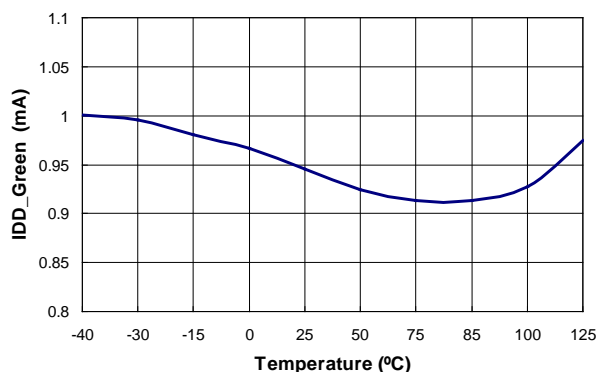
**Figure 8. Operating Current ( $I_{DD-OP}$ ) vs. Temperature**



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



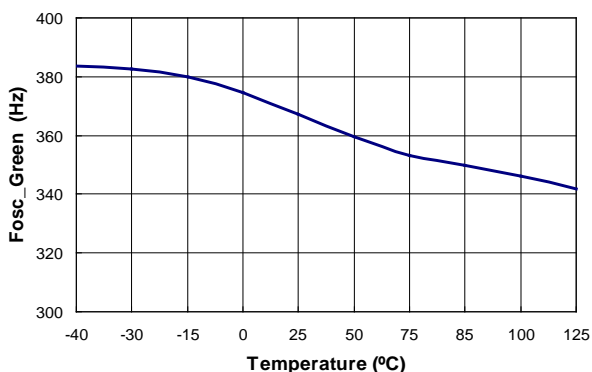
**Figure 10. Reference Voltage ( $V_{VR}$ ) vs. Temperature**



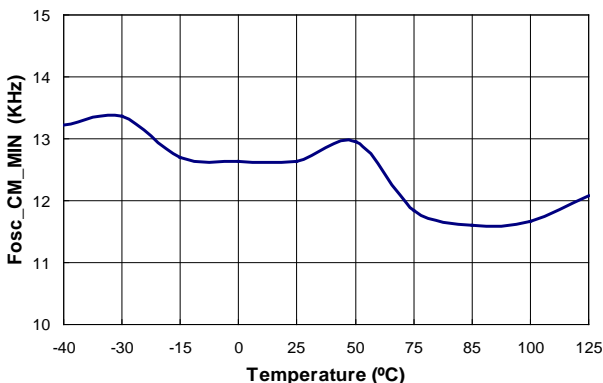
**Figure 11. Green-Mode Operating Supply Current ( $I_{DD-GREEN}$ ) vs. Temperature**



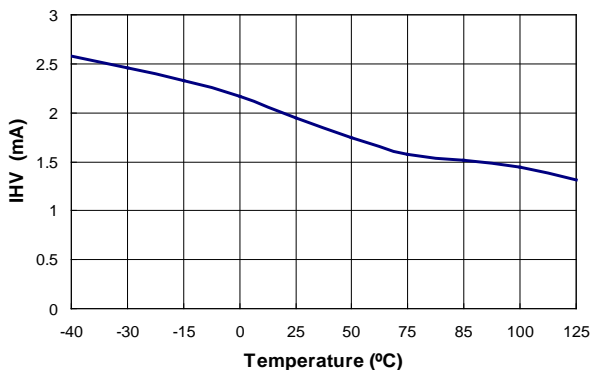
## Typical Performance Characteristics



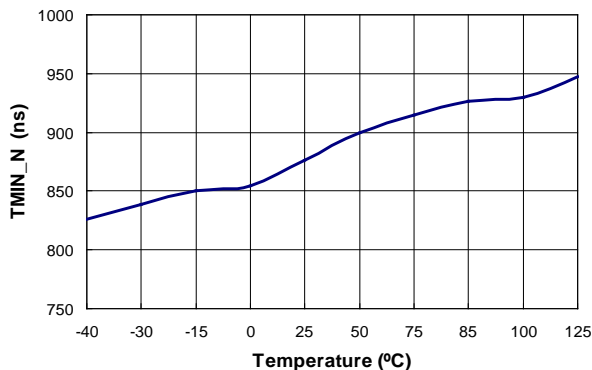
**Figure 12. Minimum Frequency at No Load ( $f_{OSC-N-MIN}$ ) vs. Temperature**



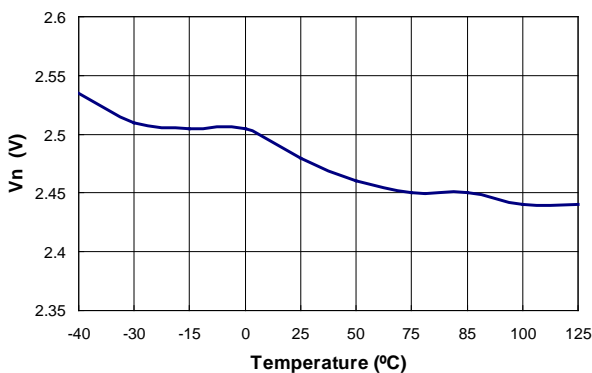
**Figure 13. Minimum Frequency at CCM ( $f_{OSC-CM-MIN}$ ) vs. Temperature**



