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#### June 2015

## FPAM50LH60 PFC SPM<sup>®</sup> 2 Series for 2-Phase Interleaved PFC

### Features

- UL Certified No.E209024 (UL1557)
- 600 V 50 A 2-Phase Interleaved PFC with Integral Gate Driver and Protection
- Very Low Thermal Resistance Using Al<sub>2</sub>O<sub>3</sub> DBC Substrate
- Full-Wave Bridge Rectifier and High-Performance Output Diode
- Optimized for 20kHz Switching Frequency
- Built-in NTC Thermistor for Temperature Monitoring
- Isolation Rating: 2500 V<sub>rms</sub>/min

## **Applications**

• 2-Phase Interleaved PFC Converter

## **General Description**

The FPAM50LH60 is a PFC SPM<sup>®</sup> 2 module providing a fully-featured, high-performance Interleaved PFC (Power Factor Correction) input power stage for consumer, medical, and industrial applications. These modules integrate optimized gate drive of the built-in IGBTs to minimize EMI and losses, while also providing multiple on-module protection features including under-voltage lockout, over-current shutdown, thermal monitoring, and fault reporting. These modules also feature a fullwave rectifier and high-performance output diodes for additional space savings and mounting convenience.



Fig. 1. 3D Package Drawing (Click to Activate 3D Content)

## Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FPAM50LH60	FPAM50LH60	S32EA-032	Rail	8

## Integrated Drive, Protection and System Control Functions

- For IGBTs: gate drive circuit, Over-Current Protection (OCP), control supply circuit Under-Voltage Lock-Out (UVLO) Protection
- Fault signal: corresponding to OC and UV fault
- Built-in thermistor: temperature monitoring
- Input interface : active-HIGH interface, works with 3.3 / 5 V logic, Schmitt trigger input

## **Pin Configuration**



Pin Number	Pin Name	Pin Description
1	C <sub>SC</sub>	Signal Input for Over-Current Detection
2,6,10	СОМ	Common Supply Ground
3	V <sub>FO</sub>	Fault Output
4	IN <sub>X</sub>	PWM Input for X IGBT Drive
5	IN <sub>Y</sub>	PWM Input for Y IGBT Drive
7	N.C	No Connection
8,9	V <sub>CC</sub>	Common Supply Voltage of IC for IGBT Drive
11	R <sub>TH</sub>	Series Resistor for The Use of Thermistor
12	V <sub>TH</sub>	Thermistor Bias Voltage
13,14	N <sub>R</sub>	Negative DC-Link of Rectifier Diode
15,16,17	N.C	No Connection
18,19	R	AC Input for R-Phase
20,21	N.C	No Connection
22,23	S	AC Input for S-Phase
24,25	Р	Output of Diode
26	P <sub>Y</sub>	Input of Diode
27	N.C	No Connection
28	P <sub>X</sub>	Input of Diode
29	X	Output of X Phase IGBT
30	Y	Output of Y Phase IGBT
31	N <sub>P</sub>	Negative DC-Link of IGBT
32	P <sub>R</sub>	Positive DC-Link of Rectifier Diode

## Internal Equivalent Circuit



FPAM50LH60 PFC SPM® 2 Series for 2-Phase Interleaved PFC

## Absolute Maximum Ratings (T<sub>J</sub> = 25°C, unless otherwise specified.)

#### **Converter Part**

Symbol	Parameter	Conditions	Rating	Unit
V <sub>i</sub>	Input Supply Voltage	Applied between R - S	264	V <sub>rms</sub>
V <sub>PN</sub>	Output Voltage	Applied between X - N <sub>P</sub> , Y - N <sub>P</sub> , P - P <sub>X</sub> , P - P <sub>Y</sub>	450	V
V <sub>PN(Surge)</sub>	Output Supply Voltage (Surge)	Applied between X - N <sub>P</sub> , Y - N <sub>P</sub> , P - P <sub>X</sub> , P - P <sub>Y</sub>	500	V
V <sub>CES</sub>	Collector-emitter Voltage	Breakdown Voltage between X - N <sub>P</sub> , Y - N <sub>P</sub>	600	V
V <sub>RRM</sub>	Repetitive Peak Reverse Voltage of FRD	Breakdown Voltage between P - P <sub>X</sub> , P - P <sub>Y</sub>	600	V
V <sub>RRMR</sub>	Repetitive Peak Reverse Voltage of Rec- tifier	Breakdown Voltage between $P_R - R$ , $P_R - S$ , R - $N_R$ , S - $N_R$	900	V
*I <sub>F</sub>	FRD Forward Current	T <sub>C</sub> = 25°C, T <sub>J</sub> < 125°C	50	А
*I <sub>FSM</sub>	Peak Surge Current of FRD	Non-Repetitive, 60 Hz Single Half-Sine Wave	500	А
*I <sub>FR</sub>	Rectified Forward Current	T <sub>C</sub> = 25°C, T <sub>J</sub> < 125°C	50	А
*I <sub>FSMR</sub>	Peak Surge Current of Rectifier	Non-Repetitive, 60 Hz Single Half-Sine Wave	500	А
± *I <sub>C</sub>	Each IGBT Collector Current	T <sub>C</sub> = 25°C, T <sub>J</sub> < 125°C	50	А
± *I <sub>CP</sub>	Each IGBT Collector Current(Peak)	$T_C = 25^{\circ}C, T_J < 125^{\circ}C,$ Under 1 ms Pulse Width	100	A
*P <sub>C</sub>	Collector Dissipation	T <sub>C</sub> = 25°C per IGBT	135	W
TJ	Operating Junction Temperature	(1st Note 1)	-40 ~ 125	°C

