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## FSL136MR Green Mode Fairchild Power Switch (FPS™)

### Features

- Internal Avalanche-Rugged SenseFET (650V)
- Under 50mW Standby Power Consumption at 265V<sub>AC</sub>, No-load Condition with Burst Mode
- Precision Fixed Operating Frequency with Frequency Modulation for Attenuating EMI
- Internal Startup Circuit
- Built-in Soft-Start: 15ms
- Pulse-by-Pulse Current Limiting
- Various Protections: Over-Voltage Protection (OVP), Overload Protection (OLP), Output-Short Protection (OSP), Abnormal Over-Current Protection (AOCP), Internal Thermal Shutdown Function with Hysteresis (TSD)
- Auto-Restart Mode
- Under-Voltage Lockout (UVLO)
- Low Operating Current: 1.8mA
- Adjustable Peak Current Limit

### Applications

- SMPS for VCR, STB, DVD, & DVCD Players
- SMPS for Home Appliance
- Adapter

### Related Resources

- [AN-4137 — Design Guidelines for Off-line Flyback Converters using FPS™](#)
- [AN-4141 — Troubleshooting and Design Tips for Fairchild Power Switch \(FPS™\) Flyback Applications](#)
- [AN-4147 — Design Guidelines for RCD Snubber of Flyback](#)

### Description

The FSL136MR integrated Pulse Width Modulator (PWM) and SenseFET is specifically designed for high-performance offline Switch-Mode Power Supplies (SMPS) with minimal external components. FSL136MR includes integrated high-voltage power switching regulators that combine an avalanche-rugged SenseFET with a current-mode PWM control block.

The integrated PWM controller includes: Under-Voltage Lockout (UVLO) protection, Leading-Edge Blanking (LEB), a frequency generator for EMI attenuation, an optimized gate turn-on/turn-off driver, Thermal Shutdown (TSD) protection, and temperature-compensated precision current sources for loop compensation and fault protection circuitry. The FSL136MR offers good soft-start performance. When compared to a discrete MOSFET and controller or RCC switching converter solution, the FSL136MR reduces total component count, design size, and weight; while increasing efficiency, productivity, and system reliability. This device provides a basic platform that is well suited for the design of cost-effective flyback converters.

Maximum Output Power <sup>(1)</sup>			
230V <sub>AC</sub> ± 15% <sup>(2)</sup>		85-265V <sub>AC</sub>	
Adapter <sup>(3)</sup>	Open Frame	Adapter <sup>(3)</sup>	Open Frame
19W	26W	14W	20W

#### Notes:

1. The junction temperature can limit the maximum output power.
2. 230V<sub>AC</sub> or 100/115V<sub>AC</sub> with doubler.
3. Typical continuous power in a non-ventilated enclosed adapter measured at 50°C ambient.

### Ordering Information

Part Number	Operating Temperature Range	Top Mark	Package	Packing Method
FSL136MR	-40 to +105°C	FSL136MR	8-Lead, Dual Inline Package (DIP)	Rail