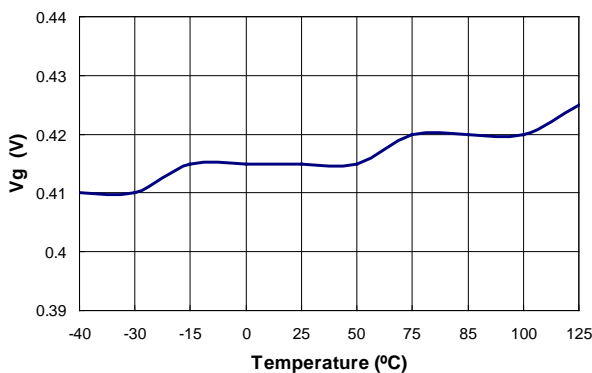
**Figure 14. Supply Current Drawn from HV Pin ( $I_{HV}$ ) vs. Temperature**



**Figure 15. Minimum On Time at No Load ( $t_{MIN-N}$ ) vs. Temperature**



**Figure 16. Green-Mode Starting Voltage on EA\_V ( $V_N$ ) vs. Temperature**



**Figure 17. Green-Mode Ending Voltage on EA\_V ( $V_G$ ) vs. Temperature**

## Typical Performance Characteristics

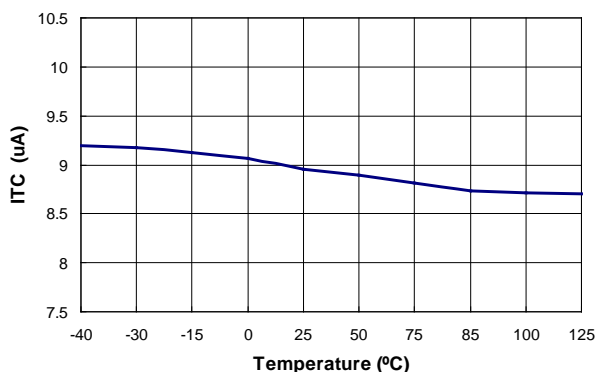


Figure 18. IC Bias Current ( $I_{tc}$ ) vs. Temperature

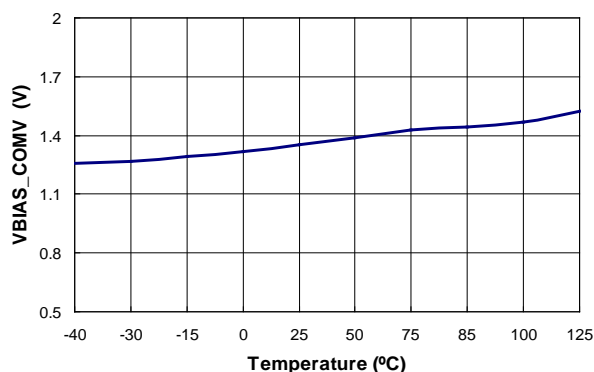


Figure 19. Adaptive Bias Voltage Dominated by  $V_{COMV}$  ( $V_{BIAS-COMV}$ ) vs. Temperature

