



# FSL136MR

High Power and Low Cost Green-Mode Fairchild Power Switch (FPS<sup>TM</sup>)

Power Conversion  
PLM Low Power

[www.fairchildsemi.com](http://www.fairchildsemi.com)

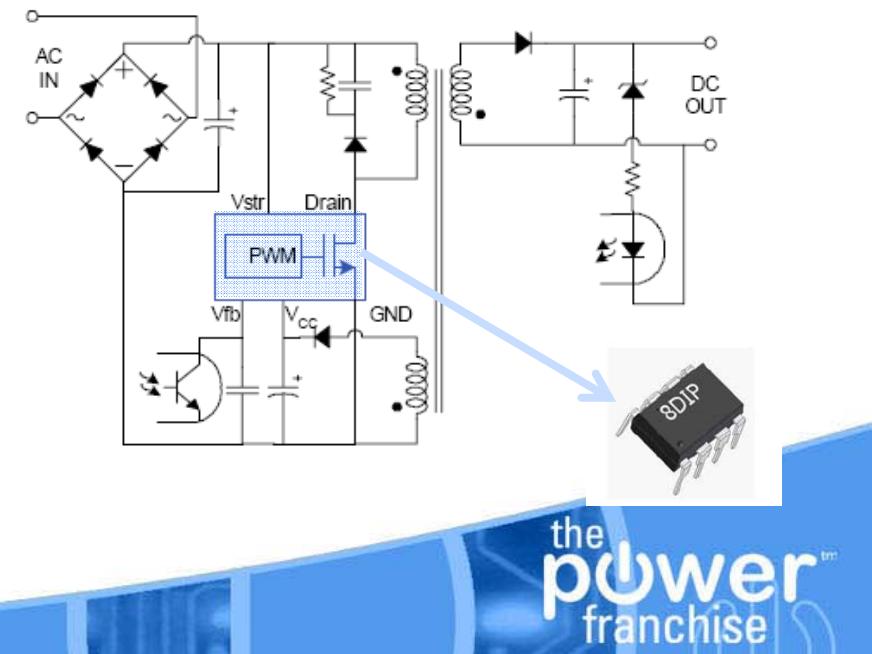
the power franchise™

# Features

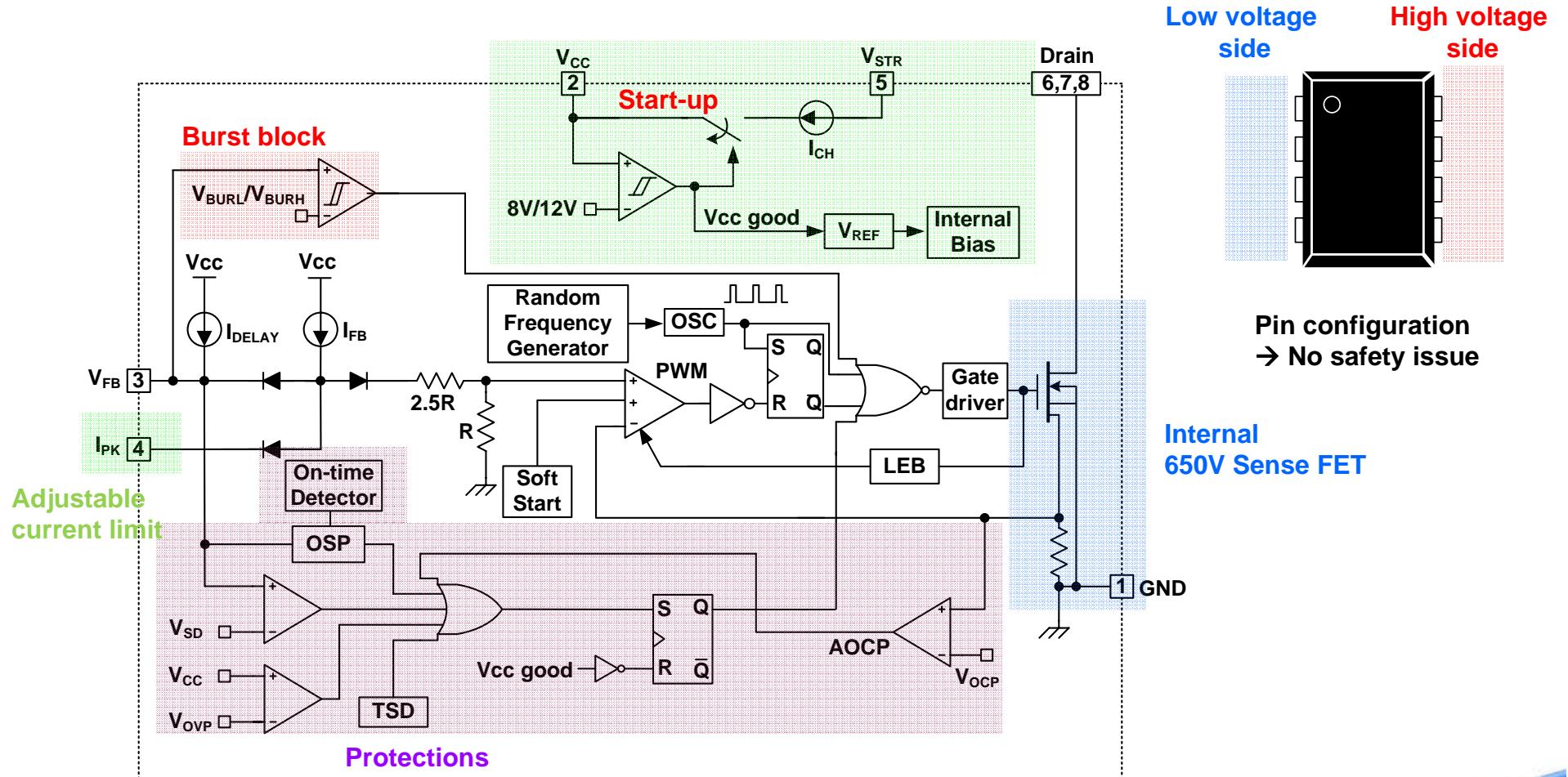
## High Power, Low Cost, Green Mode, Fairchild Power Switch (FPS™)