### Typical Application Diagram

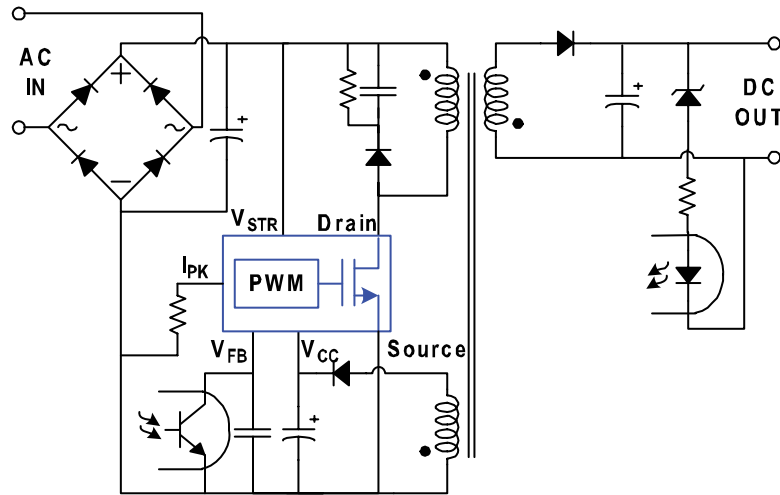


Figure 1. Typical Application

### Internal Block Diagram

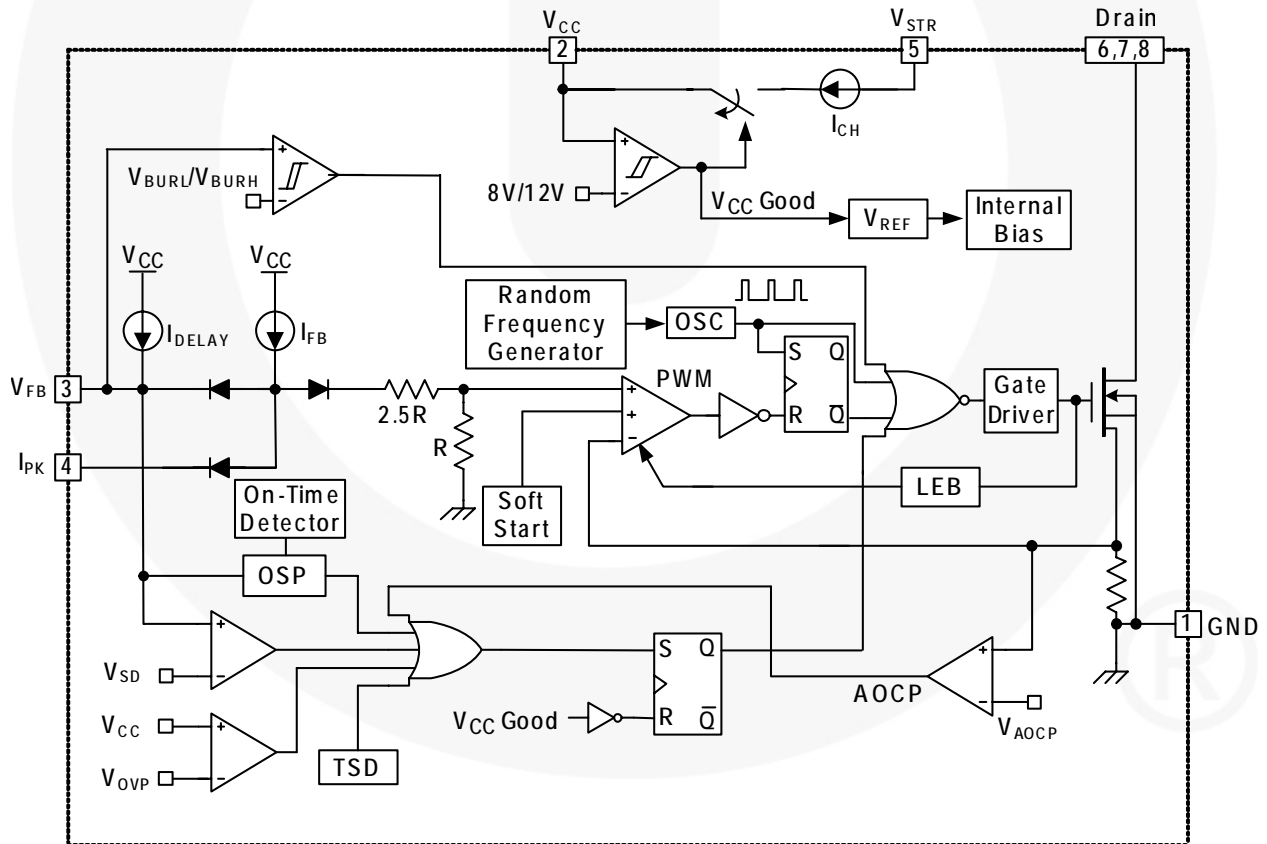


Figure 2. Internal Block Diagram

## Pin Configuration

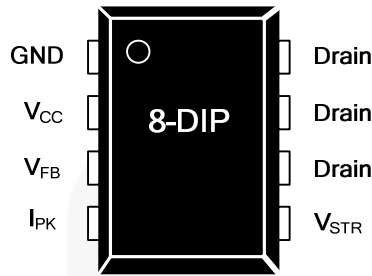


Figure 3. Pin Configuration

## Pin Definitions

Pin #	Name	Description
1	GND	<b>Ground.</b> SenseFET source terminal on the primary side and internal control ground.
2	V <sub>CC</sub>	<b>Positive Supply Voltage Input.</b> Although connected to an auxiliary transformer winding, current is supplied from pin 5 (V <sub>STR</sub> ) via an internal switch during startup (see Figure 2). Once V <sub>CC</sub> reaches the UVLO upper threshold (12V), the internal startup switch opens and device power is supplied via the auxiliary transformer winding.
3	V <sub>FB</sub>	<b>Feedback Voltage.</b> The non-inverting input to the PWM comparator, it has a 0.4mA current source connected internally, while a capacitor and opto-coupler are typically connected externally. There is a delay while charging external capacitor C <sub>FB</sub> from 2.4V to 6V using an internal 5μA current source. This delay prevents false triggering under transient conditions, but still allows the protection mechanism to operate under true overload conditions.
4	I <sub>PK</sub>	<b>Peak Current Limit.</b> Adjusts the peak current limit of the SenseFET. The feedback 0.4mA current source is diverted to the parallel combination of an internal 6kΩ resistor and any external resistor to GND on this pin to determine the peak current limit.
5	V <sub>STR</sub>	<b>Startup.</b> Connected to the rectified AC line voltage source. At startup, the internal switch supplies internal bias and charges an external storage capacitor placed between the V <sub>CC</sub> pin and ground. Once V <sub>CC</sub> reaches 12V, the internal switch is opened.