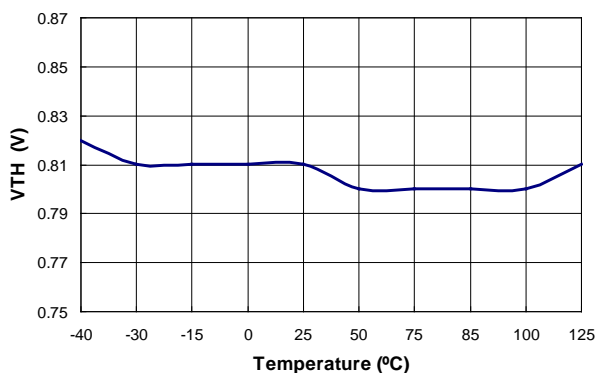


Figure 20. Threshold Voltage for Current Limit ( $V_{TH}$ ) vs. Temperature

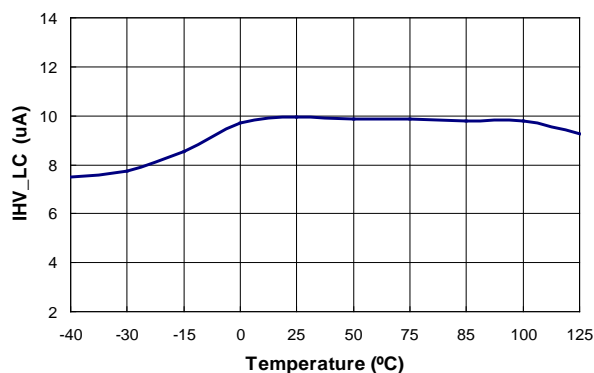


Figure 21. Leakage Current after Startup ( $I_{HV-LC}$ ) vs. Temperature

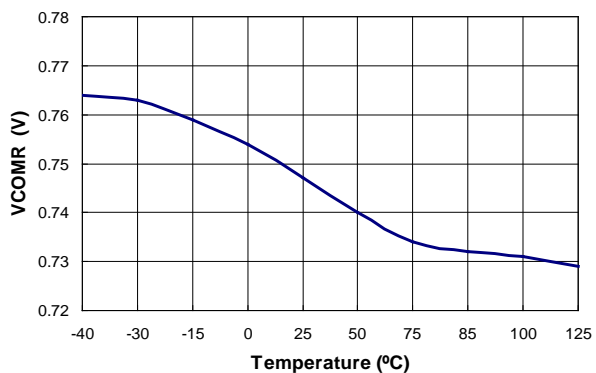


Figure 22. Variation Test Voltage on COMR Pin for Cable Compensation ( $V_{COMR}$ ) vs. Temperature

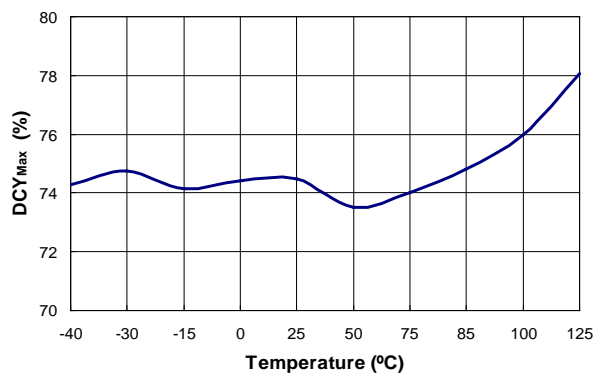


Figure 23. Maximum Duty Cycle ( $DCY_{MAX}$ ) vs. Temperature

## Functional Description

Figure 24 shows the basic circuit diagram of primary-side regulated flyback converter, with typical waveforms shown in Figure 25. Generally, discontinuous conduction mode (DCM) operation is preferred for primary-side regulation because it allows better output regulation. The operation principles of DCM flyback converter are as follows:

During the MOSFET on time ( $t_{ON}$ ), input voltage ( $V_{DL}$ ) is applied across the primary-side inductor ( $L_m$ ). Then MOSFET current ( $I_{ds}$ ) increases linearly from zero to the peak value ( $I_{pk}$ ). During this time, the energy is drawn from the input and stored in the inductor.

When the MOSFET is turned off, the energy stored in the inductor forces the rectifier diode (D) to be turned on. While the diode is conducting, the output voltage ( $V_o$ ), together with diode forward-voltage drop ( $V_F$ ), is applied across the secondary-side inductor ( $L_m \times N_s^2 / N_p^2$ ) and the diode current ( $I_D$ ) decreases linearly from the peak value ( $I_{pk} \times N_p / N_s$ ) to zero. At the end of inductor current discharge time ( $t_{DIS}$ ), all the energy stored in the inductor has been delivered to the output.

When the diode current reaches zero, the transformer auxiliary winding voltage ( $V_w$ ) begins to oscillate by the resonance between the primary-side inductor ( $L_m$ ) and the effective capacitor loaded across the MOSFET.

During the inductor current discharge time, the sum of output voltage and diode forward-voltage drop is reflected to the auxiliary winding side as  $(V_o + V_F) \times N_A / N_s$ . Since the diode forward-voltage drop decreases as current decreases, the auxiliary winding voltage reflects the output voltage best at the end of diode conduction time where the diode current diminishes to zero. Thus, by sampling the winding voltage at the end of the diode conduction time, the output voltage information can be obtained. The internal error amplifier for output voltage regulation (EA\_V) compares the sampled voltage with internal precise reference to generate error voltage ( $V_{COMV}$ ), which determines the duty cycle of the MOSFET in CV mode.

Meanwhile, the output current can be estimated using the peak drain current and inductor current discharge time because output current is same as the average of the diode current in steady state.

The output current estimator picks up the peak value of the drain current with a peak detection circuit and calculates the output current using the inductor discharge time ( $t_{DIS}$ ) and switching period ( $t_s$ ). This output information is compared with internal precise reference to generate the error voltage ( $V_{COMI}$ ), which determines the duty cycle of the MOSFET in CC mode. With Fairchild's innovative TRUECURRENT™ technique, constant current (CC) output can be precisely controlled.

Among the two error voltages,  $V_{COMV}$  and  $V_{COMI}$ , the smaller one determines the duty cycle. Therefore, during

constant voltage regulation mode,  $V_{COMV}$  determines the duty cycle while  $V_{COMI}$  is saturated to HIGH. During constant current regulation mode,  $V_{COMI}$  determines the duty cycle while  $V_{COMV}$  is saturated to HIGH.