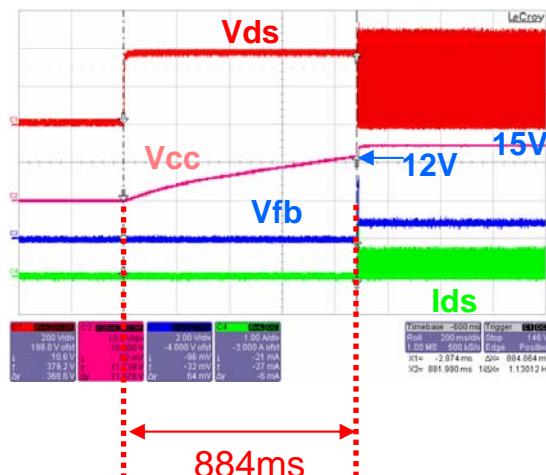
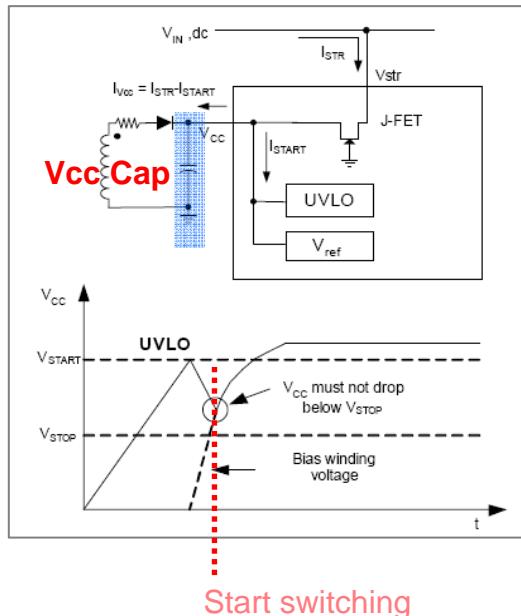
- Internal Avalanche Rugged Sense FET (650V)
- **50mW** Under Standby Power Consumption at 265Vac, No-load Condition
- Precision Fixed Operating Frequency with **Frequency Modulation for Attenuating EMI**
- Internal High-Voltage Start-up and Built-in Soft Start
- **Various Protections:** Over Voltage Protection (OVP), Over Load 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**
- **Adjustable Peak Current Limit**

Maximum Output Power			
230Vac $\pm$ 15%		85-265V <sub>AC</sub>	
Adapter	Open Frame	Adapter	Open Frame
19W	26W	14W	20W



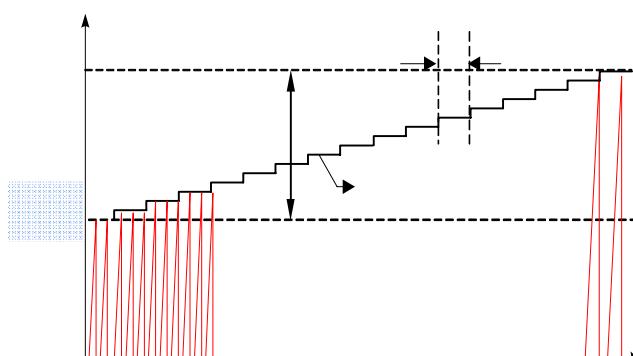
# Block Diagram



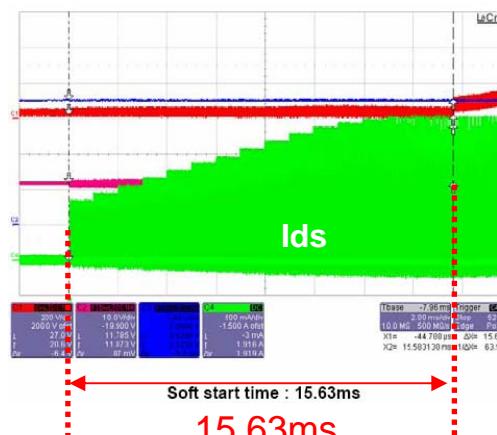


## Start up

- Charge current through external V<sub>cc</sub> capacitor.
- Start to Soft Start at 12V (V<sub>cc</sub>)
- Set V<sub>cc</sub> : 13~15V When use aux. winding
- To prevent V<sub>cc</sub> fluctuation, V<sub>cc</sub> capacitor should be used enough value. (10uF~47uF)



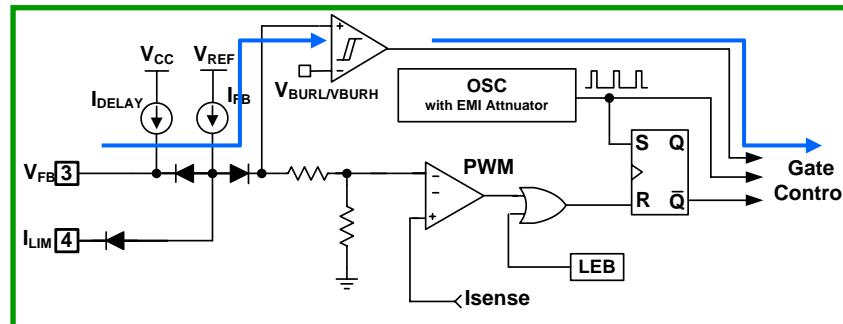
Initial start current limit value is  $0.5 \cdot I_{LIMIT}$  to establish output voltage linearly



