How to Improve SMPS Design with Fairchild's FSL series

FSL series, FPS™ Green Mode Power Switches

Fairchild Semiconductor

Solutions for Your Success™

Contents

- H/A Market Trends & Design Challenges
- Introduction of Flyback Converter Topology
- Fairchild's Differentiated Offerings:
  - FPS™ power switch family
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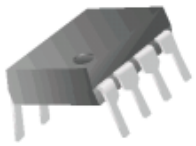
    - FSL2x series
    - FSL3x series
- Achievements from FPS™ Solution
- Design Resources

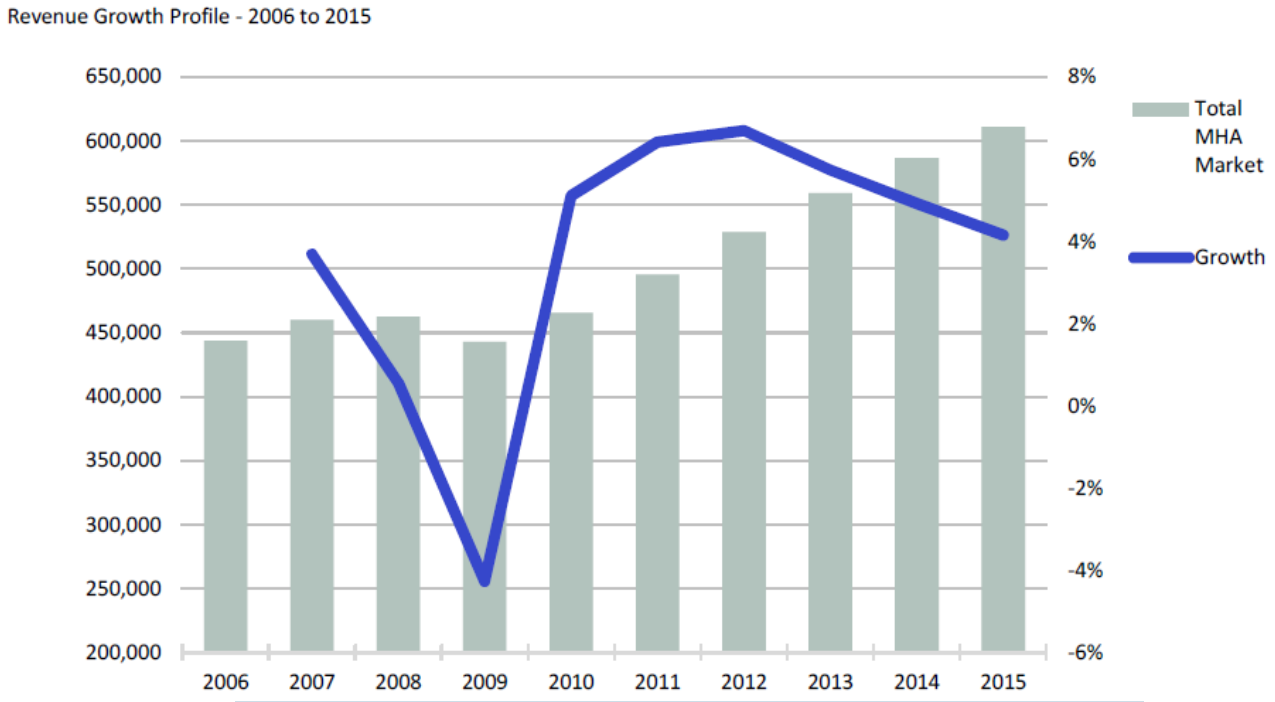


Home Appliance Market Trends And Design Challenges

Optimized Solution for H/A and Industrial Power

Home Appliance Market Research

Worldwide Total Major H/A Market Revenue Growth



	2009	2010	2011	2012	2013	2014	2015	10 - 15 CAGR
Revenues ($M)	**179,844**	**187,259**	**198,208**	**213,788**	**229,399**	**245,469**	**261,019**	**6.9%**
Annual Growth		4.1%	5.8%	7.9%	7.3%	7.0%	6.3%	
Unit Shipments	**443,040**	**465,669**	**495,566**	**528,759**	**559,090**	**586,603**	**610,928**	**5.6%**
Annual Growth		5.1%	6.4%	6.7%	5.7%	4.9%	4.1%	

Source: IMS Research **May-11**

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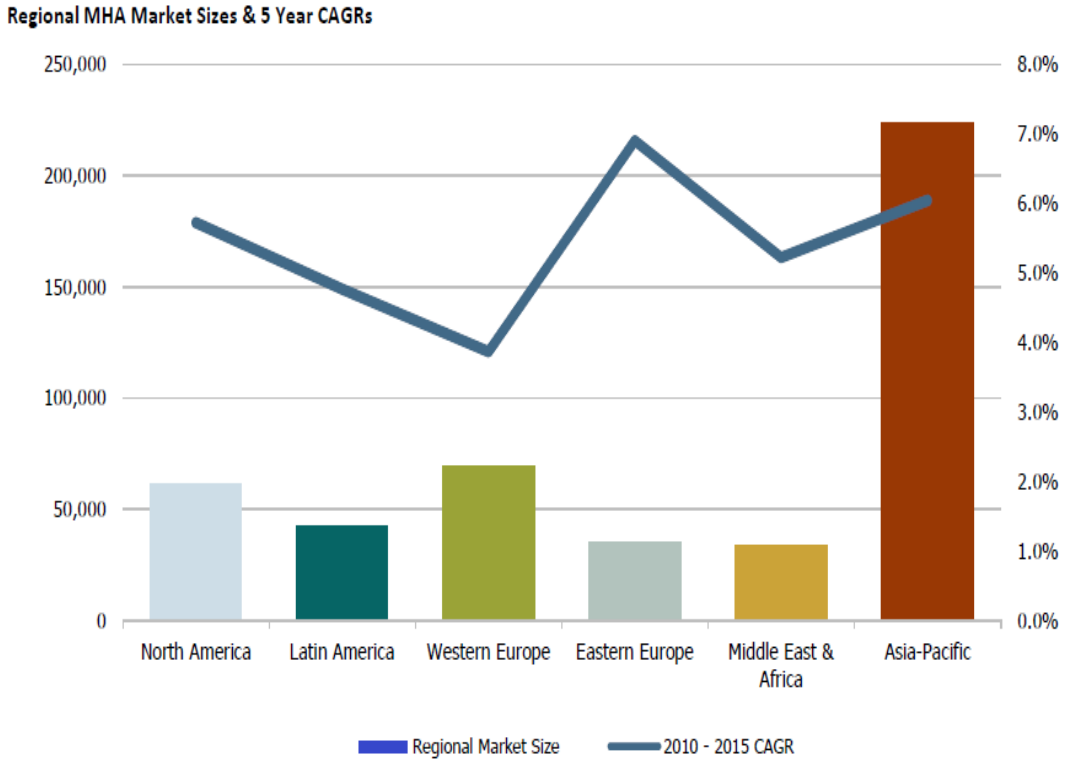
Home Appliance Market Research

Regional Major H/A Market Sizes & 5 Year CAGRs

World MHA Market by Region
Unit Shipments ('000)

Region	2009	2010	Growth
North America	59,536	61,813	3.8%
Latin America	40,415	42,154	4.3%
Western Europe	69,101	69,416	0.5%
Eastern Europe	34,584	35,007	1.2%
Middle East & Africa	32,659	33,514	2.6%
Asia-Pacific	206,745	223,765	8.2%
Total	**443,040**	**465,669**	**5.1%**



Source: IMS Research

May-11

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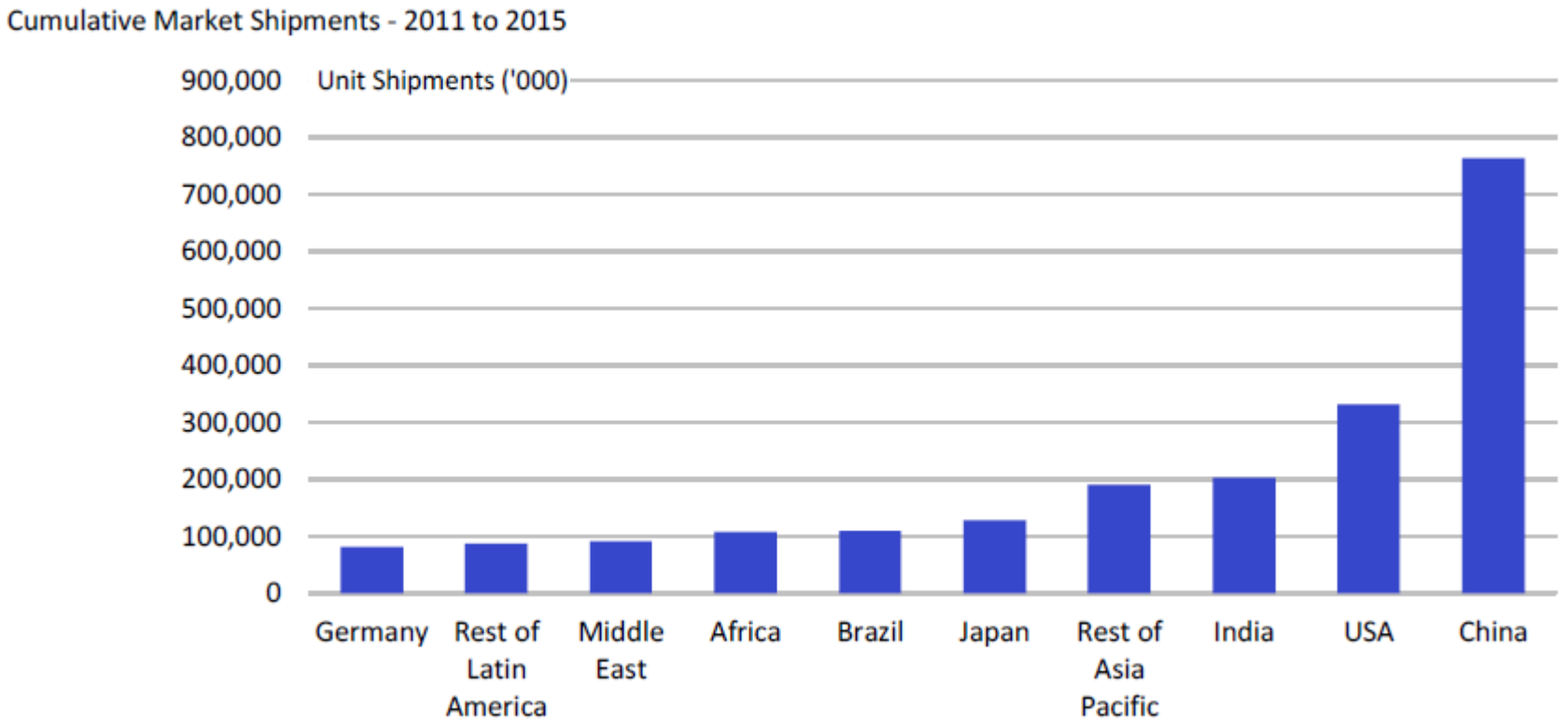
World Market for Major Home Appliance

Highest Volumes Over Next Five Years



Source: IMS Research May-11

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H/A Semiconductor Market Research

Major H/A Semiconductor Market

World MHA Semi Market by Semiconductor Type
Revenues ($M)

Product	2010	2015	CAGR 10 - 15
Micro/DSP/DSC	447.0	729.0	**10.3%**
Power Semiconductor	910.7	1,668.2	**12.9%**
Other Semiconductors	248.4	416.8	**10.9%**
Total	**1,606.1**	**2,814.0**	**11.9%**

World MHA Semiconductor Market by MHA Type
Revenues ($M)