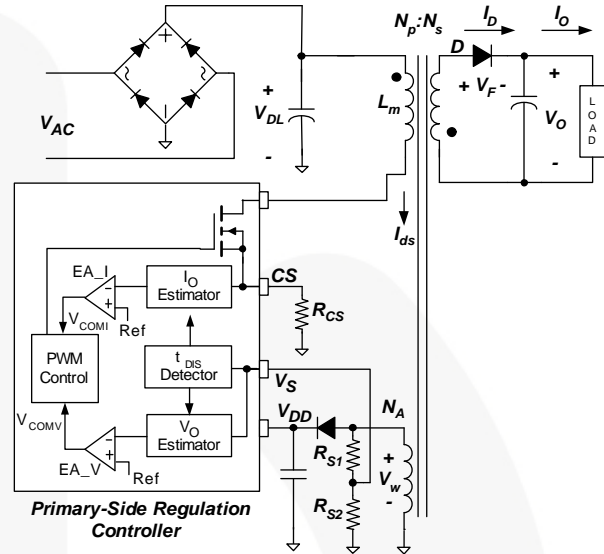


Figure 24. Simplified PSR Flyback Converter Circuit

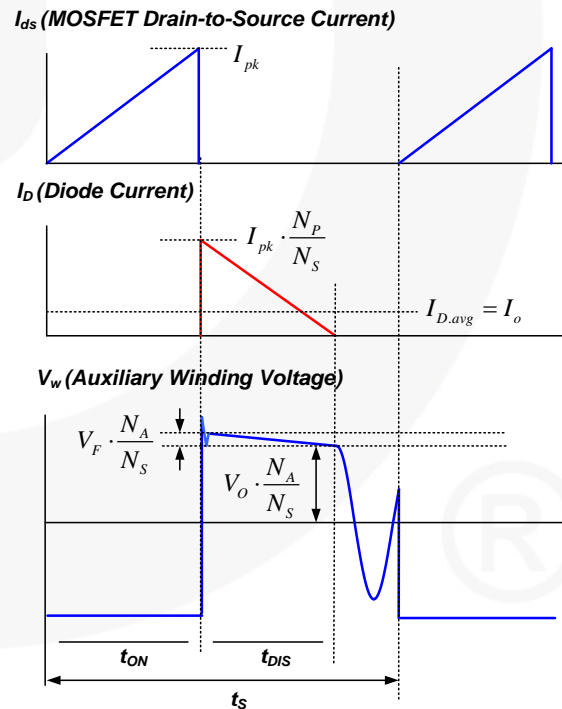


Figure 25. Key Waveforms of DCM Flyback Converter

## Cable Voltage Drop Compensation

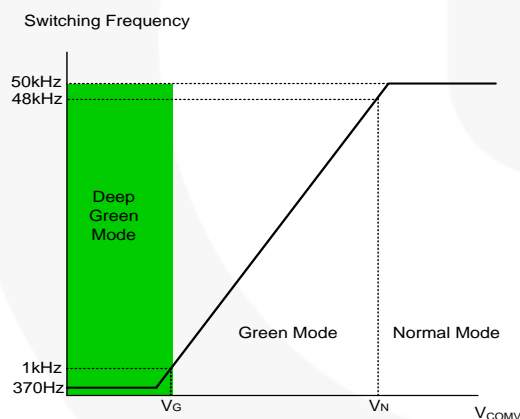
In cellular phone charger applications, the battery is located at the end of cable, which typically causes several percentage points of voltage drop on the battery voltage. FSEZ1307 has a built-in cable voltage drop compensation that provides a constant output voltage at the end of the cable over the entire load range in CV mode. As load increases, the voltage drop across the cable is compensated by increasing the reference voltage of the voltage regulation error amplifier.

### Operating Current

The FSEZ1307 operating current is as small as 2.5 mA, which results in higher efficiency and reduces the  $V_{DD}$  hold-up capacitance requirement. Once FSEZ1307 enters “deep” green mode, the operating current is reduced to 0.95 mA, assisting the power supply in meeting power conservation requirements.

## Green-Mode Operation

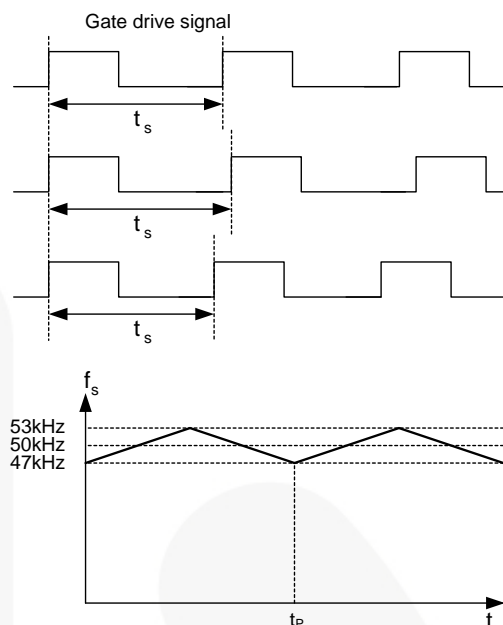
The FSEZ1307 uses voltage regulation error amplifier output ( $V_{\text{COMV}}$ ) as an indicator of the output load and modulates the PWM frequency, as shown in Figure 26. The switching frequency decreases as the load decreases. In heavy load conditions, the switching frequency is fixed at 50 kHz. Once  $V_{\text{COMV}}$  decreases below 2.5 V, the PWM frequency linearly decreases from 50 kHz. When FSEZ1307 enters deep green mode, the PWM frequency is reduced to a minimum frequency of 370 Hz, gaining power saving to meet international power conservation requirements.