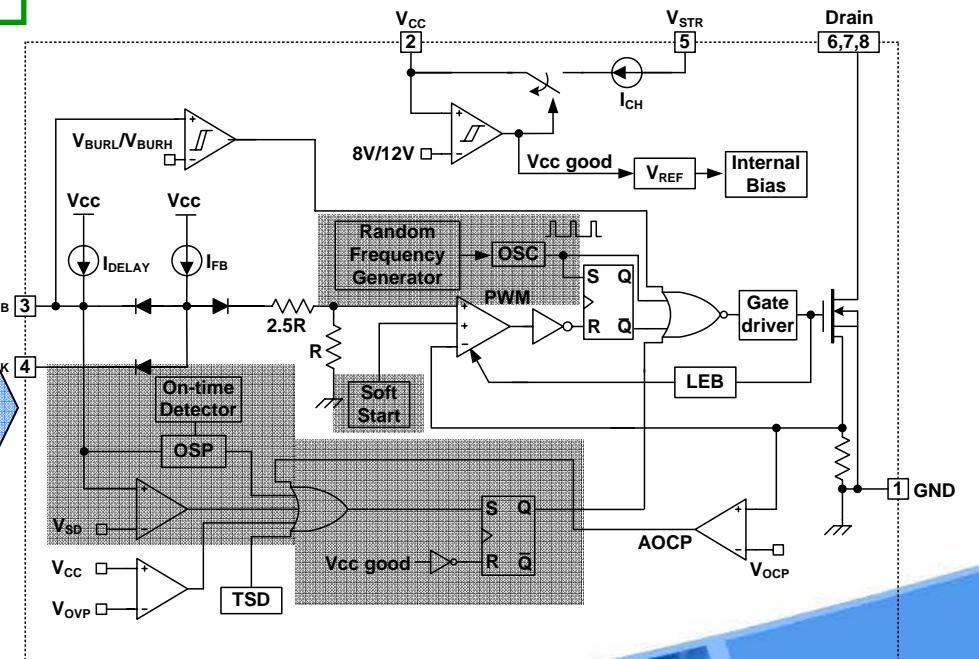
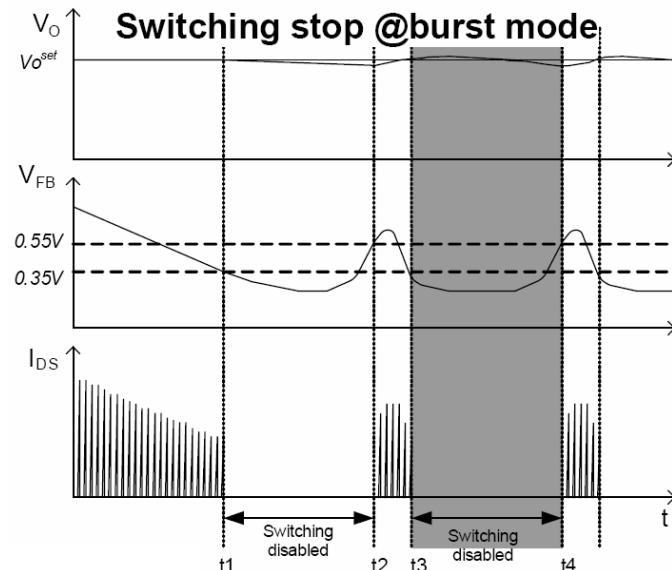
## Soft Start

- To establish proper working condition, the current should be progressively increased by soft start circuit.
- Typical soft start time: 15ms

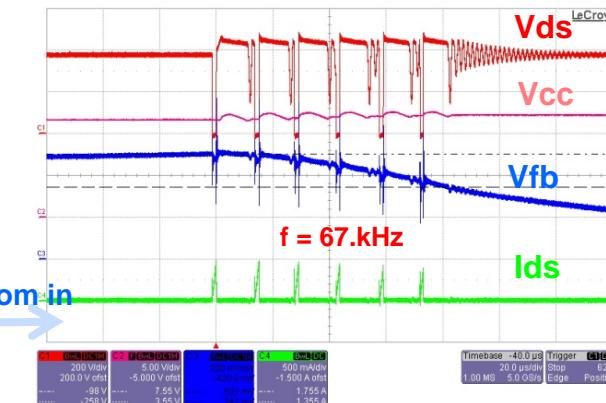
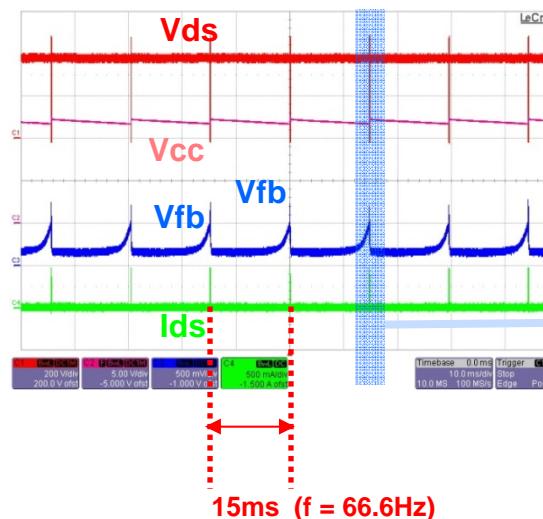
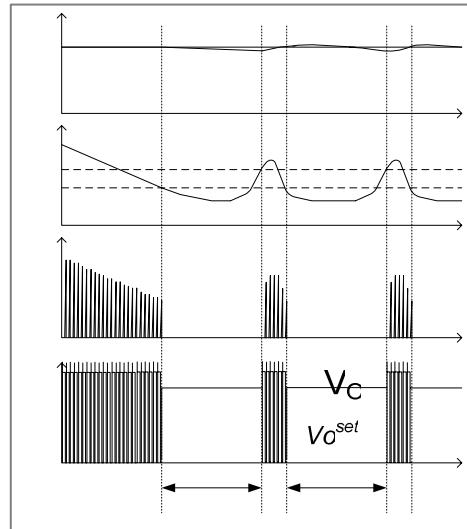
- To minimize power dissipation in standby mode



- By block disabling,  $I_{OP}$  can cut down 35% of internal controller's current consumption.
- As a result, can save Pin at standby-mode.