Region	2010	2015	CAGR 10 - 15
Washing Machines	387.4	633.3	**10.3%**
Clothes Dryers	14.7	19.6	**6.0%**
Dishwashers	90.2	164.9	**12.8%**
Fridges/Freezers	147.5	284.1	**14.0%**
Microwave Ovens	100.7	160.2	**9.7%**
Room Air Conditioners	496.4	1,057.1	**16.3%**
Induction Cookers	186.1	249.9	**6.1%**
Large Cooking (no induction	183.2	244.7	**6.0%**
Total	**1,606.1**	**2,814.0**	**11.9%**

Source: IMS Research **May-11**

H/A Semiconductor Market Research

Major H/A Semiconductor Market

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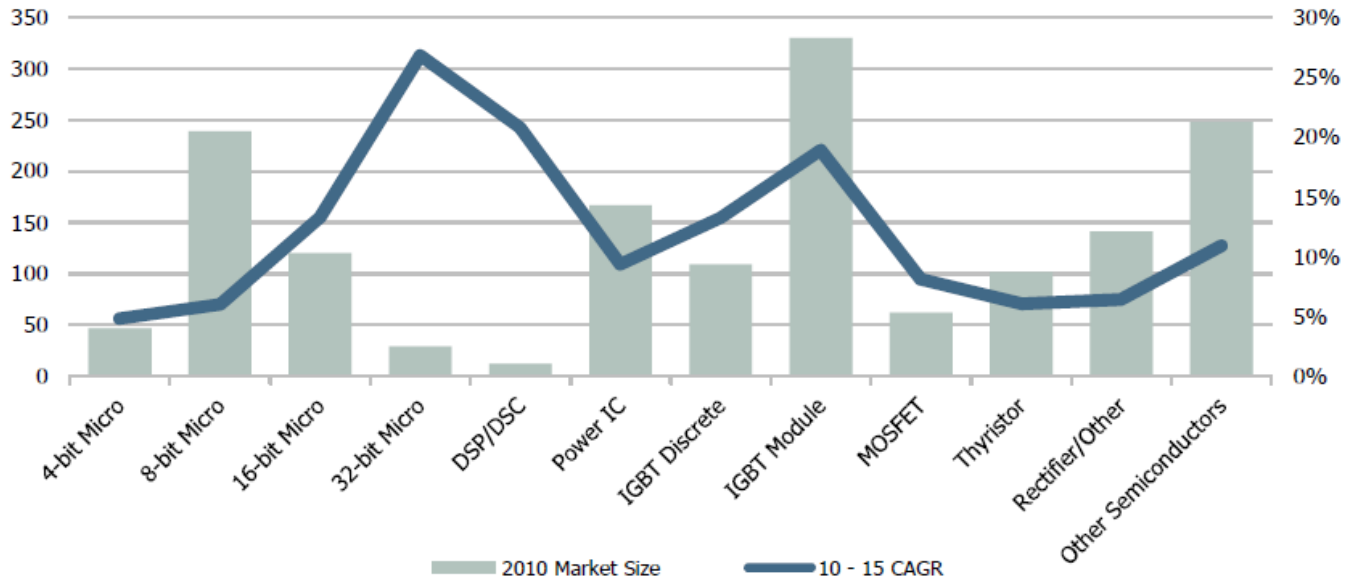
World MHA Semi Market by Semi Type

2010 Market Sizes and Projected Growth Rates



Source: IMS Research May-11

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Design Challenges and Fairchild Solution

Diagnose your Pain.

- High Design Cost
- High Manufacturing Cost

- Lack of Design Resource
- Complex Design
- Longer Design Cycles
- Time to Market

- High Failure-Rates
- Reliability Issues

- Low Performance-Rate
- Loss of Market Share

Offer the Optimum Solution.

- Cost Innovation by Improved Technology and Topology
- Less Pin-Count, BOM-count

- Offers Evaluation Boards
- Power Supply Web designer
- Integrated High-Ruggedness SenseFET.

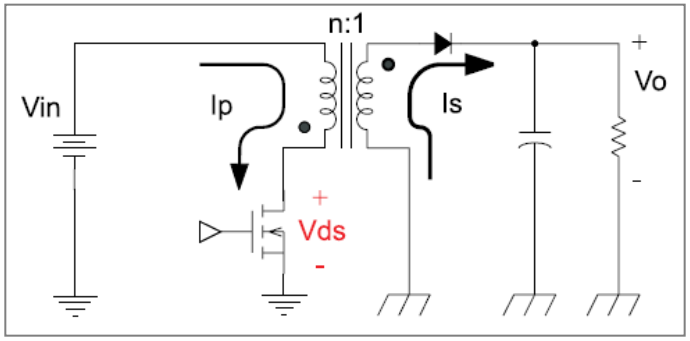
- Various Protection Functions: OCP, OVP, OLP, AOCP, TSD, OSP, with High ESD Immunity

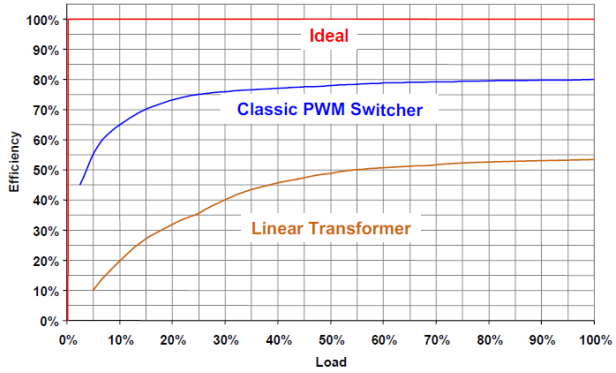
- Lower standby Power
- Improved Efficiency
- Lower thermal characteristic

Why Flyback Converter Topology?

- What makes **Switching Regulator** better over Linear Regulator?
  - Efficiency: higher efficiency with low temp
  - Regulator size: very small size
  - Protection: can protect circuit abnormal condition
  - IC technology: faster development IC tech

- What makes **Flyback Converter** better over other converters?
  - Isolation type: Safety, multi-outputs and conversion ratio
  - Smallest components: No need output inductor and reset circuit.
  - Lowest standby power: energy is transferred during off time





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Fairchild's Differentiated Offerings

Optimized Solution for H/A and Industrial Power

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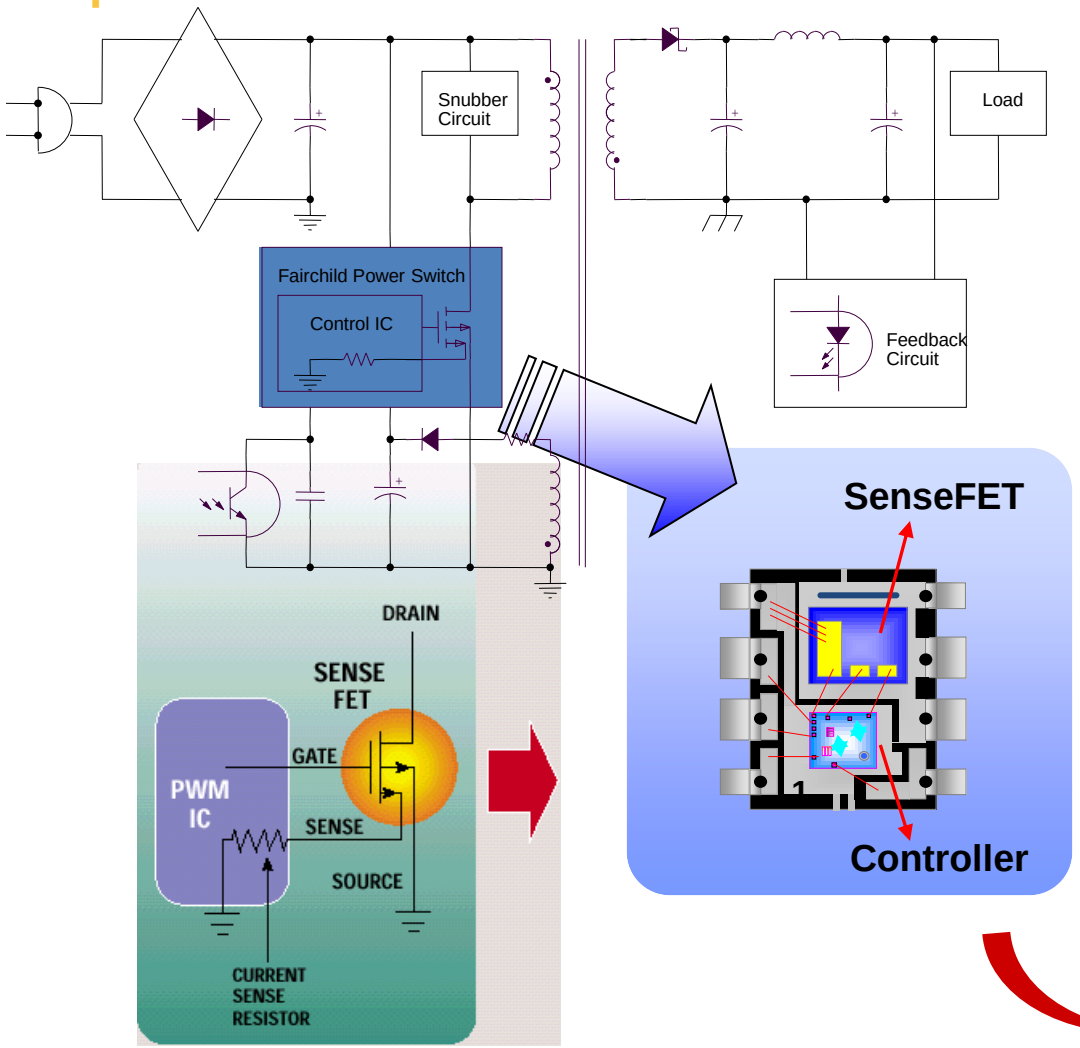
Fairchild's Flyback Converter Solution, FPS™ Power Switch

Optimum Solution for Off-Line Switch Mode Power Supplies (SMPS)



2-Chip in 1-Package Structure

- **Simple & Less components**
  - Integrate PWM and MOSFET
  - Integrate various protection functions
  - Provide competitive solution in Price & Board Size
- **Various protections, Improve Quality**
  - Good reliability in production line & field
  - System manufacturing cost saving
- **Meet the Lower Power Consumption**
  - Provide the lowest standby power with advanced burst mode and lower operating current.