### Figure 26. Switching Frequency in Green Mode

## Frequency Hopping

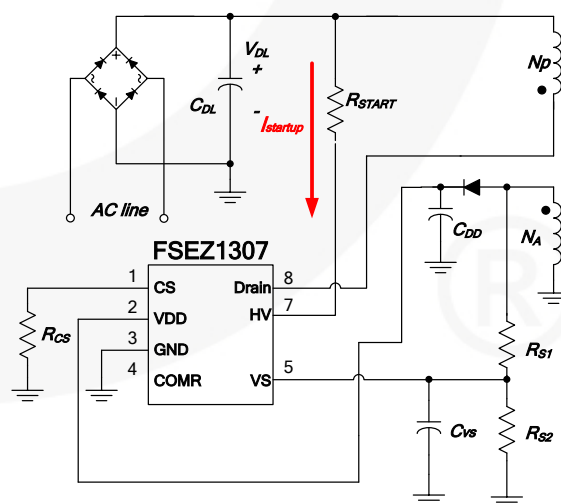
EMI reduction is accomplished by frequency hopping, which spreads the energy over a wider frequency range than the bandwidth measured by the EMI test equipment. FSEZ1307 has an internal frequency hopping circuit that changes the switching frequency between 47 kHz and 53 kHz over the period shown in Figure 27.



### Figure 27. Frequency Hopping

## High-Voltage Startup

Figure 28 shows the HV-startup circuit for FSEZ1307 applications. The HV pin is connected to the line input or bulk capacitor through a resistor,  $R_{START}$  (100 k $\Omega$  recommended). During startup, the internal startup circuit is enabled. Meanwhile, line input supplies the current,  $I_{STARTUP}$ , to charge the hold-up capacitor,  $C_{DD}$ , through  $R_{START}$ . When the  $V_{DD}$  voltage reaches  $V_{DD-ON}$ , the internal startup circuit is disabled, blocking  $I_{STARTUP}$  from flowing into the HV pin. Once the IC turns on,  $C_{DD}$  is the only energy source to supply the IC consumption current before the PWM starts to switch. Therefore,  $C_{DD}$  must be large enough to prevent  $V_{DD}$  from dropping down to  $V_{DD-OFF}$  before the power can be delivered from the auxiliary winding.



**Figure 28. HV Startup Circuit**

## Under-Voltage Lockout (UVLO)

The turn-on and turn-off thresholds are fixed internally at 16 V and 5 V, respectively. During startup, the hold-up capacitor must be charged to 16 V through the startup resistor to enable the FSEZ1307. The hold-up capacitor continues to supply  $V_{DD}$  until power can be delivered from the auxiliary winding of the main transformer.  $V_{DD}$  is not allowed to drop below 5 V during this startup process. This UVLO hysteresis window ensures that hold-up capacitor properly supplies  $V_{DD}$  during startup.

## Protections

The FSEZ1307 has several self-protection functions, such as Over-Voltage Protection (OVP), Over-Temperature Protection (OTP), and pulse-by-pulse current limit. All the protections are implemented as auto-restart mode. Once the abnormal condition occurs, the switching is terminated and the MOSFET remains off, causing  $V_{DD}$  to drop. When  $V_{DD}$  drops to the  $V_{DD}$  turn-off voltage of 5 V, the internal startup circuit is enabled again and the supply current drawn from the HV pin charges the hold-up capacitor. When  $V_{DD}$  reaches the turn-on voltage of 16 V, normal operation resumes. In this manner, the auto-restart alternately enables and disables the switching of the MOSFET until the abnormal condition is eliminated (see Figure 29).

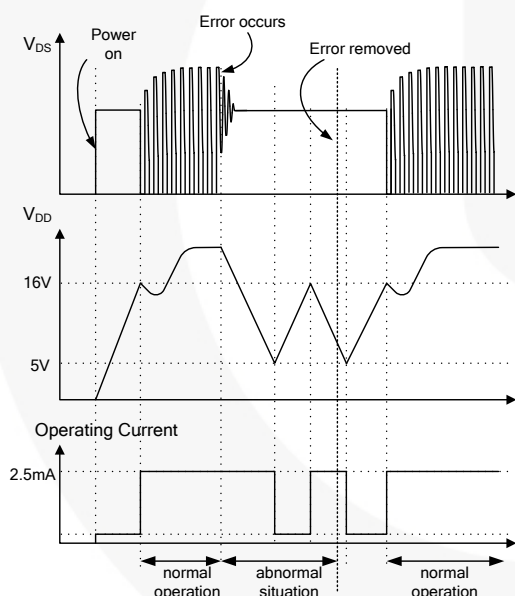


Figure 29. Auto-Restart Operation

## $V_{DD}$ Over-Voltage Protection (OVP)

$V_{DD}$  over-voltage protection prevents damage from over-voltage conditions. If the  $V_{DD}$  voltage exceeds 24 V at open-loop feedback condition, OVP is triggered and the PWM switching is disabled. The OVP has a debounce time (typically 200  $\mu$ s) to prevent false triggering due to switching noises.