# Burst Mode Operation



- Standby Power  $V_{FB}$

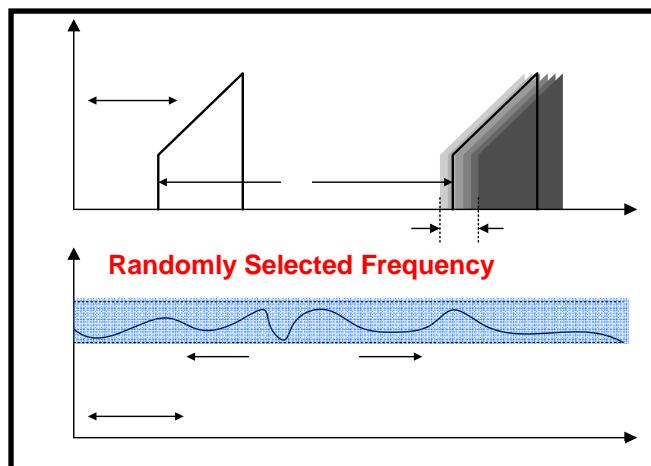
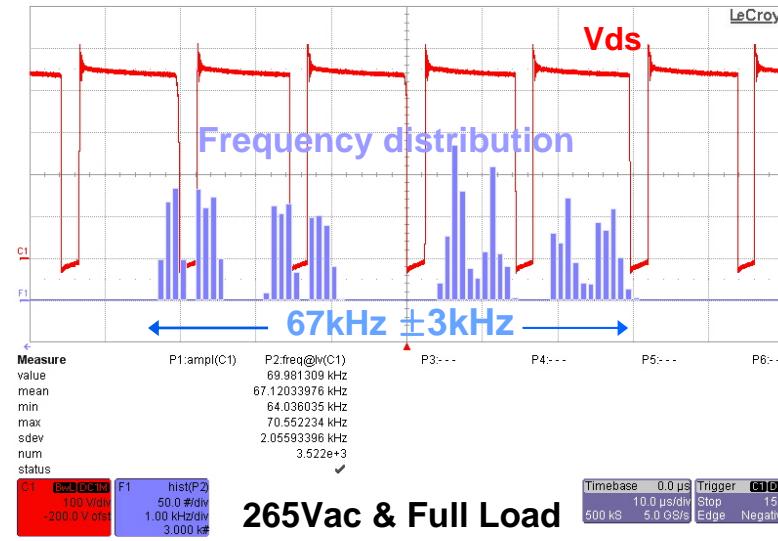
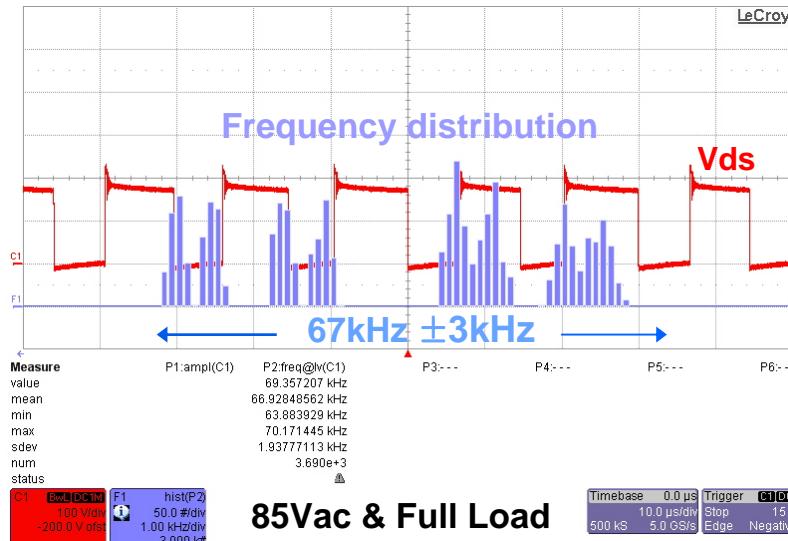
Output Power	$0.55V$ $0.35V$	85Vac	110Vac	230Vac	265Vac
4.96V / 0A		<b>0.0421W</b>	<b>0.0413W</b>	<b>0.0440W</b>	<b>0.0452W</b>
4.96V / 5mA	$I_{DS}$	<b>0.075W</b>	<b>0.076W</b>	<b>0.079W</b>	<b>0.082W</b>
4.96V / 10mA				<b>0.110W</b>	<b>0.112W</b>
4.96V / 20mA				<b>0.179W</b>	<b>0.184W</b>
4.96V / 100mA		<b>0.705W</b>	<b>0.704W</b>	<b>0.7085W</b>	<b>0.7163W</b>

\* Measurement after 1hr aging

$V_{DS}$



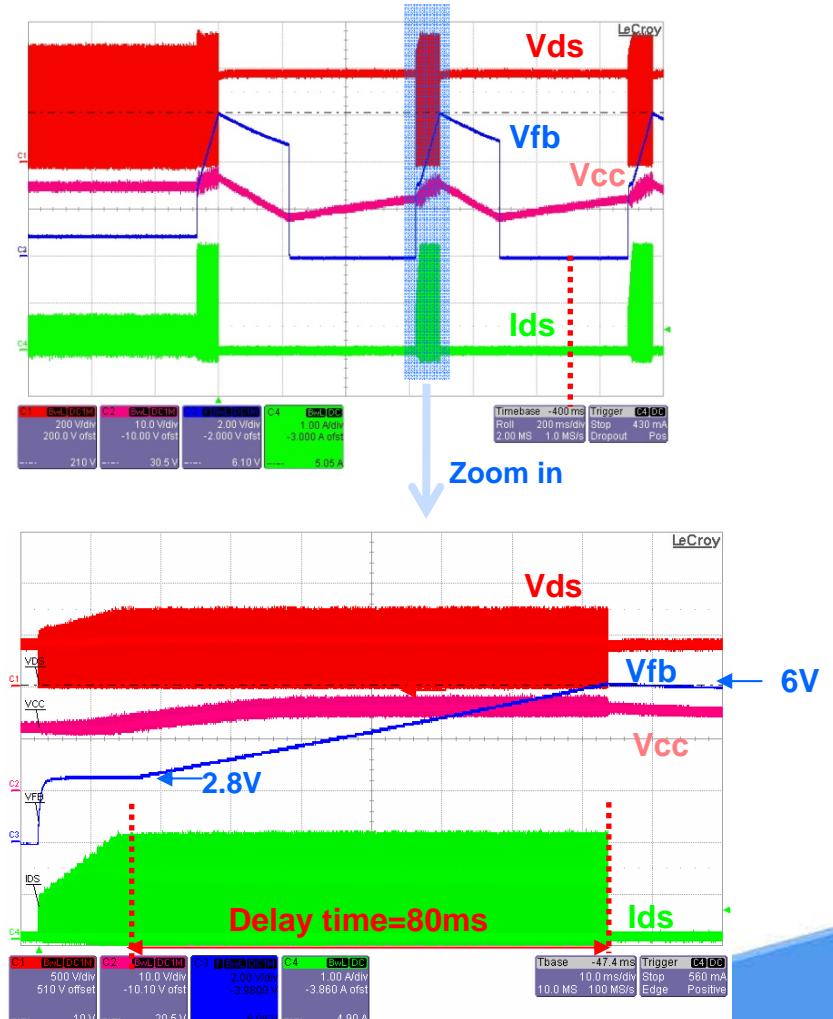
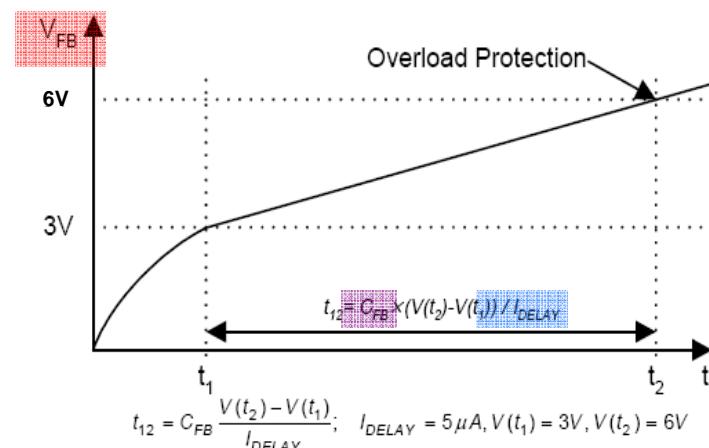
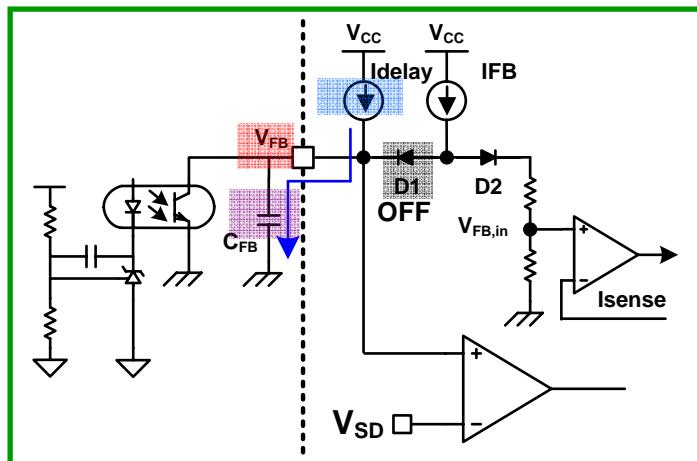
- To minimize EMI, FSL136MR adapts the frequency modulation function.