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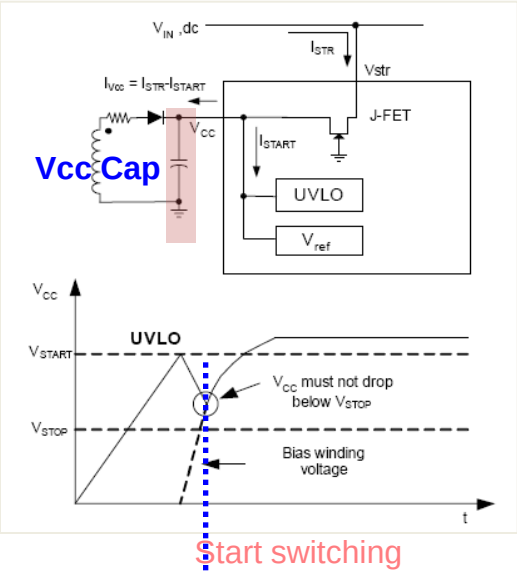
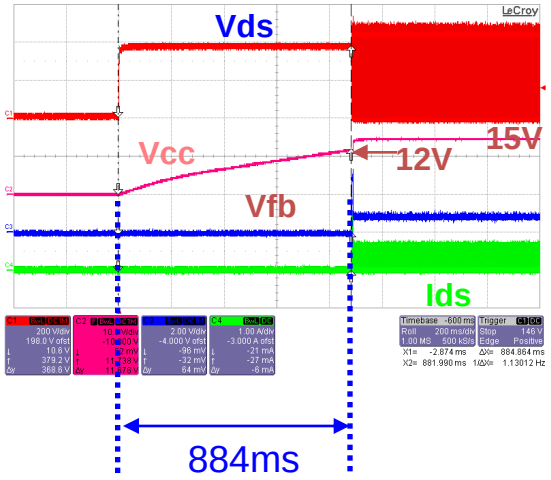
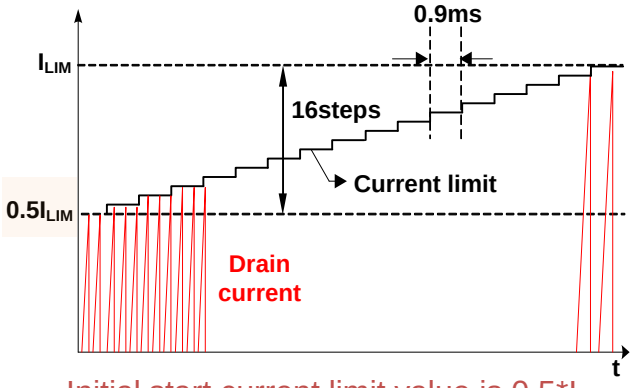
Start up Sequence and Soft Start



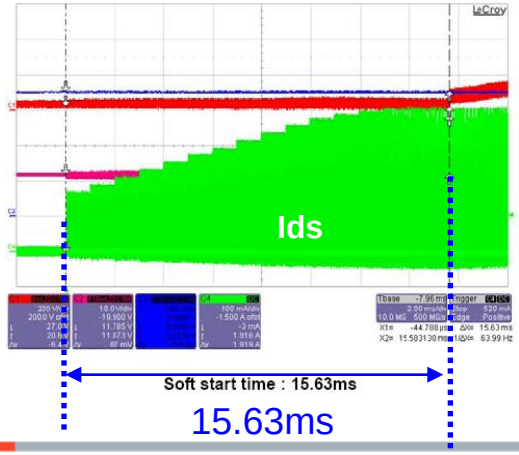


Start up

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



Initial start current limit value is $0.5*I_{LIMIT}$ 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

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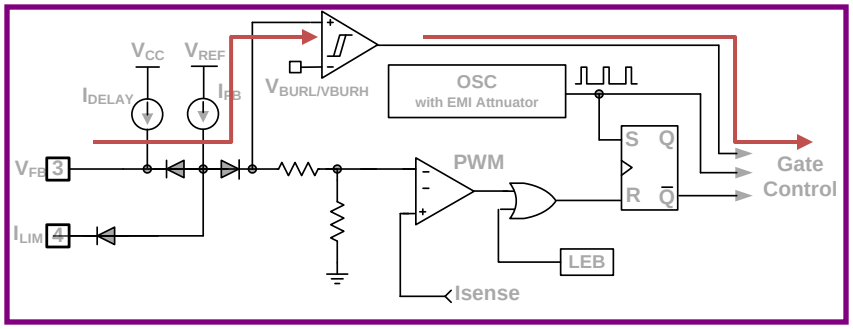
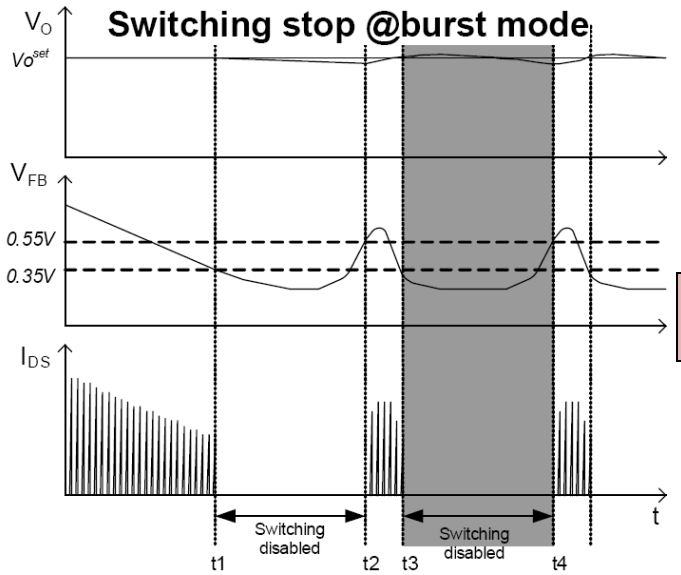
Burst Mode Operation

Data change

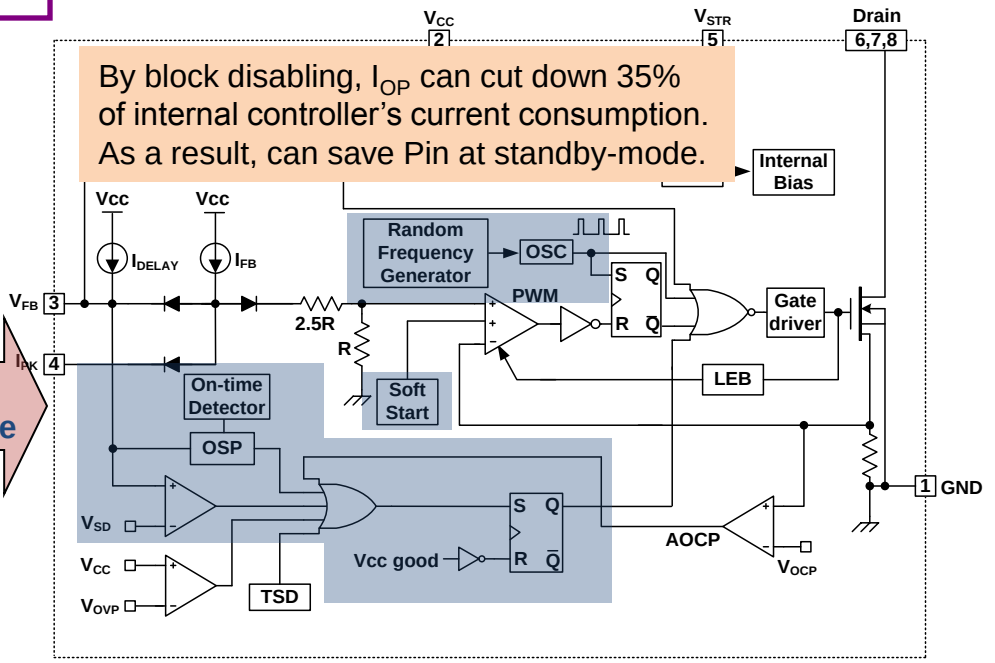
- To minimize power dissipation in standby mode



Output Power	230Vac	265Vac
4.96V / 0A	0.0440W	0.0452W
4.96V / 5mA	0.079W	0.082W
4.96V / 10mA	0.110W	0.112W
4.96V / 20mA	0.179W	0.184W
4.96V / 100mA	0.7085W	0.7163W



Block disable



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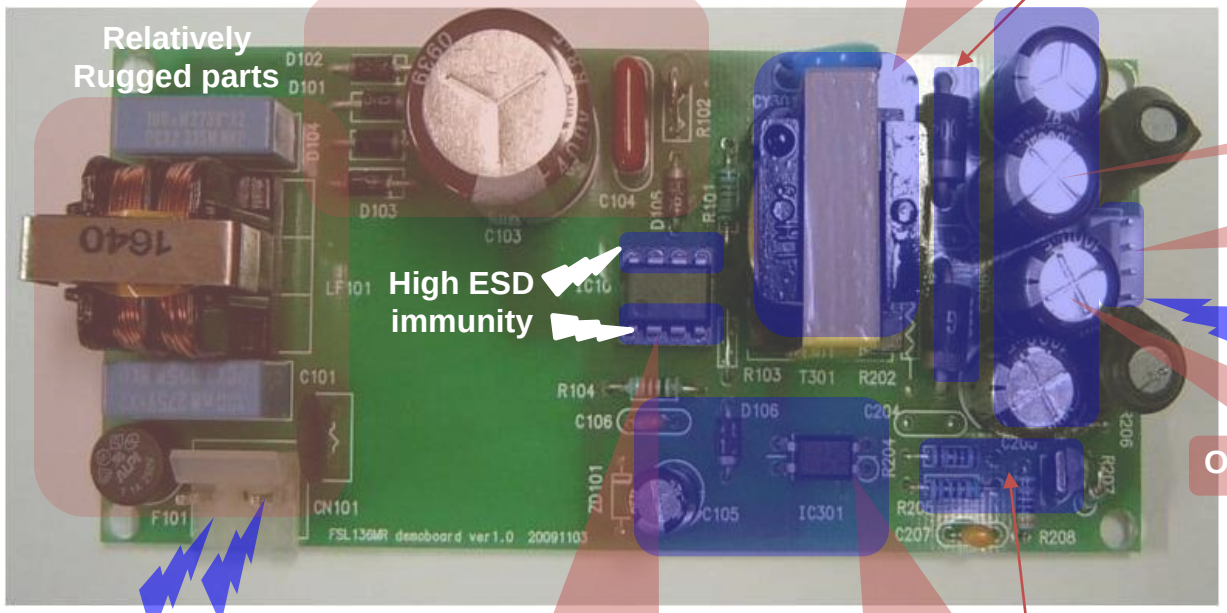
Reliability and Safety

- The semiconductor devices and electrolytic capacitor may have the possibility of failure.
- The opened or shorted parts can be found during assembly process.
  → For all these case, IC should protect other device and not be exploded itself.

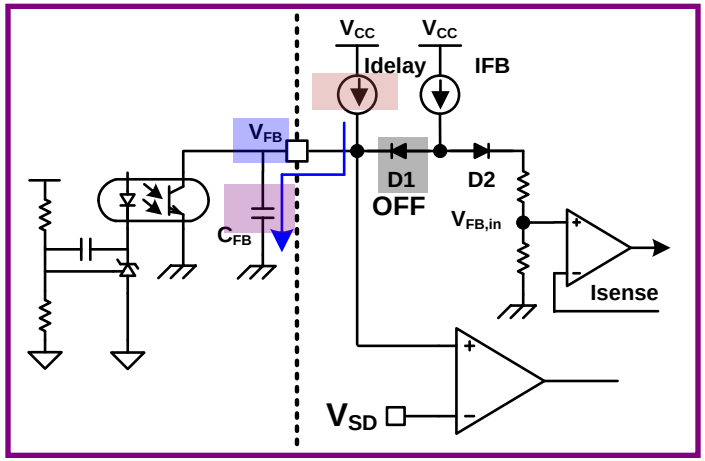


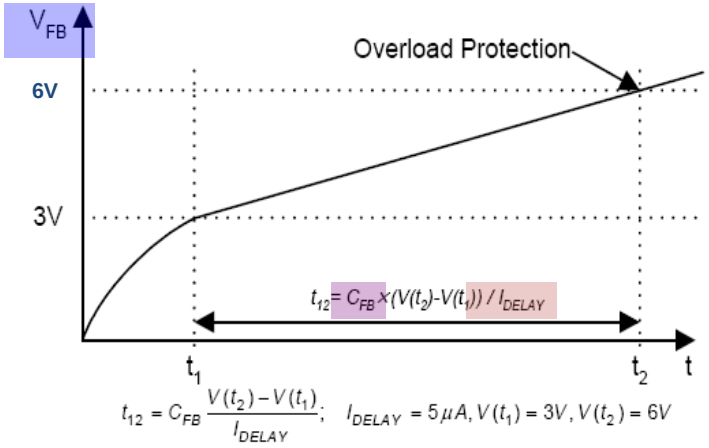
Failure possibility parts (Open or short) ⟷ **Protected by OCP, OLP, OVP, AOCP, OSP, TSD**