#### 1st Notes:

1. The maximum junction temperature rating of the power chips integrated within the PFC  $\text{SPM}^{\textcircled{B}}$  product is 125°C.

2. Marking "\*" is calculation value or design factor.

### **Control Part**

Symbol	Parameter	Conditions	Rating	Unit
V <sub>CC</sub>	Control Supply Voltage	Applied between V <sub>CC</sub> - COM	20	V
V <sub>IN</sub>	Input Signal Voltage	Applied between IN <sub>X</sub> , IN <sub>Y</sub> - COM	$-0.3 \sim V_{CC} + 0.3$	V
V <sub>FO</sub>	Fault Output Supply Voltage	Applied between V <sub>FO</sub> - COM	$-0.3 \sim V_{CC} + 0.3$	V
I <sub>FO</sub>	Fault Output Current	Sink Current at V <sub>FO</sub> Pin	1	mA
V <sub>SC</sub>	Current Sensing Input Voltage	Applied between C <sub>SC</sub> - COM	-0.3 ~ V <sub>CC</sub> + 0.3	V

## **Total System**

Symbol	Parameter	Conditions	Rating	Unit
T <sub>STG</sub>	Storage Temperature		-40 ~ 125	°C
V <sub>ISO</sub>	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat-Sink Plate	2500	V <sub>rms</sub>

## **Thermal Resistance**

Symbol	Parameter	Condition	Min.	Тур.	Max.	Unit
R <sub>th(j-c)Q</sub>	Junction to Case Thermal	Each IGBT under Operating Condition	-	-	0.74	°C/W
R <sub>th(j-c)D</sub>	Resistance	Each Diode under Operating Condition	-	-	1.13	°C/W
R <sub>th(j-c)R</sub>		Each Rectifier under Operating Condition	-	-	0.74	°C/W

## Electrical Characteristics (T<sub>J</sub> = 25°C, unless otherwise specified.)

#### **Converter Part**

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
V <sub>CE(SAT)</sub>	IGBT Saturation Voltage	$V_{CC} = 15 \text{ V}, V_{IN} = 5 \text{ V}, I_C = 50 \text{ A}$	-	1.7	2.2	V
V <sub>FF</sub>	FRD Forward Voltage	I <sub>F</sub> = 50 A	-	1.9	2.4	V
V <sub>FR</sub>	Rectifier Forward Voltage	I <sub>FR</sub> = 50 A	-	1.13	1.35	V
I <sub>RR</sub>	Switching Characteristic	$V_{PN} = 400 \text{ V}, V_{CC} = 15 \text{ V}, I_{C} = 25 \text{ A},$	-	27	-	А
t <sub>RR</sub>		$V_{IN} = 0 V \leftrightarrow 5 V$ , Inductive Load (1st Note 3),	-	55	-	ns
t <sub>ON</sub>			-	772	-	ns
t <sub>OFF</sub>			-	1117	-	ns
t <sub>C(ON)</sub>			-	110	-	ns
t <sub>C(OFF)</sub>			-	125	-	ns
I <sub>CES</sub>	Collector - Emitter Leakage Current	V <sub>CES</sub> = 600 V	-	-	250	μΑ

1st Notes:

3. t<sub>ON</sub> and t<sub>OFF</sub> include the propagation delay of the internal drive IC. t<sub>C(ON)</sub> and t<sub>C(OFF)</sub> are the switching time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 4.