- This frequency modulation technique belongs to Fairchild (No patent issue)
- This frequency modulation allows to minimize EMI filter and satisfy world-wide EMI requirement

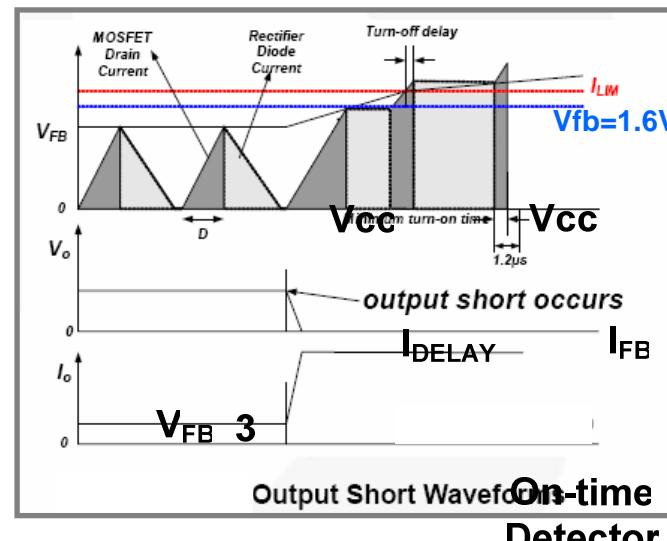
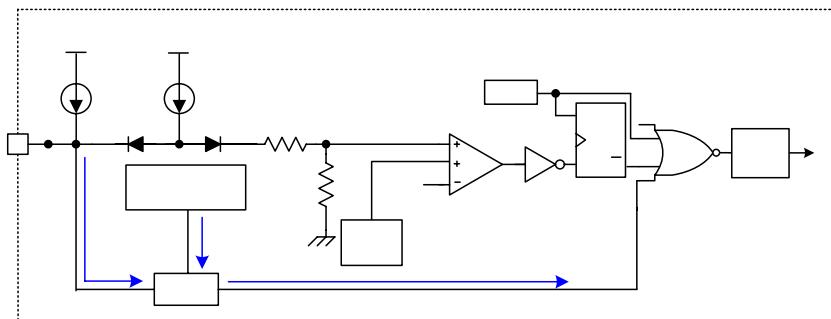
## OLP

- $V_{FB}$  exceeds 3V,  $I_{delay}$  current starts to charge  $C_{FB}$ (5 $\mu$ A).
- $V_{FB} = 6V$ , switching operation is terminated
- $T_{12}$  : the delay time for shutdown

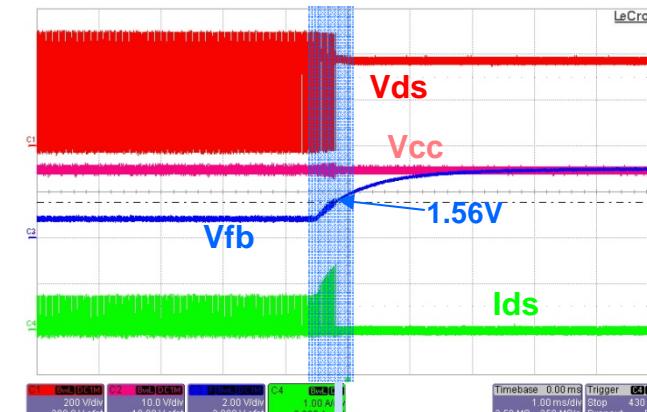


## OSP

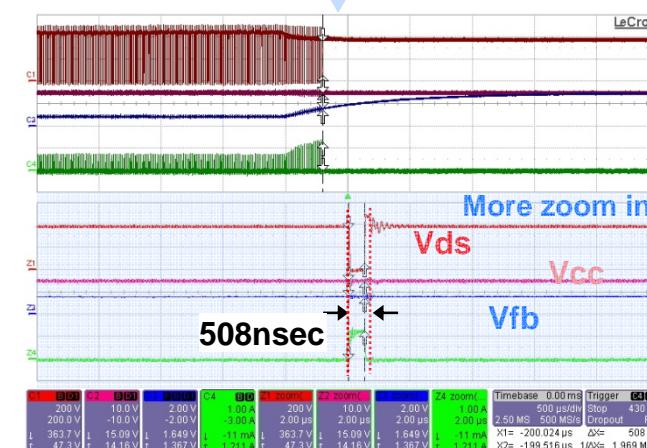
- OSP is triggered when  $t_{ON} < 1.2\mu s$  and  $V_{FB} > 1.6V$ .
- Together with AOCP, FPS is free from burnt out when output is in abnormal conditions.



$V_{FB} > 1.6V$        $t_{ON} < 1.2\mu s$  <sup>9</sup>



Zoom in



Gate driver

Soft Start

OSP triggering

the power franchise



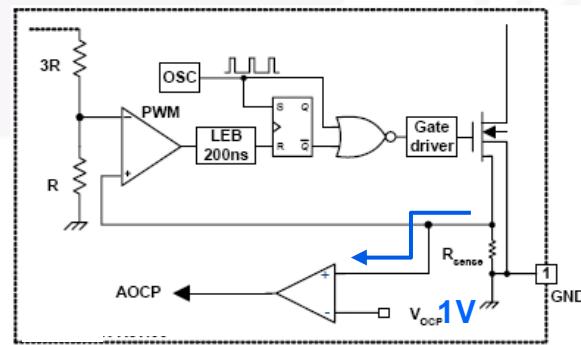
## OVP

- If  $V_{cc}$  exceeds 24V(typ.), IC quits the switching operation.
- Automatically restart when  $V_{cc}$  go down and reach 12V.  
(Wide  $V_{cc}$  rating)
- Wide selection of  $V_{cc}$  diode and more flexibility on  $V_{cc}$  circuitry is possible.