## Over-Temperature Protection (OTP)

The built-in temperature-sensing circuit shuts down PWM output if the junction temperature exceeds 140°C.

## Pulse-by-Pulse Current Limit

When the sensing voltage across the current-sense resistor exceeds the internal threshold of 0.8 V, the MOSFET is turned off for the remainder of switching cycle. In normal operation, the pulse-by-pulse current limit is not triggered since the peak current is limited by the control loop.

## Leading-Edge Blanking (LEB)

Each time the power MOSFET switches on, a turn-on spike occurs at the sense resistor. To avoid premature termination of the switching pulse, a leading-edge blanking time is built in. During this blanking period, the current-limit comparator is disabled and cannot switch off the gate driver. As a result, conventional RC filtering can be omitted.

## Gate Output

The FSEZ1307 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 the 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 FSEZ1307 has a synchronized, positive-slope ramp built-in at each switching cycle.

## 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 these problems, further precautions should still be taken. Good placement and layout practices should be followed. Avoiding long PCB traces and component leads, locating compensation and filter components near the FSEZ1307, and increasing the power MOS gate resistance are advised.

## Typical Application Circuit (Primary-Side Regulated Flyback Charger)

Application	Fairchild Device	Input Voltage Range	Output	Output DC cable
Cell Phone Charger	FSEZ1307	90~265 V <sub>AC</sub>	5 V/0.7 A (3.5 W)	AWG26, 1.8 Meter

### Features

- High efficiency (>65.5% at full load) meeting EPS 2.0 regulation with enough margin
- Low standby (Pin<30 mW at no-load condition)