FPAM50LH60
PFC SPM® 2
2 Series for :
2-Phase Inte
erleaved PFC

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
I <sub>QCC</sub>	Quiescent V <sub>CC</sub> Supply Current	$V_{CC}$ = 15 V, IN <sub>X</sub> , IN <sub>Y</sub> - COM = 0 V, Supply current between $~V_{CC}$ and COM	-	-	2.65	mA
I <sub>PCC</sub>	Operating V <sub>CC</sub> Supply Current	$V_{CC}$ = 15 V, $f_{PWM}$ = 20 kHz, Duty = 50% Applied to One PWM Signal Input per IGBT Supply Current between $V_{CC}$ and COM	-	-	7.0	mA
V <sub>FOH</sub>	Fault Output Voltage	$V_{SC} = 0 \text{ V}, \text{ V}_{FO} \text{ Circuit: } 10 \text{ k}\Omega \text{ to } 5 \text{ V} \text{ Pull-up}$	4.5	-	-	V
V <sub>FOL</sub>		$V_{SC}$ = 1 V, $V_{FO}$ Circuit: 10 k $\Omega$ to 5 V Pull-up	-	-	0.5	V
V <sub>SC(Ref)</sub>	Over-Current Protection Trip Level Voltage of CSC Pin	V <sub>CC</sub> = 15 V	0.45	0.5	0.55	V
UV <sub>CCD</sub>	Supply Circuit Under-	Detection Level	10.5	-	13.0	V
UV <sub>CCR</sub>	Voltage Protection	Reset Level	11.0	-	13.5	V
t <sub>FOD</sub>	Fault-Out Pulse Width		30	-	-	μS
V <sub>IN(ON)</sub>	ON Threshold Voltage	Applied between IN <sub>X</sub> , IN <sub>Y</sub> - COM	2.6	-	-	V
V <sub>IN(OFF)</sub>	OFF Threshold Voltage	Applied between IN <sub>X</sub> , IN <sub>Y</sub> - COM	-	-	0.8	V
R <sub>TH</sub>	Resistance of Thermistor	at T <sub>TH</sub> = 25°C (1st Note 4, Figure 5)	-	47	-	kΩ
		at T <sub>TH</sub> = 100°C (1st Note 4, Figure 5)	-	2.9	-	kΩ

1st Notes:

4.  $T_{TH}$  is the temperature of thermister itself. To know case temperature ( $T_C$ ), please make the experiment considering your application.



**R-T Curve** 

(1) - 20 C, unless otherwise specified.)						
Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
Vi	Input Supply Voltage	Applied between R - S	187	-	253	V <sub>rms</sub>
l <sub>i</sub>	Input Current	$T_{C}$ < 100°C, V <sub>i</sub> = 220 V, V <sub>O</sub> = 360 V, $f_{PWM}$ = 20 kHz per IGBT	-	-	35	A <sub>rms</sub>
V <sub>PN</sub>	Supply Voltage	Applied between X - N <sub>P</sub> , Y - N <sub>P</sub> , P - P <sub>X</sub> , P - P <sub>Y</sub>	-	-	400	V
V <sub>CC</sub>	Control Supply Voltage	Applied between V <sub>CC</sub> - COM	13.5	15.0	16.5	V
dV <sub>CC</sub> /dt	Supply Variation		-1	-	1	V/µs
I <sub>FO</sub>	Fault Output Current	Sink Current at V <sub>FO</sub> Pin	-	-	1	mA
f <sub>PWM</sub>	PWM Input Frequency	-40°C < T <sub>J</sub> < 125°C per IGBT	-	20	-	kHz

## Recommended Operating Conditions (T<sub>J</sub> = 25°C, unless otherwise specified.)

## **Mechanical Characteristics and Ratings**

Parameter	Conditions		Min.	Тур.	Max.	Unit
Mounting Torque	Mounting Screw: M4	Recommended 0.98 N•m	0.78	0.98	1.17	N•m
		Recommended 10 kg•cm	8	10	12	kg•cm
Device Flatness	See Figure 6	See Figure 6		-	+150	μm
Weight			-	32	-	g



Figure 6. Flatness Measurement Position





#### 2nd Notes:

- 1. To avoid malfunction, the wiring of each input should be as short as possible(less than 2 ~ 3 cm).
- 2. V<sub>FO</sub> output is open-drain type. This signal line should be pulled up to the positive-side of the MCU or control power supply with a resistor that makes I<sub>FO</sub> up to 1 mA. 3. Input signal is active-HIGH type. There is a 5 ko resistor inside the IC to pull-down each input signal line to GND. RC coupling circuits is recommanded for the prevention of input signal oscillation.  $R_FC_F$  constant should be selected in the range 50~150ns (recommended  $R_F$  = 100  $\Omega$  ,  $C_F$  = 1 nF).
- 4. To prevent error of the protection function, the wiring related with  $R_{SCF}$  and  $C_{SCF}$  should be as short as possible.
- 5. In the over current protection circuit, please select the R\_{SCF} , C\_{SCF} time constant in the range 1.5 ~ 2  $\mu s.$ 6. Each capacitors should be mounted as close to the PFC SPM® product pins as possible.
- 7. Relays are used at almost every systems of electrical equipments of home appliances. In these cases, there should be sufficient distance between the MCU / controller and the relays.
- 8. Internal NTC thermistor can be used for monitoring of the case temperature and protecting the device from the overheating operation. Select an appropriate resistor RT according to the application.
- 9. It is recommended that anti-parallel diode  $(D_X, D_Y)$  be connected with each IGBT.



Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:

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