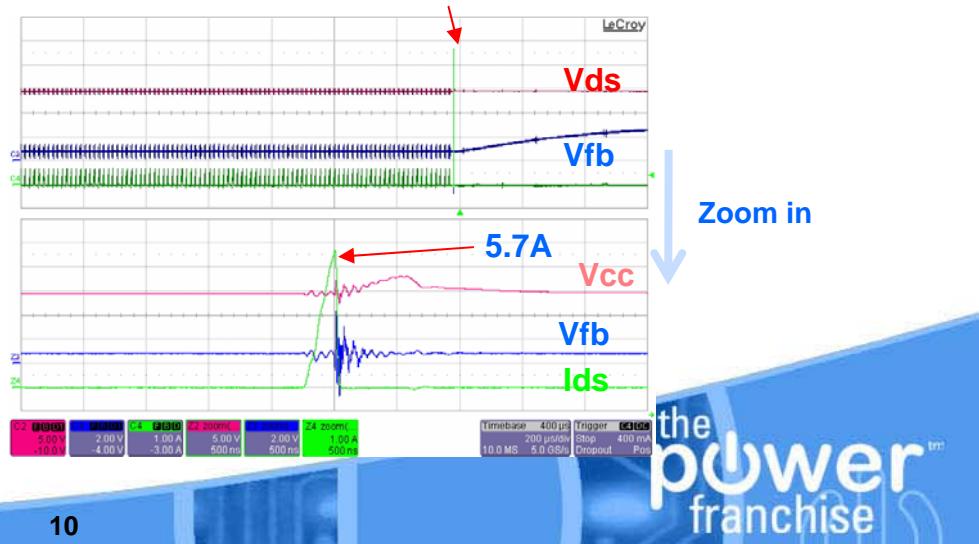
## AOCP

- To prevent FPS from extremely high  $di/dt$ , AOCP block is enabled when the preset voltage across the sensing resistor is larger than the AOCP level.