6, 7, 8	Drain	<b>Drain.</b> Designed to connect directly to the primary lead of the transformer and capable of switching a maximum of 650V. Minimizing the length of the trace connecting these pins to the transformer decreases leakage inductance.

## 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.  $T_J = 25^\circ\text{C}$ , unless otherwise specified.

Symbol	Parameter	Min.	Max.	Unit
$V_{STR}$	$V_{STR}$ Pin Voltage	-0.3	650.0	V
$V_{DS}$	Drain Pin Voltage	-0.3	650.0	V
$V_{CC}$	Supply Voltage		26	V
$V_{FB}$	Feedback Voltage Range	-0.3	12.0	V
$I_D$	Continuous Drain Current		3	A
$I_{DM}$	Drain Current Pulsed <sup>(4)</sup>		12	A
$E_{AS}$	Single Pulsed Avalanche Energy <sup>(5)</sup>		230	mJ
$P_D$	Total Power Dissipation		1.5	W
$T_J$	Operating Junction Temperature	Internally Limited		$^\circ\text{C}$
$T_A$	Operating Ambient Temperature	-40	+105	$^\circ\text{C}$
$T_{STG}$	Storage Temperature	-55	+150	$^\circ\text{C}$
ESD	Human Body Model, JESD22-A114 <sup>(6)</sup>	5.0		KV
	Charged Device Model, JESD22-C101 <sup>(6)</sup>	1.5		
$\theta_{JA}$	Junction-to-Ambient Thermal Resistance <sup>(7,8)</sup>		80	$^\circ\text{C}/\text{W}$
$\theta_{JC}$	Junction-to-Case Thermal Resistance <sup>(7,9)</sup>		19	$^\circ\text{C}/\text{W}$
$\theta_{JT}$	Junction-to-Top Thermal Resistance <sup>(7,10)</sup>		33.7	$^\circ\text{C}/\text{W}$

### Notes:

- Repetitive rating: pulse width limited by maximum junction temperature.
- $L=51\text{mH}$ , starting  $T_J=25^\circ\text{C}$ .
- Meets JEDEC standards JESD 22-A114 and JESD 22-C101.
- All items are tested with the standards JESD 51-2 and JESD 51-10.
- $\theta_{JA}$  free-standing, with no heat-sink, under natural convection.
- $\theta_{JC}$  junction-to-lead thermal characteristics under  $\theta_{JA}$  test condition.  $T_C$  is measured on the source #7 pin closed to plastic interface for  $\theta_{JA}$  thermo-couple mounted on soldering.
- $\theta_{JT}$  junction-to-top of thermal characteristic under  $\theta_{JA}$  test condition.  $T_t$  is measured on top of package. Thermo-couple is mounted in epoxy glue.

## Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	
<b>SenseFET Section</b>							
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{CC} = 0V, I_D = 250\mu A$	650			V	
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 650V, V_{GS} = 0V$			250	$\mu A$	
$R_{DS(ON)}$	Drain-Source On-State Resistance	$V_{GS} = 10V, V_{DS} = 0V, T_C = 25^\circ C$		3.5	4.0	$\Omega$	
$C_{ISS}$	Input Capacitance	$V_{GS} = 0V, V_{DS} = 25V, f = 1MHz$		290		pF	
$C_{OSS}$	Output Capacitance	$V_{GS} = 0V, V_{DS} = 25V, f = 1MHz$		45		pF	
$C_{RSS}$	Reverse Transfer Capacitance	$V_{GS} = 0V, V_{DS} = 25V, f = 1MHz$		5.5		pF	
$t_{d(ON)}$	Turn-On Delay	$V_{DD} = 350V, I_D = 3.5A$		12		ns	
$t_r$	Rise Time	$V_{DD} = 350V, I_D = 3.5A$		22		ns	
$t_{d(OFF)}$	Turn-Off Delay	$V_{DD} = 350V, I_D = 3.5A$		20		ns	
$t_f$	Fall Time	$V_{DD} = 350V, I_D = 3.5A$		19		ns	
<b>Control Section</b>							
$f_{OSC}$	Switching Frequency	$V_{DS} = 650V, V_{GS} = 0V$	61	67	73	KHz	
$\Delta f_{OSC}$	Switching Frequency Variation	$V_{GS} = 10V, V_{GS} = 0V, T_C = 125^\circ C$		$\pm 5$	$\pm 10$	%	
$f_{FM}$	Frequency Modulation			$\pm 3$		KHz	
$D_{MAX}$	Maximum Duty Cycle	$V_{FB} = 4V$	71	77	83	%	
$D_{MIN}$	Minimum Duty Cycle	$V_{FB} = 0V$	0	0	0	%	
$V_{START}$	UVLO Threshold Voltage		11	12	13	V	
$V_{STOP}$		After Turn-On	7	8	9	V	
$I_{FB}$	Feedback Source Current	$V_{FB} = 0V$	320	400	480	$\mu A$	
$t_{S/S}$	Internal Soft-Start Time	$V_{FB} = 4V$	10	15	20	ms	
<b>Burst Mode Section</b>							
$V_{BURH}$	Burst Mode Voltage	$T_J = 25^\circ C$	0.4	0.5	0.6	V	
$V_{BURL}$			0.25	0.35	0.45	V	
$V_{BUR(HYS)}$				150		mV	
<b>Protection Section</b>							
$I_{LIM}$	Peak Current Limit	$T_J = 25^\circ C, di/dt = 300mA/\mu s$	1.89	2.15	2.41	A	
$t_{CLD}$	Current Limit Delay Time <sup>(11)</sup>		200			ns	
$V_{SD}$	Shutdown Feedback Voltage	$V_{CC} = 15V$	5.5	6.0	6.5	V	
$I_{DELAY}$	Shutdown Delay Current	$V_{FB} = 5V$	3.5	5.0	6.5	$\mu A$	
$V_{OVP}$	Over-Voltage Protection Threshold	$V_{FB} = 2V$	22.5	24.0	25.5	V	
$t_{OSP}$	Output-Short Protection <sup>(11)</sup>	Threshold Time		1.00	1.35	$\mu s$	
$V_{OSP}$		Threshold Feedback Voltage	$T_J = 25^\circ C$ OSP Triggered When $t_{ON} < t_{OSP}$ , $V_{FB} > V_{OSP}$ and Lasts Longer than $t_{OSP\_FB}$	1.44	1.60		V
$t_{OSP\_FB}$		Feedback Blanking Time		2.0	2.5		$\mu s$
$V_{AOCP}$	AOCP Voltage <sup>(11)</sup>	$T_J = 25^\circ C$	0.85	1.00	1.15	V	
TSD	Thermal Shutdown <sup>(11)</sup>	Shutdown Temperature	125	137	150	$^\circ C$	
HYS <sub>TSD</sub>		Hysteresis		60		$^\circ C$	
$t_{LEB}$	Leading-Edge Blanking Time <sup>(11)</sup>		300			ns	

Continued on the following page...

## Electrical Characteristics (Continued)

T<sub>A</sub> = 25°C unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
<b>Total Device Section</b>						
I <sub>OP1</sub>	Operating Supply Current <sup>(11)</sup> (While Switching)	V <sub>CC</sub> = 14V, V <sub>FB</sub> > V <sub>BURH</sub>		2.5	3.5	mA
I <sub>OP2</sub>	Operating Supply Current (Control Part Only)	V <sub>CC</sub> = 14V, V <sub>FB</sub> < V <sub>BURL</sub>		1.8	2.5	mA
I <sub>CH</sub>	Startup Charging Current	V <sub>CC</sub> = 0V	0.90	1.10	1.30	mA
V <sub>STR</sub>	Minimum V <sub>STR</sub> Supply Voltage	V <sub>CC</sub> = V <sub>FB</sub> = 0V, V <sub>STR</sub> Increase	35			V

**Note:**

11. Though guaranteed by design, it is not 100% tested in production.

## Typical Performance Characteristics

These characteristic graphs are normalized at  $T_A=25$ .