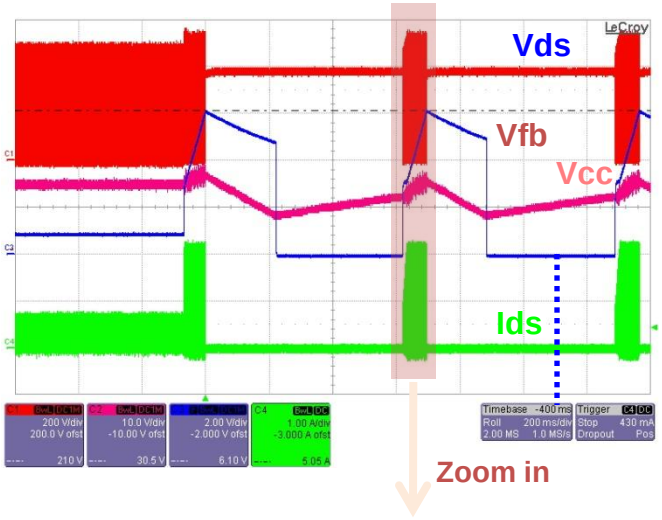
Integrated Protections: OLP

OLP (Over Load Protection)

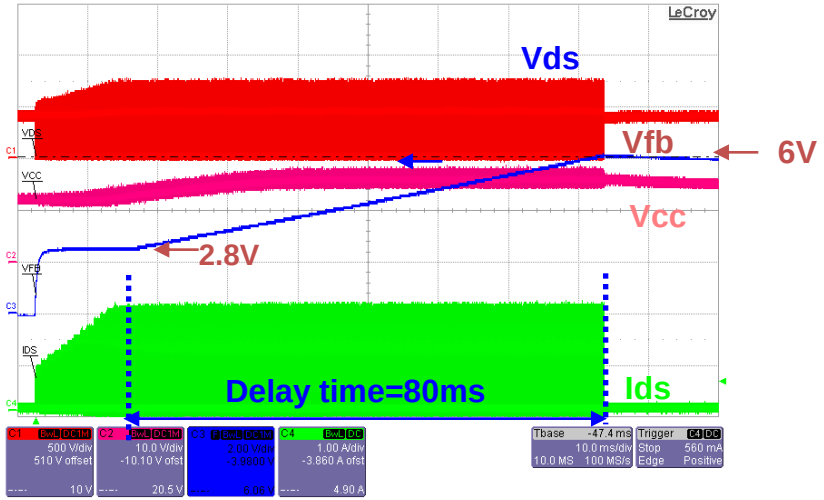
- V_{FB} exceeds 3V, I_{delay} current starts to charge C_{FB}(5uA).
- V_{FB} = 6V, switching operation is terminated
- T_{12} : the delay time for shutdown







Zoom in



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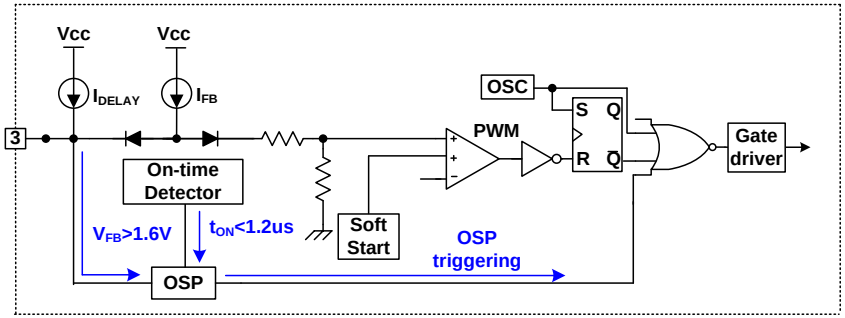
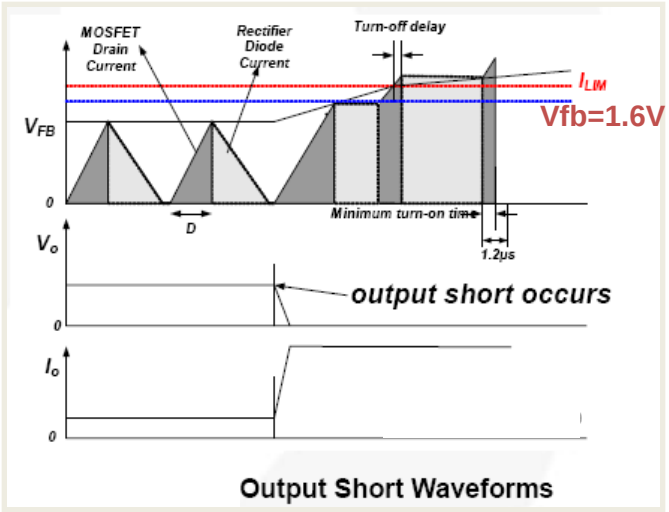
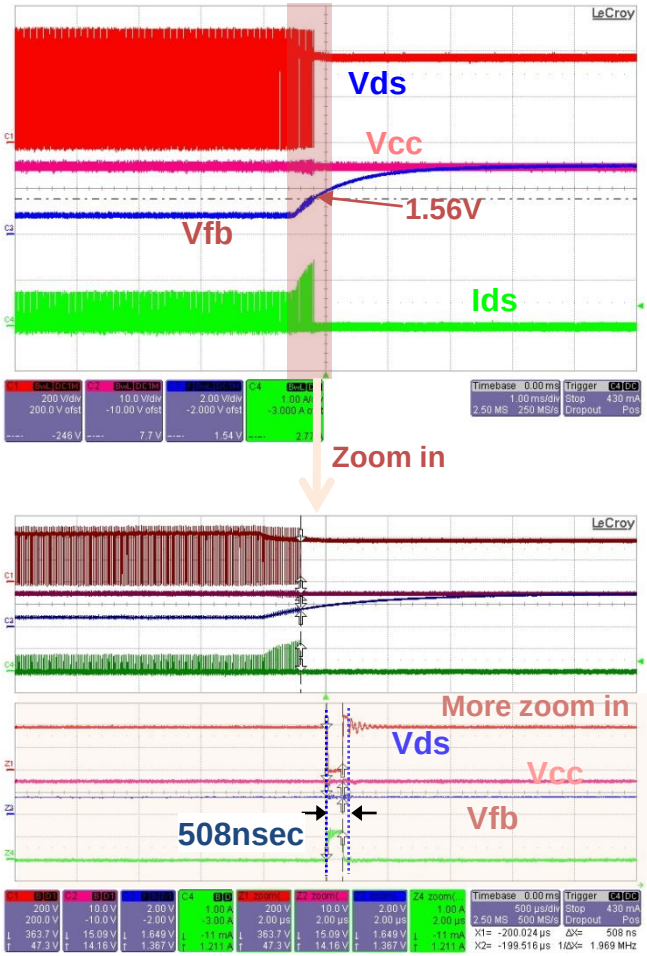
Integrated Protections: OSP

OSP (Output Short Protection)

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







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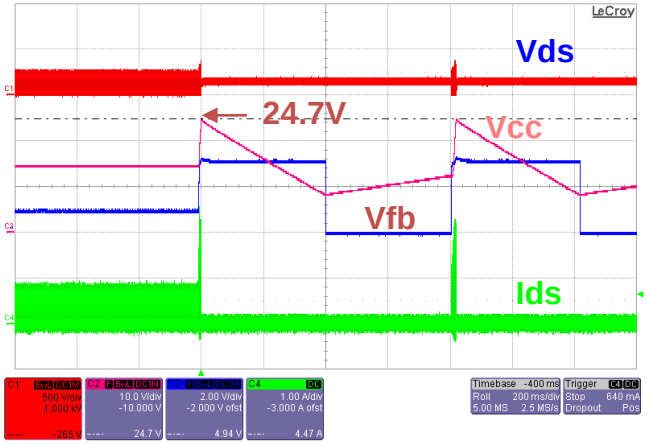
Integrated Protections: OVP and AOCP

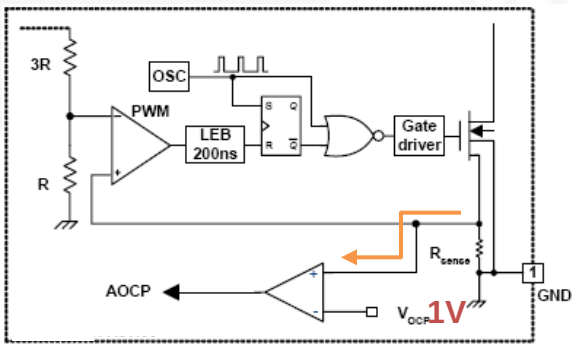


OVP (Over Voltage Protection)

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

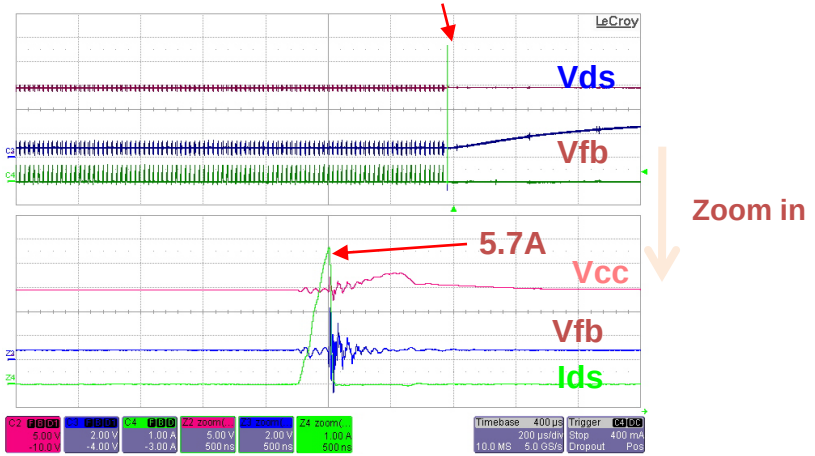
AOCP (Abnormal Over Current Protection)

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



Abnormal Over-Current Protection

AOCP trigger



Zoom in

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ESD Performance

ESD Test Result

Device	Item	Test Data [V]	Reference Standard
FSDM0365	HBM	2000	JEDEC
FSQ110	HBM	2000	JEDEC
FSQ311	HBM	2500	JEDEC
FSL Family	HBM	5000	JEDEC
	CDM	2000	JEDEC

* Note: 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.

Ruggedness Comparison: VDMOS vs. LDMOS

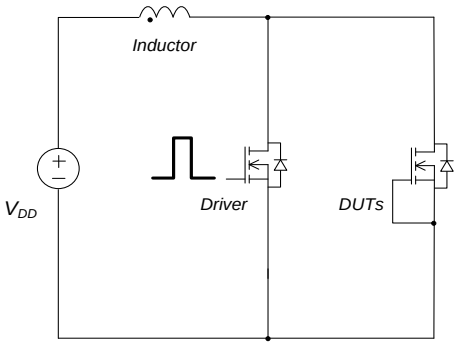
- **Background**
  - Internal MOSFET of FPS™ power switch has the vertical structure MOSFET(VDMOS)
  - Competitor A has the lateral structure MOSFET(LDMOS).
  - Lateral structure is suitable for integration but not for obtaining high voltage ratings meanwhile Competitor A's solution is single chip design.
  - Drain and source terminal of vertical structure are placed on the opposite sides of a wafer so suitable for a high voltage devices.

- **FPS™ solution has higher avalanched energy than competitors**.