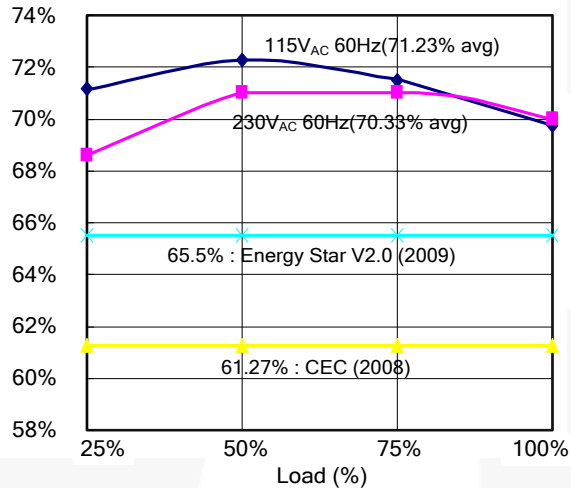


Figure 30. Measured Efficiency

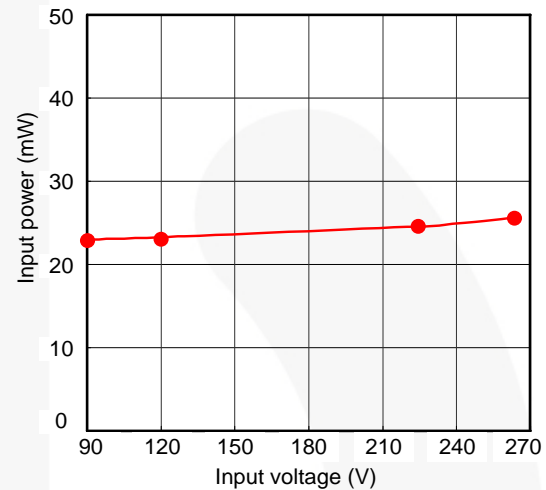


Figure 31. Standby Power

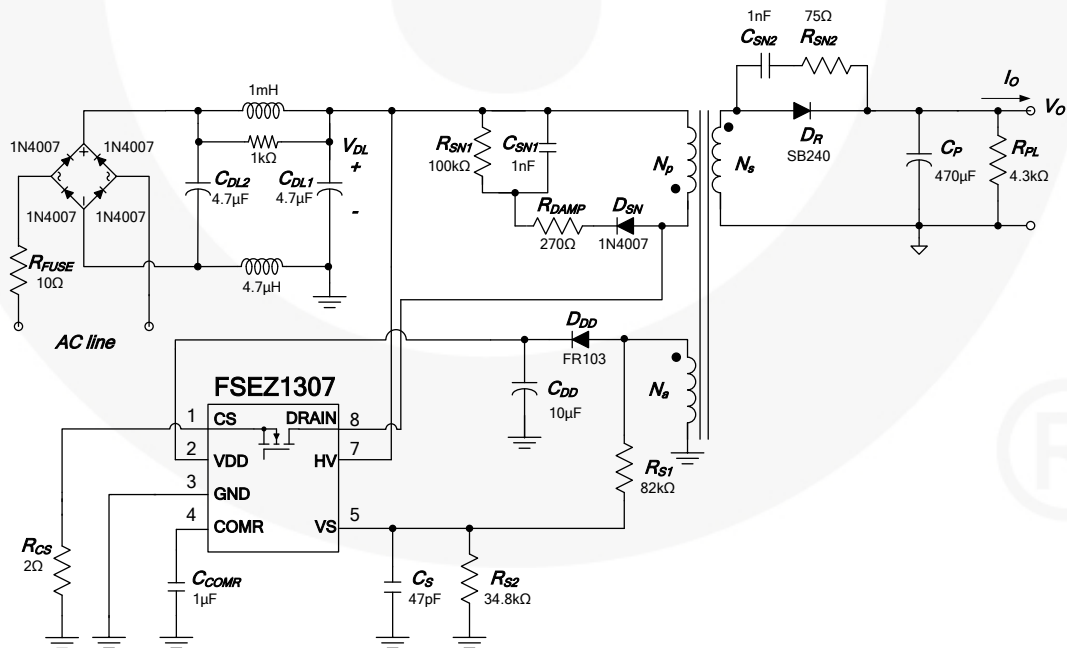
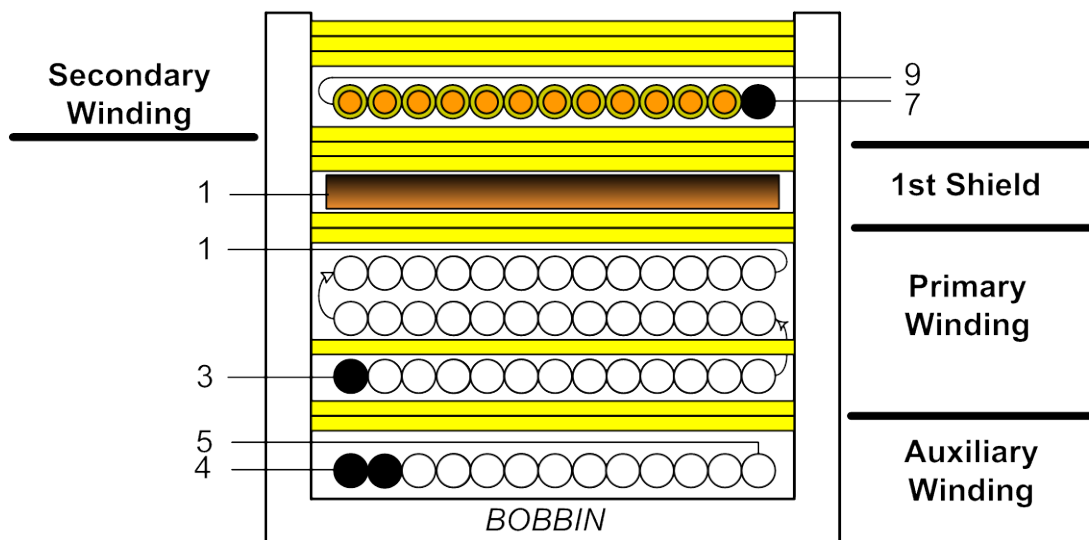