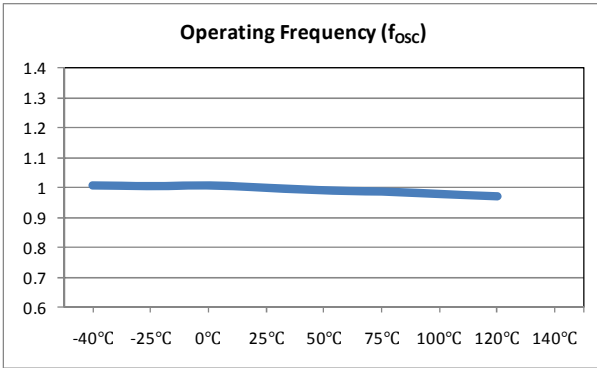


Figure 4. Operating Frequency vs. Temperature

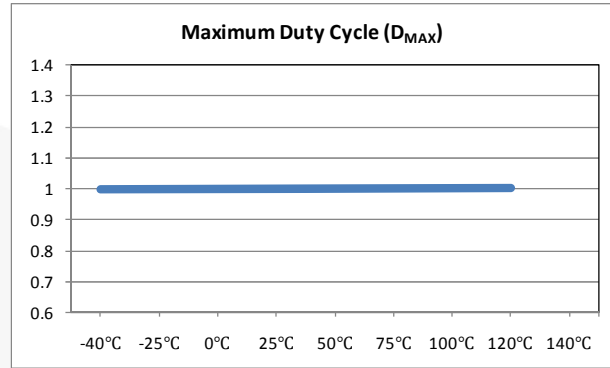


Figure 5. Maximum Duty Cycle vs. Temperature

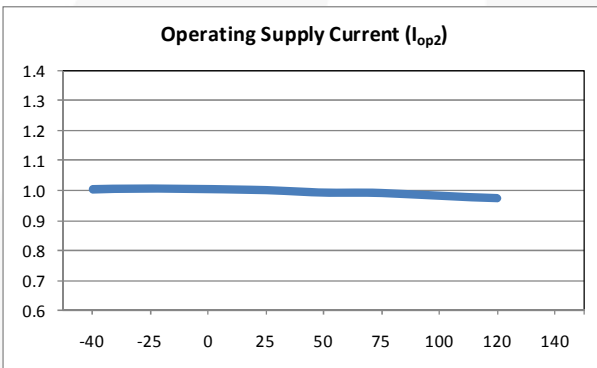


Figure 6. Operating Supply Current vs. Temperature

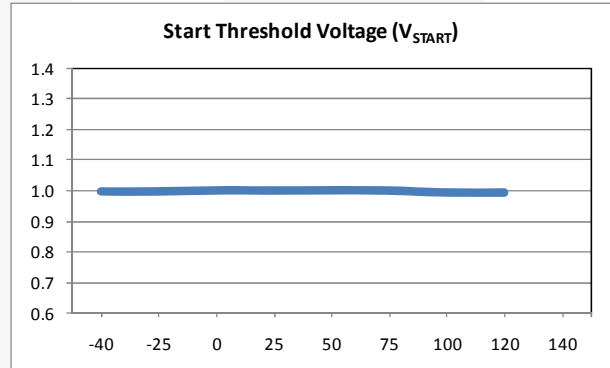


Figure 7. Start Threshold Voltage vs. Temperature

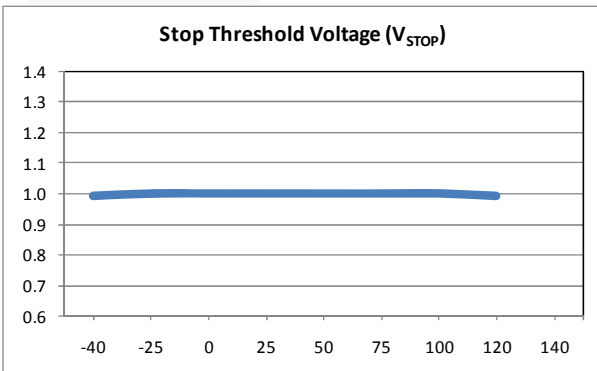


Figure 8. Stop Threshold Voltage vs. Temperature

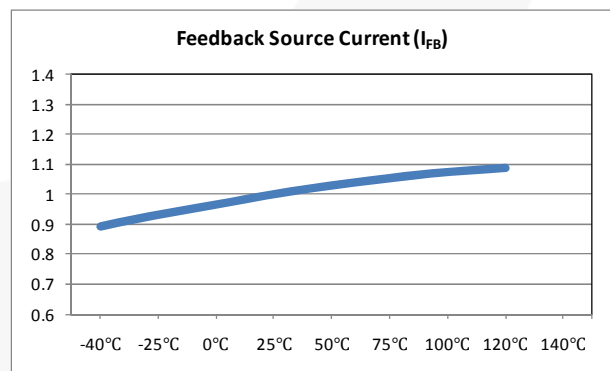


Figure 9. Feedback Source Current vs. Temperature