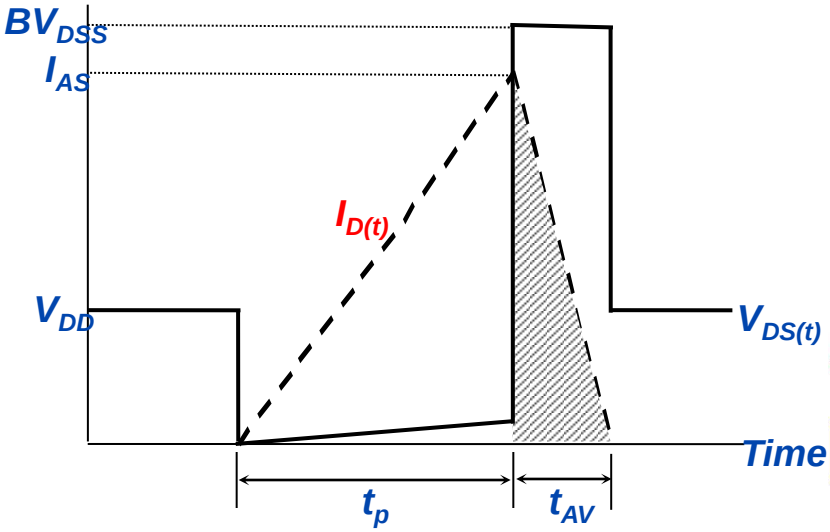
Product	Integrated Switch	B.V	Rdosn(max)	E_{AS} using low current capability driver	E_{AS} using high current capability driver
FSGM0565	VDMOS	650V	2.2 ohm	135mJ	424mJ
Competitor A	LDMOS	725V	2.3 ohm	3.12mJ	3.67mJ

- **VDMOS is much stronger breakdown point than LDMOS, so high avalanche energy is guaranteed.**

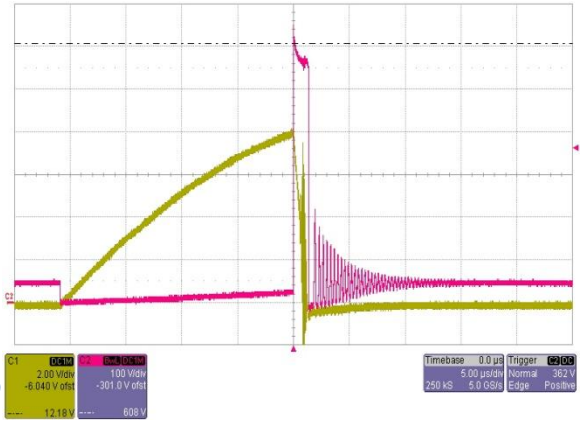
Test Method for UIS and E_{AS}: VDMOS vs. LDMOS



Test Circuit



Unclamped inductive switching waveforms



Test Waveform

- Waveform shows the drain voltage and current when a single pulse is supplied at the unclamped inductive load circuit.
  - $I_{D(t)}$ can be changed by the inductor load size, supply voltage (V_{DD}) and the gate pulse width (t_P).
  - The shaded area of the avalanche region (t_{AV}) shows the dissipation energy (E_{AS}). E_{AS} can be calculated with the following equation.

$$E_{AS} = \frac{1}{2} L_L I_{AS}^{\ 2} \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

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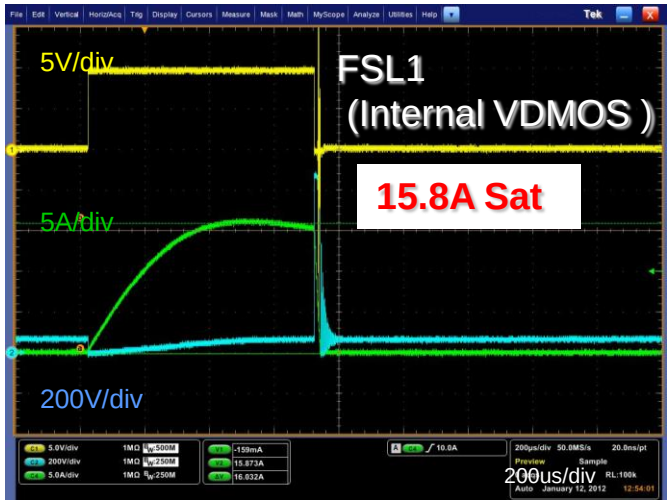
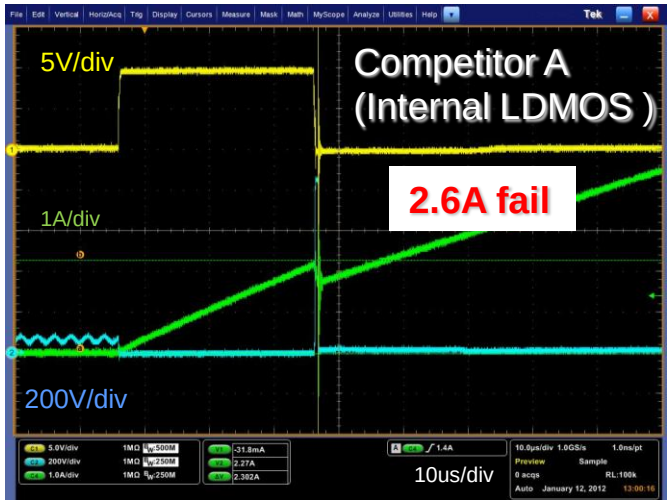
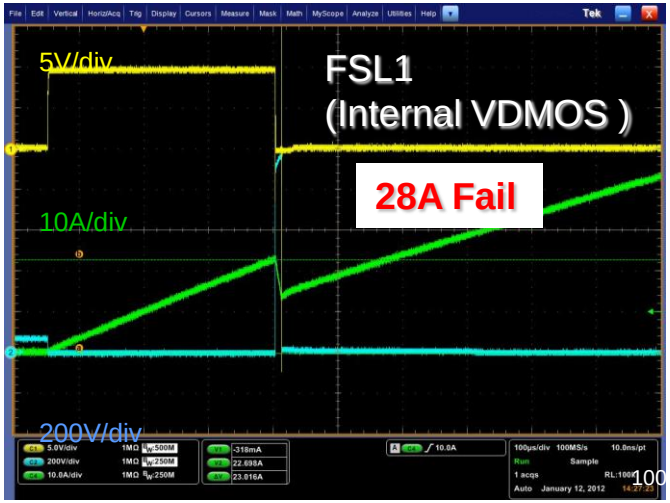
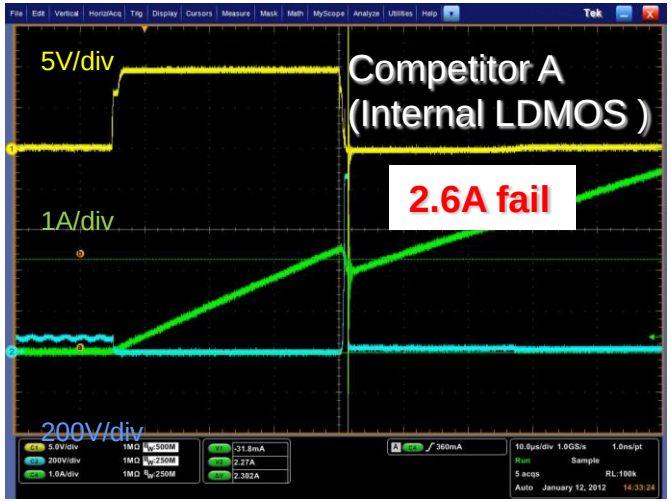
Test Waveforms: VDMOS vs. LDMOS





* Test condition :
VGS=10V, VDD=70V,
RG=50ohm,
Driver=FQPF8N90C,
L=1mH





* Test condition :
VGS=10V, VDD=70V,
RG=50ohm,
Driver=FGL35N120FTD,
L=1mH

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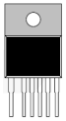
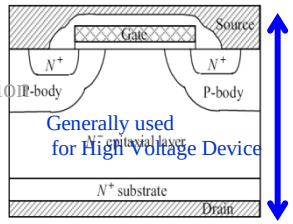
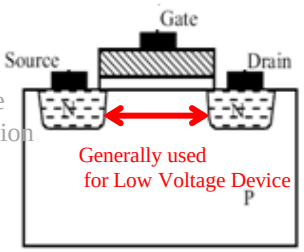
Comparison Table

	FSL 1Series	Competitor Part
BVDSS	**650V, 700V, 800V**	**650V, 700V, 725V**
Reliability In MOSFET	**VDMOS** Vertical Structure  General Structure Information  Strong at Breakdown condition (UniFET: E_{AS}=400mJ)	**LDMOS** Lateral Structure  General Structure Information  Very Weak at Breakdown condition (Eas = 4mJ)
Stand-by Power Consumption	**< 25mW~40mW at 265 VAC /No Load**	**<50mW~100mW at 265 VAC /No Load**
Secondary Short Protections	**Abnormal OCP, Output Short Protection**	**N/A**

Fairchild's Value Added Solutions
FPS™ FSLx series

Improves System Performance, Cost-efficiency

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FSL1 Series

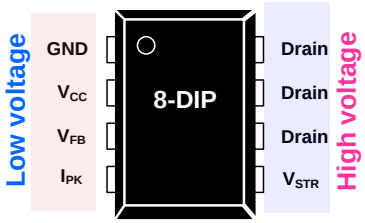
❑ Description

The FSL1 integrates PWM & Sense FETs, designed for high- performance Switch Mode Power Supplies (SMPS) with minimal external components.

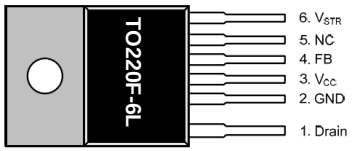
❑ Key Functions

- •Avalanche Rugged Sense FET (650V, 700V, 800V)
- • Standby Power <50mW at 265Vac, No-load
- • Precision Fixed Operating Frequency with Frequency Jittering for Attenuating EMI
- • Internal High-Voltage Start-up and Built-in Soft Start
- • Low Operating Current (1.8mA)
- • Protections: OVP, OLP, OSP, AOCP, TSD with AR
- • Adjustable Peak Current Limit
- • Ruggedness for ESD Immunity
- • Wide range Vcc voltage (24V)

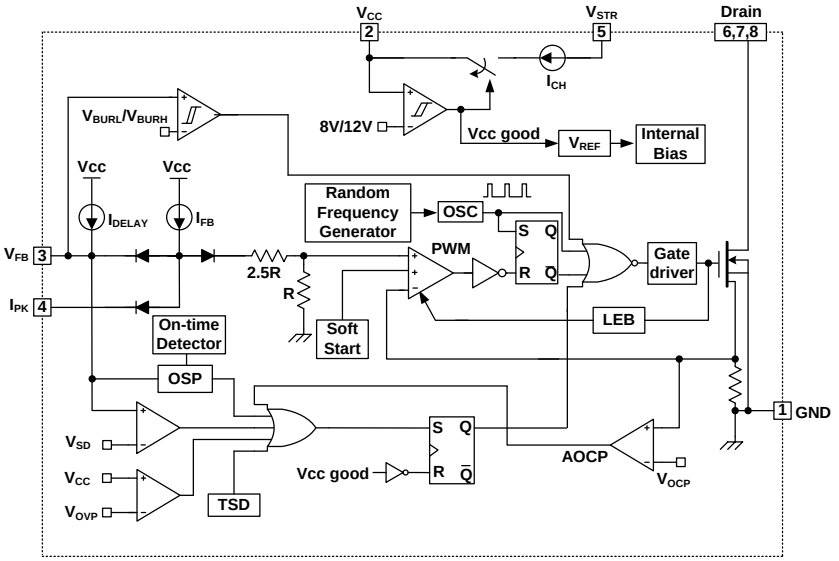
❑ Package



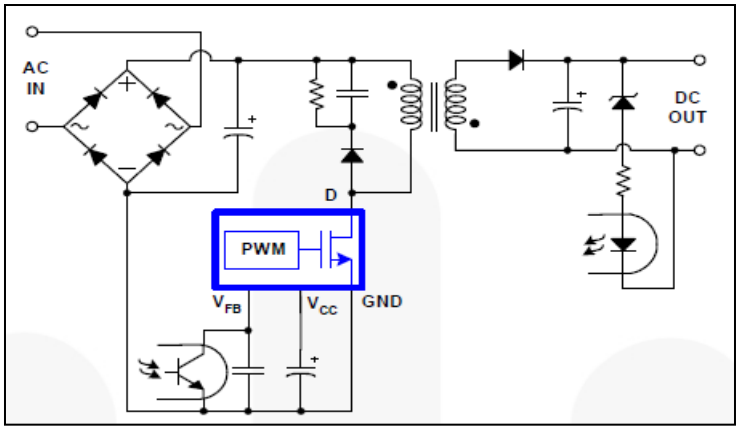
No Creepage issue
UL Safety spec meet



❑ Block Diagram



❑ Application Circuit



FAIRCHILD SEMICONDUCTOR®

FSL1x7MRIN for Home Appliance Single Platform

❑ Key Technology

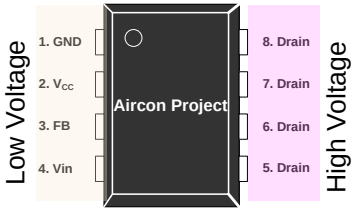
- Avalanche Rugged Sense FET (700V)
- Start-up JFET (700V)