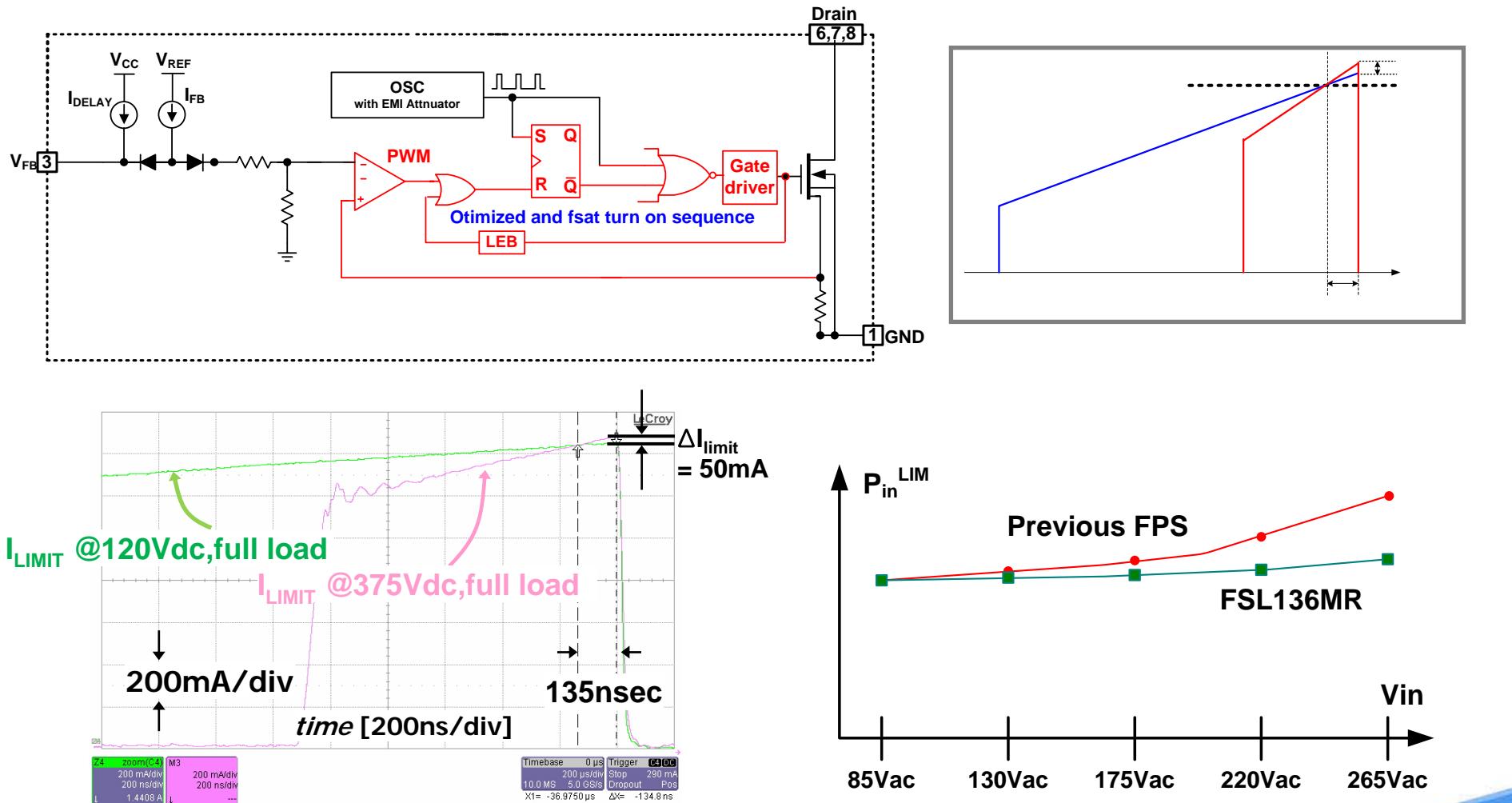
AOCP trigger



Abnormal Over-Current Protection

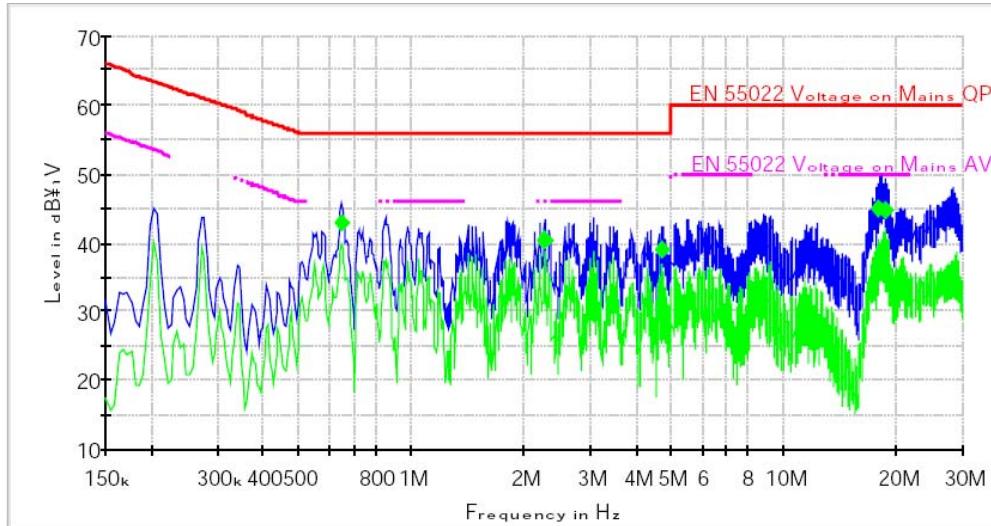


# Faster Current Limit Delay Time - $T_{CLD}$

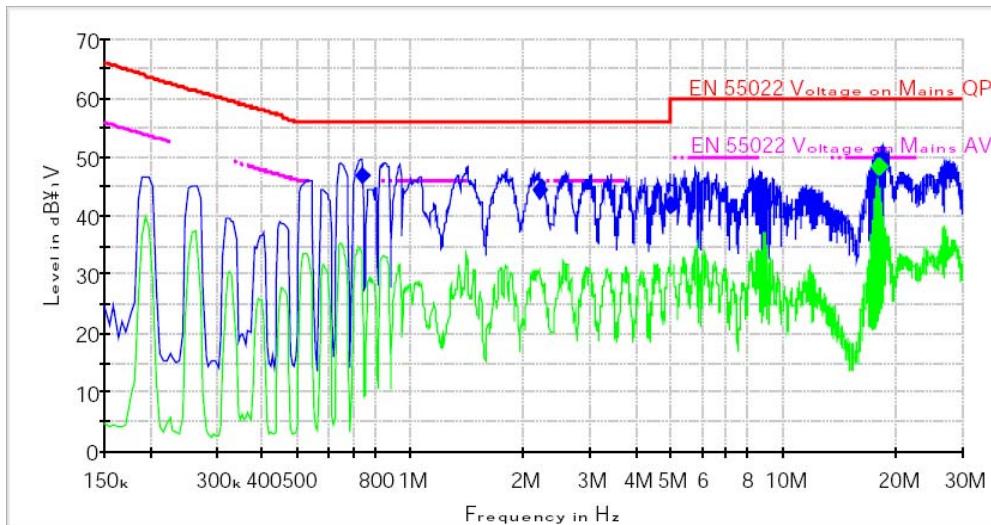


The smaller  $T_{CLD}$ , the smaller  $\Delta I_{LIMIT}$   
 $\rightarrow$  small  $\Delta I_{LIMIT}$   $\rightarrow$  no need power compensate

# EMI Test Result (Conduction)



New Frequency Jittering  
(FSL136MR, EVT1)



OLD Frequency Jittering  
(FSDM0365)

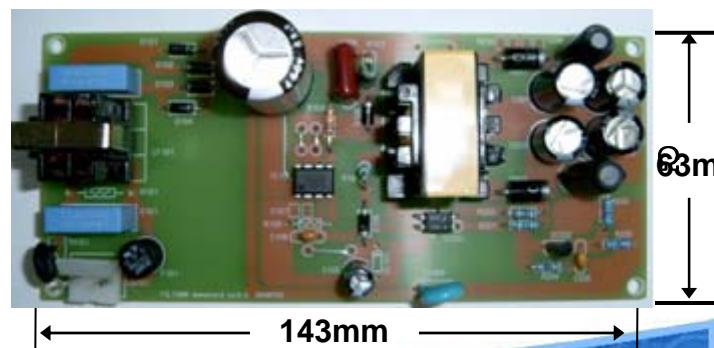
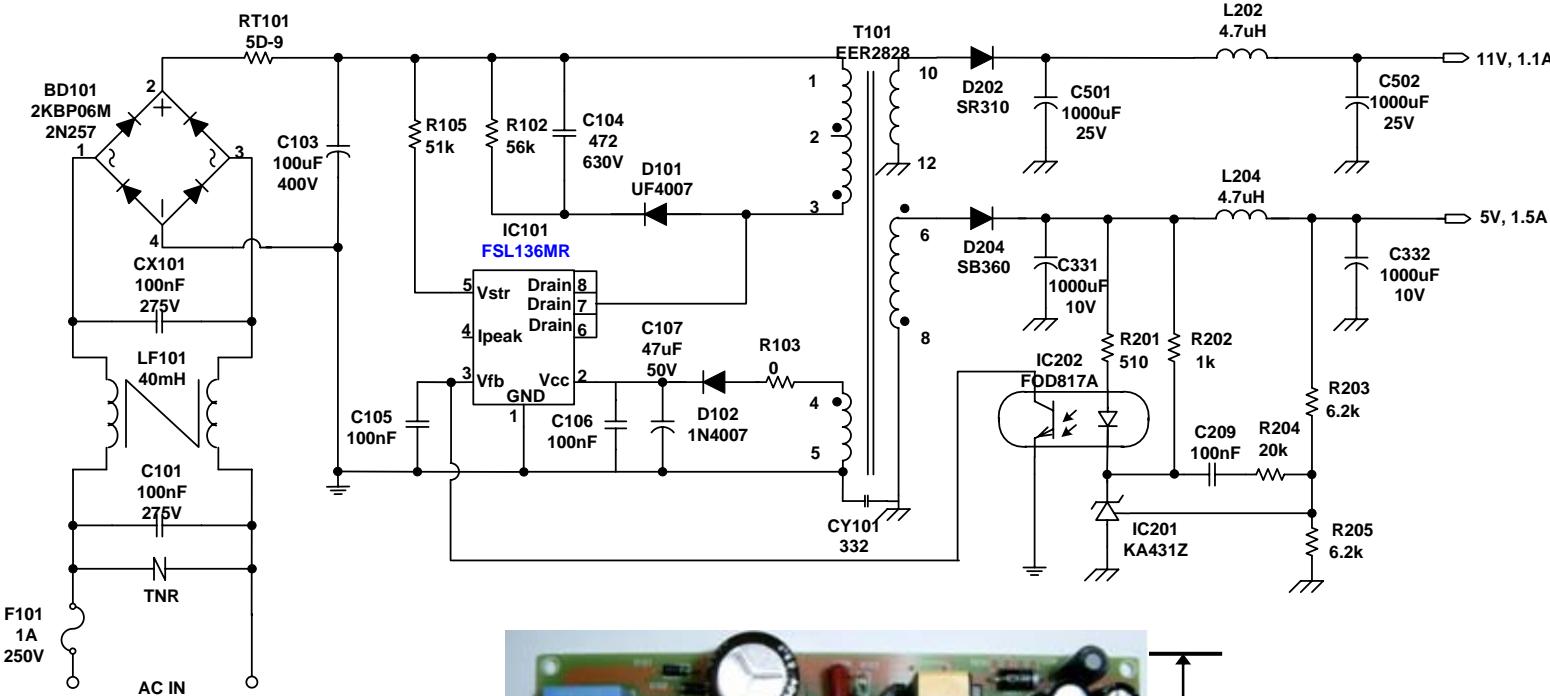
ESD Test Result