Figure 32. Schematic of Typical Application Circuit

**Typical Application Circuit** (Continued)**Transformer Specification**

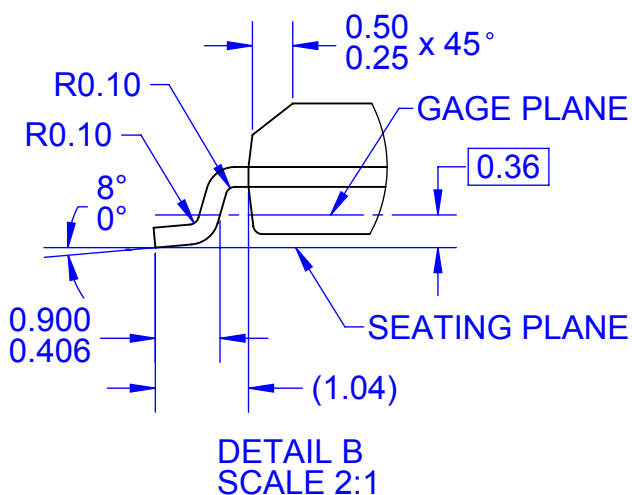
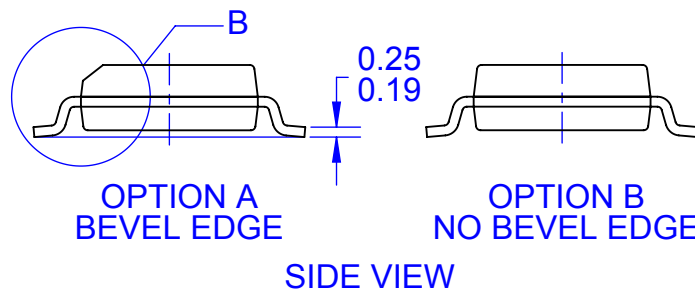
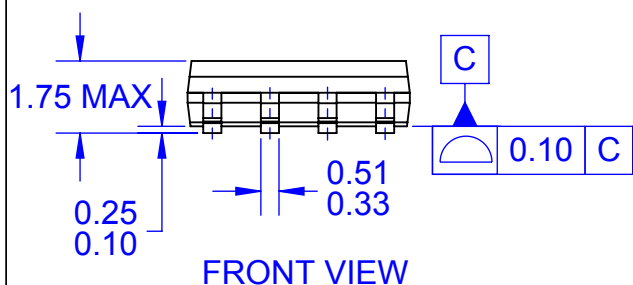
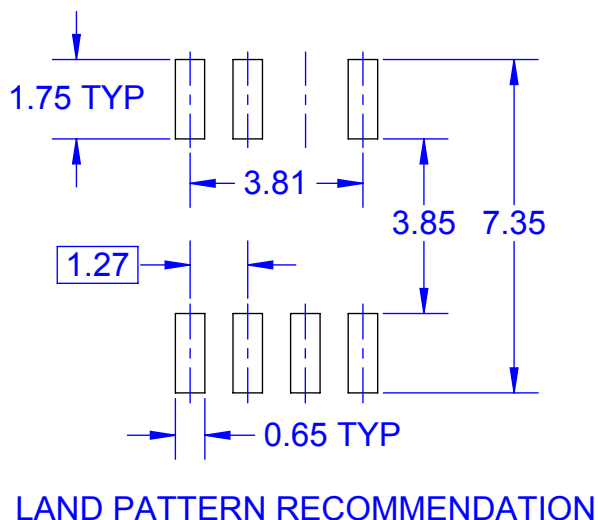
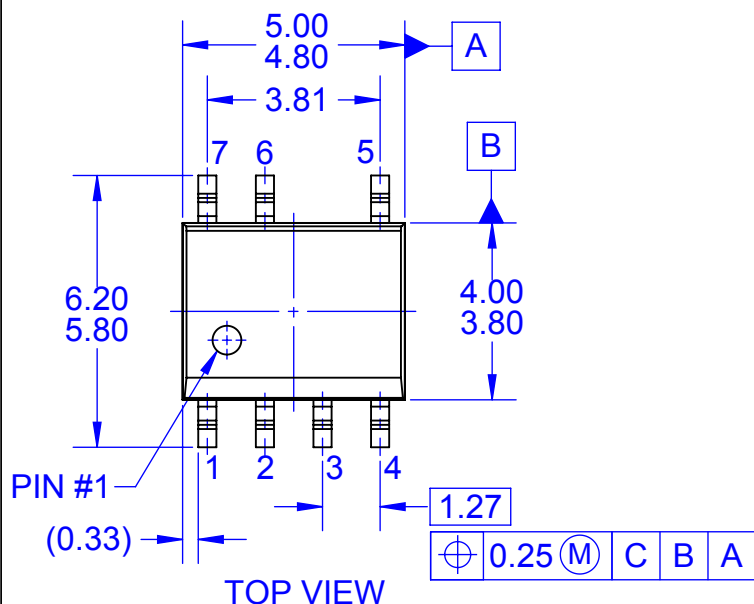
- Core: EE16
- Bobbin: EE16

**Note**

6. 1
7. When W2 is winding, it must wind three layers and put one layer of tape after winding the first layer.

NO	TERMINAL		WIRE	$t_s$	INSULATION	BARRIER TAPE	
	S	F			$t_s$	Primary	Seconds
W1	4	5	2UEW 0.23*2	15	2		
W2	3	1	2UEW 0.17*1	41	1		
				39	0		
				37	2		
W3	1		COPPER SHIELD	1.2	3		
W4	7	9	TEX-E 0.55*1	9	3		
			CORE ROUNDING TAPE		3		

	Pin	Specification	Remark
Primary-Side Inductance	1 – 3	2.25 mH $\pm$ 7%	100 kHz, 1 V
Primary-Side Effective Leakage	1 – 3	80 $\mu$ H $\pm$ 5%	Short One of the Secondary Windings



#### NOTES:

- THIS PACKAGE DOES NOT FULLY CONFORM TO JEDEC MS-012, VARIATION AA
- ALL DIMENSIONS ARE IN MILLIMETERS
- DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS
- DRAWING FILENAME: MKT-M07Brev4





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](http://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:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada

**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910

**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)

**Order Literature:** <http://www.onsemi.com/orderlit>

For additional information, please contact your local  
Sales Representative