❑ Key Application

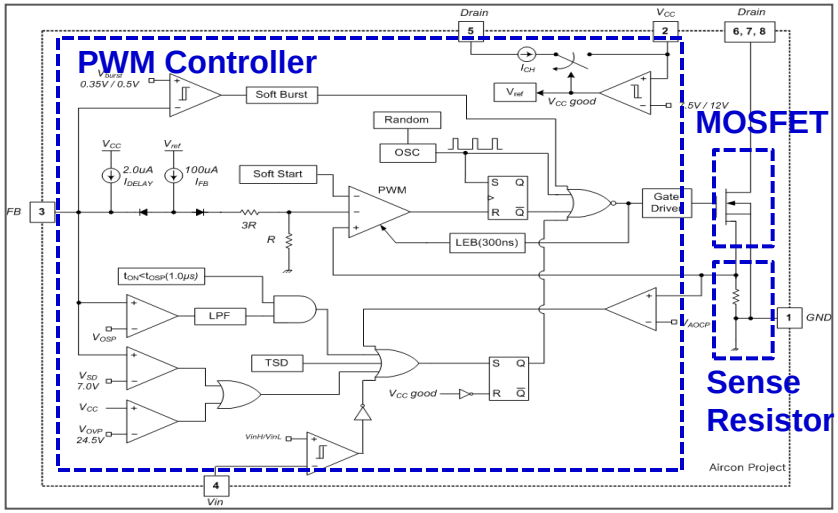
- Input OVP protects Bridge Diode, Input Capacitor, MOSFET
- Single platform for Domestic Model and Export Model

❑ Product Line-up

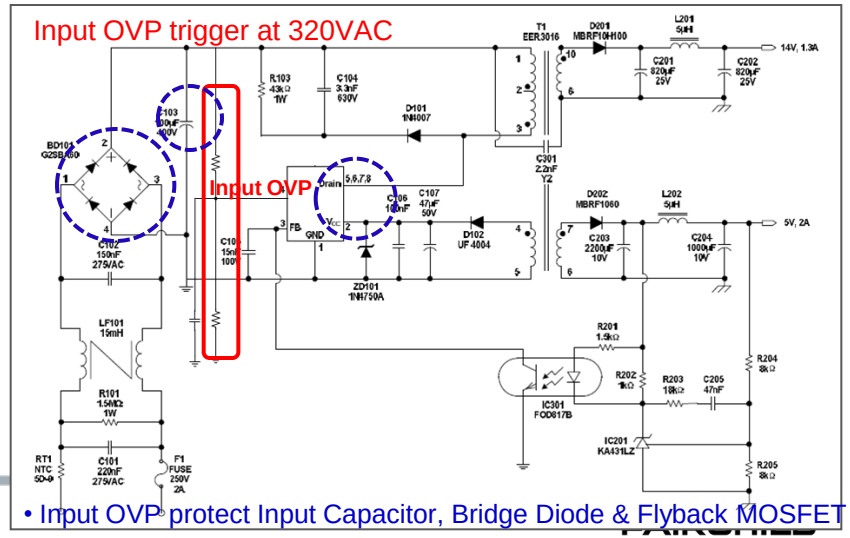
- FSL117MRIN : Rdosn.max= 10Ohm
- FSL127MRIN : Rdosn.max= 6Ohm
- FSL137MRIN : Rdosn.max= 4Ohm
- FSL156MRIN : Rdosn.max= 2.2Ohm



❑ IC Block Diagram



❑ SMPS Design



FSL2 Series

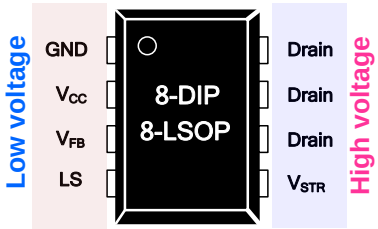
❑ Description

The FSL2 Series integrates PWM & Sense FETs, designed for high- performance Switch Mode Power Supplies (SMPS) with minimal external components.

❑ Key Functions

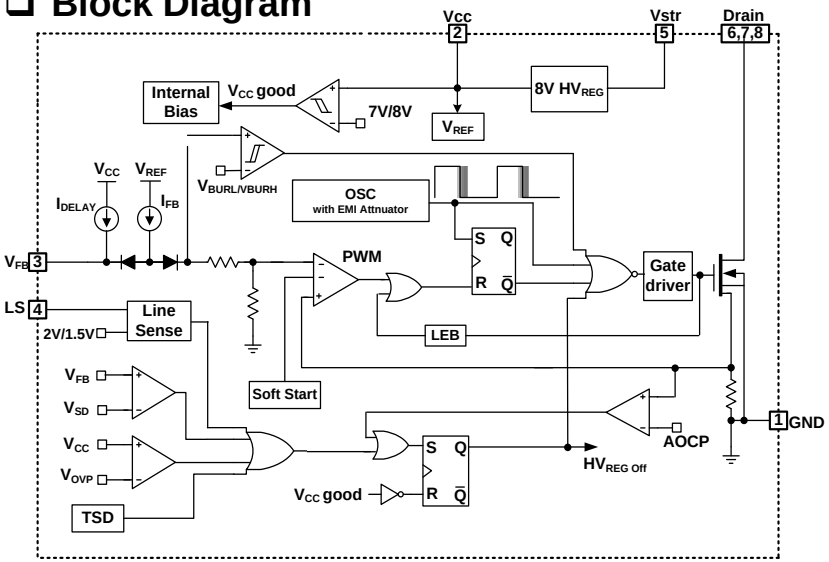
- Internal Rugged 650V SenseFET
- Precision Fixed Operating (67kHz)
- No-load Power Consumption:
  <150mW at 265VAC w/o bias wind
  <25mW with bias winding
- Frequency Jitter for attenuating EMI
- No Need for Auxiliary Bias Winding
- Low Under Voltage Lockout (UVLO)
- Ultra low Operating Current :0.3mA and FSL1 is 1.8mA)
- Various Protections: OLP, OVP, AOCP, TSD and LS

❑ Package

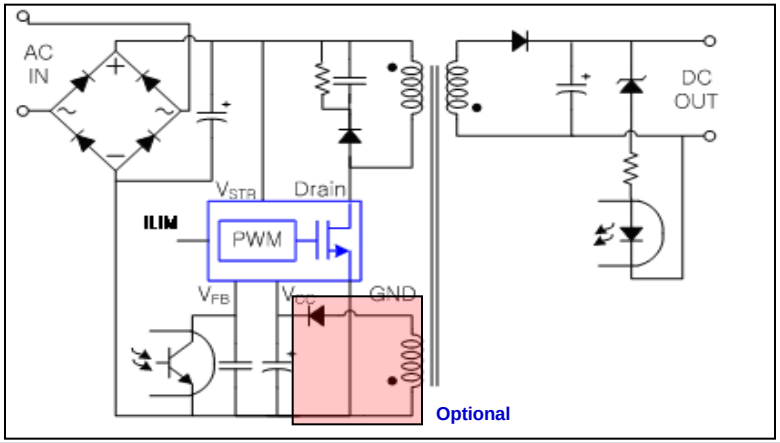


No Creepage issue
UL Safety spec meet

❑ Block Diagram



❑ Application Circuit



FAIRCHILD SEMICONDUCTOR®

FSL3 Series

Sample Available in Q4, 2012

❑ Description

The FSL3 series integrate PWM, MOSFET and Sense Resistor and it is designed for high- performance Buck , Buck-Boost and Non-Isolation flyback Switch Mode Power Supplies with minimal external components.

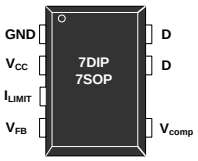
❑ Key Functions

- No Bias winding option
- Green Mode Function in Light Load Range
- TCLD: typ 50ns (TLEB: typ. 200ns)
- No Load Standby consumption <125mW with non-bias winding
- No Load Standby consumption <25mW with bias winding
- I limit Adjustable for flexible OCP Design
- Multi level TSD for flexible load response
- OLP, OVP in Auto Restart mode (650msec sleeping time)

❑ FSL3 Series

Part Number	Operating Junction Temperature	Package	Packing	Current Limit	$R_{DS(ON),MAX}$
FSL306LRN	-40℃~125℃	DIP7	Rail	0.3A	18Ω
FSL306LRQX	-40℃~125℃	PowerMLP	Tape&Reel	0.3A	18Ω
FSL326LRN	-40℃~125℃	DIP7	Rail	0.8A	6Ω
FSL326LRQX	-40℃~125℃	PowerMLP	Tape&Reel	0.8A	6Ω
FSL336LRN	-40℃~125℃	DIP7	Rail	1.1A	4Ω