Device	Item	Test Data [V]	Reference Standard
FSDM0365	HBM	2000	JEDEC
FSQ110	HBM	2000	JEDEC
FSQ311	HBM	2500	JEDEC
<b>FSL136MR</b>	<b>HBM</b>	<b>5000</b>	<b>JEDEC</b>

The method uses every fresh sample for every test combination, while the new one uses only one sample for all test combinations at a voltage step

# Test Circuit

Application	FPS device	Input voltage range	Rated output power	Output voltage (Rated current)
SMPS	FSL136 MR	85-265Vac	20W	5V-1.5A 11V-1.1A

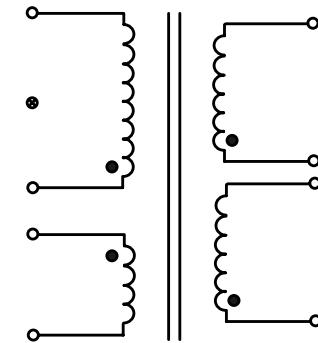


# Efficiency

		85Vac		110Vac		230Vac		265Vac	
<100% Load> 5V/1.4A & 11V/1.1A	5V output	4.931V	79.00%	4.931V	81.69%	4.931V	84.49%	4.931V	84.76%
	12V output	11.075V		11.035V		10.990V		11.000V	
	input power	24.16W		23.31W		22.48W		22.42W	
<75% Load> 5V/1.05A & 11V/0.825A	5V output	4.931V	81.03%	4.931V	82.89%	4.931V	85.11%	4.946V	85.12%
	12V output	11.100V		11.075V		11.065V		11.070V	
	input power	17.69W		17.27W		16.81W		16.83W	
<50% Load> 5V/0.7A & 11V/0.55A	5V output	4.931V	82.84%	4.931V	83.98%	4.931V	84.75%	4.962V	84.79%
	12V output	11.105V		11.100V		11.105V		11.105V	
	input power	11.54W		11.38W		11.28W		11.30W	
<25% Load> 5V/0.35A & 11V/0.275A	5V output	4.931V	83.29%	4.931V	84.05%	4.931V	83.49%	4.962V	82.95%
	12V output	11.140V		11.145V		11.150V		11.150V	
	input power	5.75W		5.70W		5.74W		5.79W	
Average Power			81.54%		83.15%		84.46%		84.41%

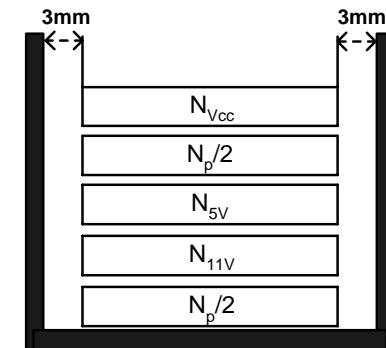
## 1. Electrical Specification.

	Pin	Spec.	Remark
Inductance	1 – 3	1.10 mH $\pm$ 10%	66 kHz, 1 V
Leakage	1 – 3	< 30 uH Max.	Short all other pins



## 2. Winding Specification.

No	Pin (S → F)	Wire	Turns	Winding Method
1	P1 ( $N_p/2$ ) / 3→2	0.25Φ	39Ts	Solenoid Winding
2	S1 ( $N_{11V}$ ) / 10→12	0.35Φ*2	13Ts	Solenoid Winding
3	S2 ( $N_{5V}$ ) / 6→8	0.4Φ*2	6Ts	Space Winding
4	P1 ( $N_p/2$ ) / 2→1	0.25Φ	39Ts	Solenoid Winding
5	S3 ( $N_{Vcc}$ ) / 4→5	0.35Φ	15Ts	Center Solenoid Winding



Core & Bobbin : EER2828

# Line-up of FSL Series

Product number	PKG	Ope. Temp.	$I_{LIM}$	$R_{DS(ON)MAX.}$	Maximum output power <sup>(1)</sup>				Replaces Devices & Remark	
					230Vac±15% <sup>(2)</sup>		85~265Vac			
					Adapter <sup>(3)</sup>	Open frame	Adapter	Open frame <sup>(4)</sup>		
FSL136MR	8DIP	-40 ~85°C	2.15A	4Ω	19W	26W	14W	20W	FSDM0365(P2P) FSQ0365RN	
FSL126MR			1.5A	6Ω	15W	21W	12W	17W	FSDM0265(P2P) FSQ0265RN	
FSL116LR			1.2A	10Ω	11W	16W	10W	14W	FSDL0165(P2P) FSQ0165RN	
FSL106HR			0.75A	19Ω	9W	13W	8W	10W	FSDH321(P2P) FSQ321	
FSL106MR			0.58A	19Ω	7W	10W	6W	8W	FSDM311(P2P) FSQ311	

(1) The junction temperature can limit the maximum output power.

(2) 230Vac or 110/115Vac with doubler.

(3) Typical continuous power in a non-ventilated enclosed adapter measured 50°C ambient temperature.

(4) Maximum practical continuous power in an open-frame design at 50°C ambient.

- **Code S: FSL136MR (P10, 2009) → Sample available**

**FSL126MR (P02, 2010)**

**FSL116LR (P12, 2009)**

**FSL106HR (P02, 2010)**

**FSL106MR (P12, 2009)**

☞ Note: FSL Naming Rule

- FSL1XX is the 1'st generation
- FSLX2XX will be 2'nd G in next time
- **FSL116MR → M : 67Khz , 1: 1'st G , 1: 1A , 6: 650V , R: Auto-restart**  
**H: 100kHz**  
**L: 50kH**

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# Thank you