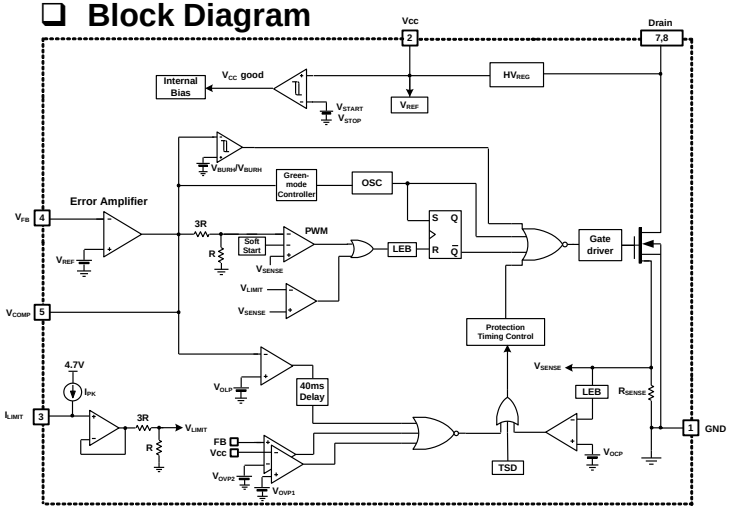
❑ Package



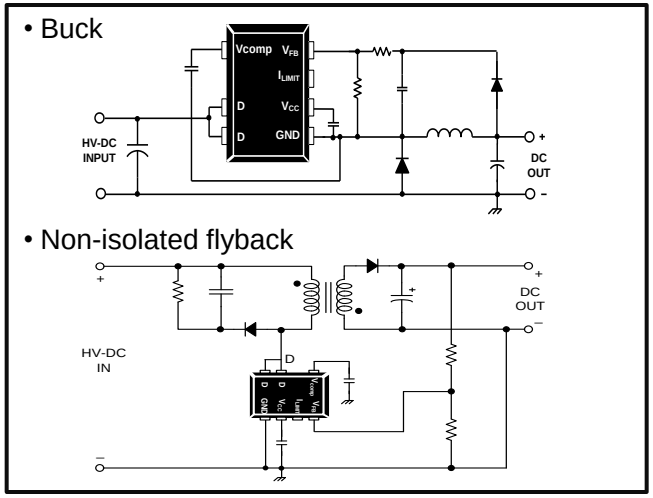
DIP7

PowerMLP

❑ Block Diagram



❑ Application Circuit



FAIRCHILD SEMICONDUCTOR®

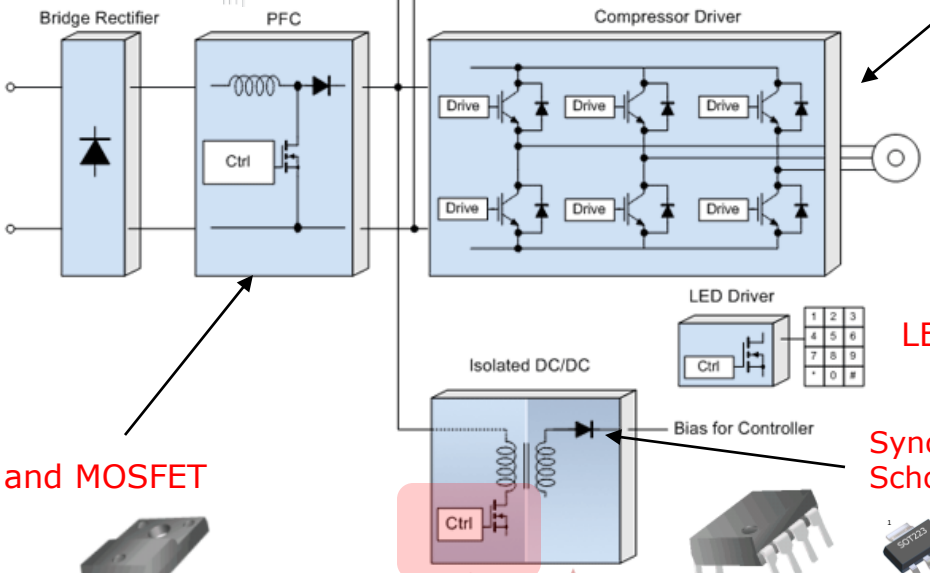
Design Support

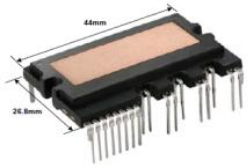
Design Resource Center

Fairchild's Total Solution

Aircon example: System integration for improved reliability and ruggedness.

Bridge Rectifier

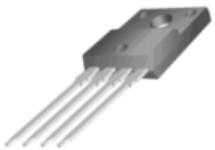




SPM® smart power module
High Voltage Gate Drivers (HVIC)
Discrete MOSFETs

LED Drivers

PFC Controller and MOSFET

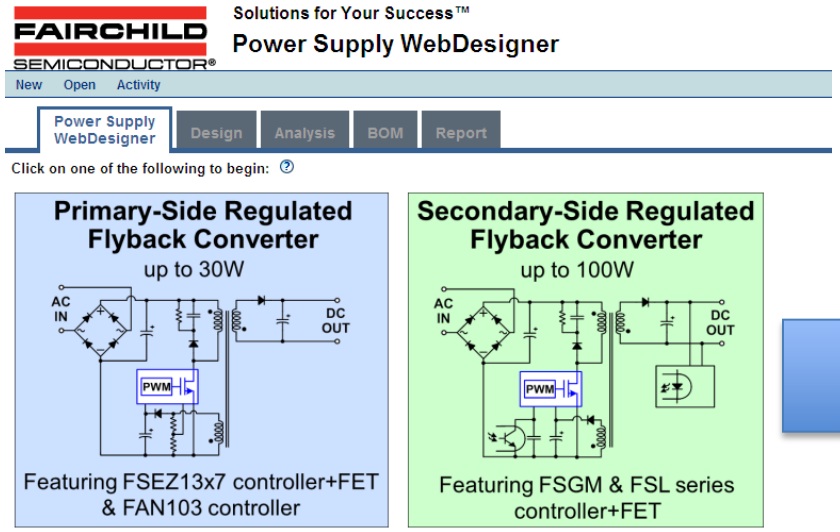


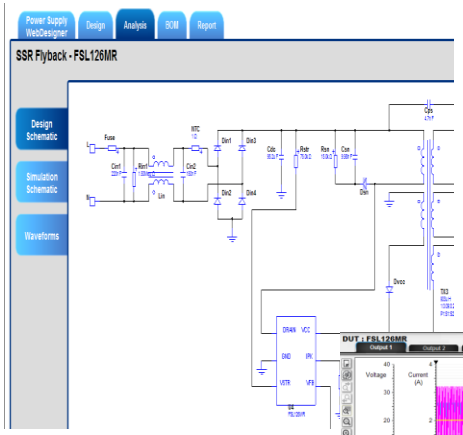
Synchronous Rectifier Controllers and MOSFET
Schottky Diodes

FSL1x Series: Flyback Controller with Integrated MOSFET

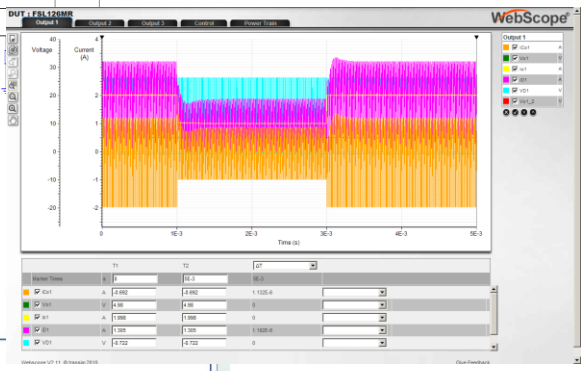
Power Supply Design Web-based Simulation Tool

For the easiest design in a minute with no expense, please visit us on:
http://www.fairchildsemi.com/design_tools/power-supply-webdesigner/

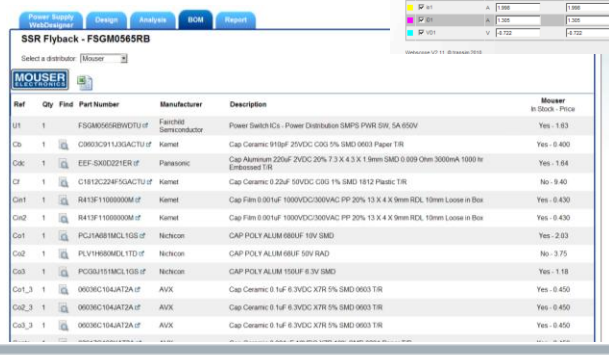




1) Provides the optimized circuit diagram



2) Performance Simulations



3) The optimum result of Bill of Material

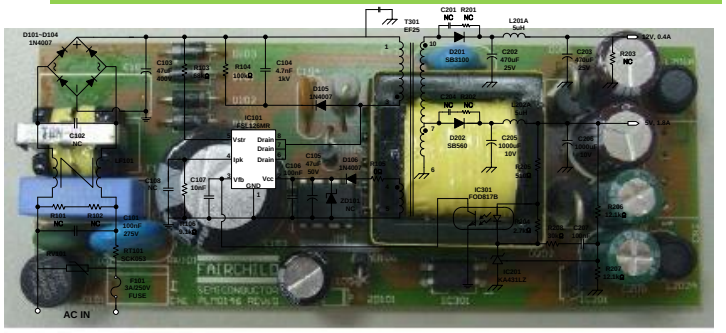
FAIRCHILD SEMICONDUCTOR®

Demo Board for Customer Evaluation

- All FSL1x EVB were prepared for customer evaluation.
- Test report includes all test results and board information.

Application	Part No.	Input voltage range	Rated output power	Output voltage (Rated current)
SMPS	FSL126MR	90-265Vac	13.8W	5V-2A 12V-0.6A

Example of FSL126MR demo board



the power franchise — Evaluation Board of FSL126MR 13.8W — Consumer Product Line

FEB432-001

FSL126MR 5V+12V
Green Mode Fairchild Power Switch (FPS™)

FSL126MR EVB Test Report

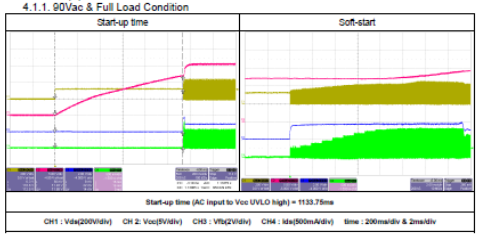
Contents

the power franchise — Evaluation Board of FSL126MR 13.8W — Consumer Product Line

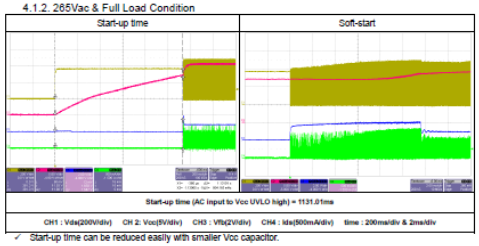
Doc.Title	FEB432-001 Function Test Report	Instituted by	ES Kim

4.1. Start up performance

4.1.1. 90Vac & Full Load Condition



4.1.2. 265Vac & Full Load Condition



✓ Start-up time can be reduced easily with smaller Vcc capacitor.

the power franchise — Evaluation Board of FSL126MR 13.8W — Consumer Product Line

Doc.Title	FEB432-001 BOM	Instituted by	ES Kim

Component	Q'ty	Part No.	Manufacturer	Reference
JUMPER WIRE 0.6*52mm	1			JP1
Metal Oxide Film Resistor 2W-5 100KΩ +/-5%	1			R104
Chip Resistor 0805 0Ω +/-5%	1			R105
Chip Resistor 0805 510Ω +/-5%	1			R205
Chip Resistor 0805 9K1Ω +/-1%	1			R106
Chip Resistor 0805 12K1Ω +/-1%	1			R207
Chip Resistor 0805 30KΩ +/-5%	1			R208
Chip Resistor 1206 2K7Ω +/-5%	1			R204
Chip Resistor 1206 12K1Ω +/-1%	1			R206
Chip Resistor 1206 68KΩ +/-5%	1			R103
NTC 8Ω 5Ω SCK053	1			RT101
Ceramic Capacitor 472P 1KV +80/-20%	1			C104
0805 MLCC X7R +/-10% 103P 50V	1			C107
0805 MLCC X7R +/-10% 104P 50V	2			C106 C207
Electrolytic Capacitor 47u 50V 105℃	1	8*11	Jakycon	C105
Electrolytic Capacitor 47u 400V 105℃	1	18*20 WXA	Rubycon	C103
Electrolytic Capacitor 470u 35V 105℃	2	10*16	NCC	C202 C203
Electrolytic Capacitor 1000u 10V 105℃	2	8*16 GK	SAMXON	C205 C206
X2 Capacitor 0.1u275V +/-20%	1			C101
Y1 Capacitor 102P 250V +/-20%	1			CY301
Inductor DR6X8 5uH	2	TRN0216	SEN HUEI	L201A L202A
Inductor UU9.8 50mH	1	TRN0177	SEN HUEI	LF101
Transformer EF-25-H 1.4mH	1	TRN0310	SEN HUEI	T301
Diode 1A/700V DO-41	6	1N4007	Fairchild	D101 D102 D103 D104 D105 D106
Schottky Diode 3A/100V DO-201AD	1	SB3100	Fairchild	D201
Schottky Diode 3A/60V DO-201AD	1	SB360	Fairchild	D202
IC FOD817B DIP	1		Fairchild	IC301
REGULATOR KA431L +/-0.5%	1		Fairchild	IC201
IC FSL126MR DIP	1		Fairchild	IC101
FUSE BUSS SR-5 1A/250V	1			F101

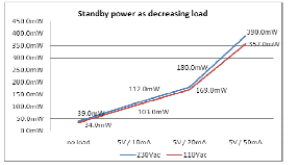
the power franchise — Evaluation Board of FSL126MR 13.8W — Consumer Product Line

Doc.Title	FEB432-001 Function Test Report	Instituted by	ES Kim

4.8. Standby Power Consumption

		90Vac		110Vac		230Vac		265Vac	
		Vo	Io	Vo	Io	Vo	Io	Vo	Io
50mA	5V output	5.002V	50.6mA	5.002V	50.6mA	5.001V	50.6mA	5.001V	50.6mA
	12V output	12.290V	0.0mA	12.300V	0.0mA	12.380V	0.0mA	12.420V	0.0mA
	Input power	355.0mW		357.0mW		389.0mW		403.0mW	
20mA	5V output	5.002V	20.6mA	5.002V	20.6mA	5.002V	20.6mA	5.002V	20.6mA
	12V output	12.120V	0.0mA	12.130V	0.0mA	12.210V	0.0mA	12.220V	0.0mA
	Input power	168.0mW		169.0mW		180.0mW		181.0mW	
10mA	5V output	5.002V	10.1mA	5.002V	10.1mA	5.002V	10.1mA	5.002V	10.1mA
	12V output	12.010V	0.0mA	12.020V	0.0mA	12.050V	0.0mA	12.080V	0.0mA
	Input power	104.0mW		103.0mW		112.0mW		117.0mW	
0mA	5V output	5.002V	0.0mA	5.002V	0.0mA	5.002V	0.0mA	5.002V	0.0mA
	12V output	11.690V	0.0mA	11.610V	0.0mA	11.610V	0.0mA	11.610V	0.0mA
	Input power	33.0mW		34.0mW		39.0mW		44.0mW	

✓ Above test result represents changing 5V load condition with no load condition of 12V output.



FAIRCHILD SEMICONDUCTOR®

Available Evaluation Board List for Order

Fairchild controller	Output Power	Output spec	Switching frequency [kHz]	Application	FEB ID
FSL106MR	**6W**	Output 1: 3.3V/0.2A Output 2: 15V/0A, Output 3: 20V/0.2A	67	**Flyback**	FEB429-001
FSL106HR	**6W**	Output 1: 3.3V/0.2A Output 2: 15V/0A Output 3: 20V/0.2A	100	**Flyback**	FEB430-001
FSL116HR	**12.3W**	Output 1: 5V/1.5A Output 2: 12V/0.4A	100	**Flyback**	FEB431-001
FSL126MR	**13.8W**	Output 1: 5V/1.8A Output 2: 12V/0.4A	67	**Flyback**	FEB432-001
FSL127H	**10.2W**	12V/0.8A	100	**Flyback**	FEB353-001
FSL136MR	**17.2W**	Output: 5V/2A, Output 2: 12V/0.6A	67	**Flyback**	FEB443-001
FSL137H	**15W**	5V/3A	100	**Flyback**	FEB441-001
FSL206MR	**2.19W** (No bias winding)	Output 1: 3.3V/0.15A, Output 2: 5V/0.15A (LDO output) Output 3:15.75V/0.06A (LDO output)	67	**Non-isolation Flyback**	FEB451-001
	5W	5V/1A	67	**Flyback**	FEB482-001
	2.1W (No external bias)	Output 1: 5V/0.06A, Output 2: 15V/0.12A	67	**Buck**	FEB445-001
	2.1W	Output 1: 5V/0.06A, Output 2: 15V/0.12A	67	**Buck**	FEB440-001
FSQ500L	**2W**	5V/0.4A	130	**Flyback**	FEB257-001
	1.2W	12V/0.1A	130	**Buck**	FEB273-001
FSL136MRT	**23W**	Under preparing (EVB available)	67	**Flyback**	
FSL138MRT	**23W**	Under preparing	67	**Flyback**	

Appendix

FSLx Series Line-up

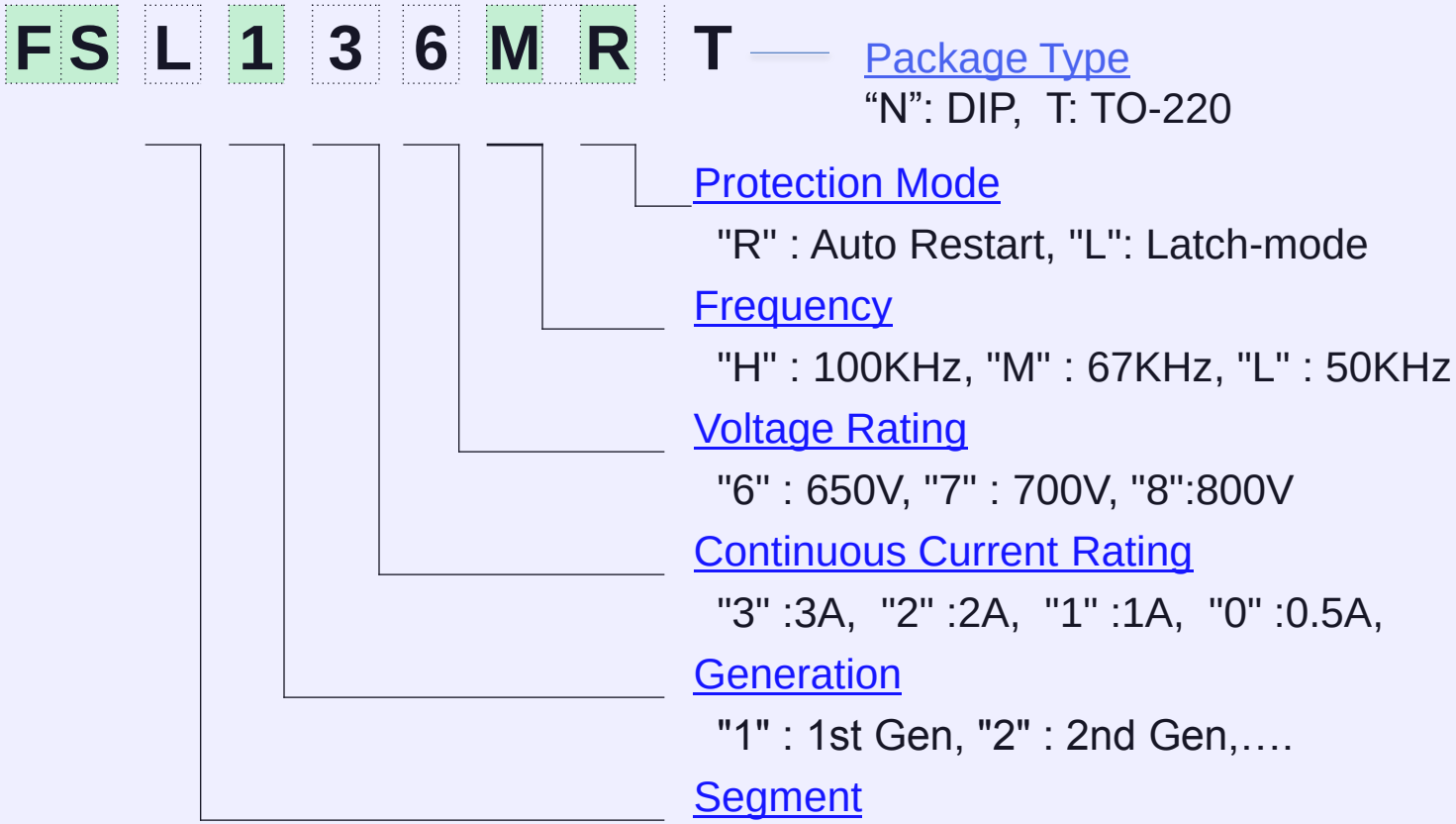
Part ID	Package	Specification			Protection	Status
		VDSS	Max Output Power Open Frame (85-265Vac) Watt	Fsw		
FSL176MRT	TO220F-6L	650V	**70 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSGM0565R	TO220F-6L	650V	**60 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSGM0465R	TO220F-6L	650V	**48 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL136MRT	TO220F-6L	650V	**35 W**	67Khz	OLP, TSD, AOCP, OVP	Released
FSL138MRT	TO220F-6L	800V	**35 W**	67Khz	OLP, TSD, AOCP, OVP	Released
FSL156MRBN	DIP8	650V	**30 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL156MRIN	DIP8	650V	**30 W**	67Khz	Input OVP, OLP, TSD, AOCP, OVP, OSP	Released
FSL126MRT	TO220F-6L	650V	**25 W**	67Khz	OLP, TSD, AOCP, OVP	Released
FSL128MRT	TO220F-6L	800V	**25 W**	67Khz	OLP, TSD, AOCP, OVP	Released
FSL146MRBN	DIP8	650V	**25 W**	67Khz	OLP, TSD, OVP	Released
FSL137MIRN	DIP8	700V	**20 W**	67Khz	Input OVP, OLP, TSD, AOCP, OVP, OSP	ER Sample
FSL136HR	DIP8/LSOP8	650V	**20 W**	100Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL136MR	DIP8	650V	**20 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL126MR	DIP8	650V	**17 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL126HR	DIP8	650V	**17 W**	100Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL127MIRN	DIP8	700V	**17 W**	67Khz	Input OVP, OLP, TSD, AOCP, OVP, OSP	ER Sample
FSL117MIRN	DIP8	700V	**14 W**	67Khz	Input OVP, OLP, TSD, AOCP, OVP, OSP	Released
FSL116LR	DIP8	650V	**14 W**	50Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL116HR	DIP8	650V	**14 W**	100Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL106MR	DIP8	650V	**8 W**	67Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL106HR	DIP8	650V	**8 W**	100Khz	OLP, TSD, AOCP, OVP, OSP	Released
FSL206MR	DIP8/LSOP8	650V	**7 W**	67Khz	Brownout, OLP, TSD, AOCP, OVP	Released
FSQ501L	SOT223	700V	**6 W**	130KHz	OLP, TSD, OVP, OVP	ER Sample
FSQ500N	DIP8	700V	**6 W**	130KHz	OLP, TSD, OVP, OVP	Released
FSQ500L	SOT223	700V	**2 W**	130KHz	OLP, TSD, OVP, OVP	Released

FSLx Series Line-up

Part Number	Core Device	Protections*	Self-bias	External function (external components)	Standby power consumption
FSL136M/HR	FSL136MR	OLP, OVP, TSD, AOCP, OSP	No	Current limit adjustable (1 resistor)	Under 50mW at 265Vac
FSL126M/HR					
FSL116L/HR					
FSL106M/HR					
FSL206MRN/MRBN	FSL206MRN	OLP, OVP, TSD, AOCP	Yes	Brown in/out function (2 resistor & 1 capacitor)	Under 25mW at 265Vac (Under 150mW for self-bias)
FSL206MRL					
FSL117MRIN	FSD176MRT	OLP, OVP, TSD, AOCP, OSP	No	Input OVP (2 resistor & 1 capacitor)	Under 40mW at 265Vac
FSL156MRIN					
FSL136MRT		OLP, OVP, TSD, AOCP		No external function	
FSL126MRT					
FSL138MRT					
FSL128MRT					
FSL176MRT		OLP, OVP, TSD, AOCP, OSP			
FSQ500L	FSQ500L	OLP and TSD	Yes	No external function	Under 60mW at 265Vac (Under 250mW for self-bias)

* OLP : Over Load Protection, OVP : Over Voltage Protection, TSD : Thermal Shut Down Protection, AOCP : Abnormal Over Current Protection, OSP : Output Short Protection

FSLx Series Naming Rule



Thank You

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