

FPAM50LH60G

PFC SPM[®] 2 Series for 2-Phase Interleaved PFC

General Description

The FPAM50LH60G is a PFC SPM 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.

Features

- UL Certified No. E209204 (UL1557)
- 600 V – 50 A 2-Phase Interleaved PFC with Integral Gate Driver and Protection
- Very Low Thermal Resistance Using AlN DBC Substrate
- Full-Wave Bridge Rectifier and High-Performance Output Diode
- Optimized for 20 kHz Switching Frequency
- Built-in NTC Thermistor for Temperature Monitoring
- Isolation Rating: 2500 V_{RMS}/min
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

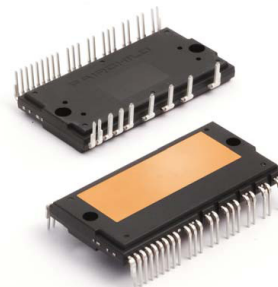
Applications

- 2-Phase Interleaved PFC Converter



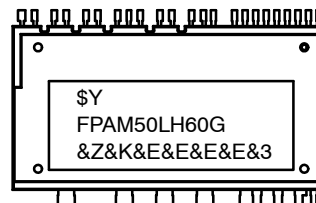
ON Semiconductor[®]

www.onsemi.com



S32CA-032
CASE MODEB

MARKING DIAGRAM



\$Y	= ON Semiconductor Logo
&Z	= Assembly Plant Code
&3	= Numeric Date Code
&K	= Lot Code
&E	=
FPAM50LH60G	= Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

FPAM50LH60G

PACKAGE MARKING AND ORDERING INFORMATION

Device	Device Marking	Package	Packing Type	Quantity
FPAM50LH60G	FPAM50LH60G	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

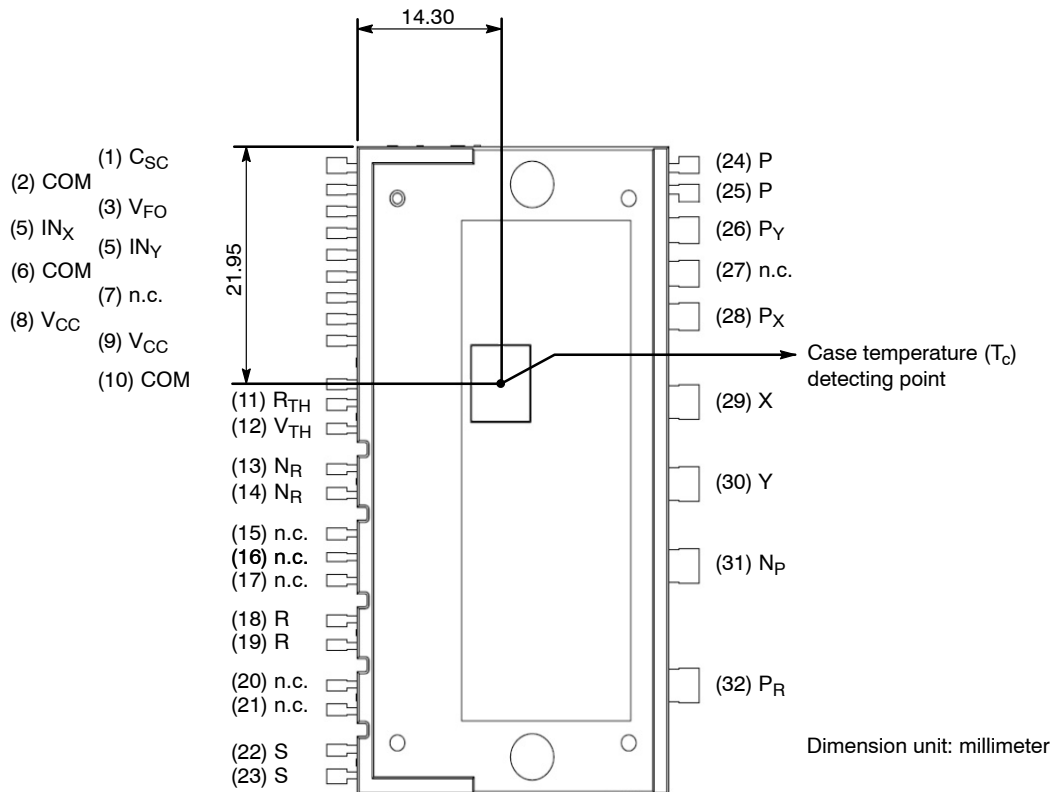


Figure 1. Top View

FPAM50LH60G

PIN DESCRIPTIONS

Pin Number	Pin Name	Pin Description
1	Csc	Signal Input for Over-Current Detection
2, 6, 10	COM	Common Supply Ground
3	VFO	Fault Output
4	IN _X	PWM Input for X IGBT Drive
5	IN _Y	PWM Input for Y IGBT Drive
7	N.C	No Connection
8, 9	VCC	Common Supply Voltage of IC for IGBT Drive
11	R _{TH}	Series Resistor for The Use of Thermistor
12	V _{TH}	Thermistor Bias Voltage
13, 14	N _R	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	P	Output of Diode
26	P _Y	Input of Diode
27	N.C	No Connection
28	P _X	Input of Diode
29	X	Output of X Phase IGBT
30	Y	Output of Y Phase IGBT
31	N _P	Negative DC-Link of IGBT
32	P _R	Positive DC-Link of Rectifier Diode

INTERNAL EQUIVALENT CIRCUIT

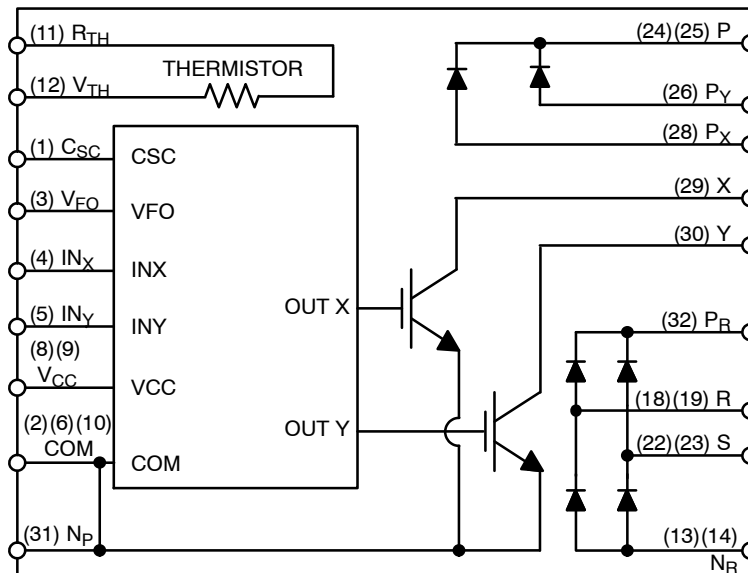


Figure 2. Internal Block Diagram

FPAM50LH60G

ABSOLUTE MAXIMUM RATINGS (T_J = 25°C, Unless otherwise specified)

Symbol	Parameter	Conditions	Rating	Unit
CONVERTER PART				
V _i	Input Supply Voltage	Applied between R – S	264	V _{RMS}
V _{PN}	Output Voltage	Applied between X – N _P , Y – N _P , P – P _X , P – P _Y	450	V
V _{PN(Surge)}	Output Supply Voltage (Surge)	Applied between X – N _P , Y – N _P , P – P _X , P – P _Y	500	V
V _{CES}	Collector-emitter Voltage	Breakdown Voltage between X – N _P , Y – N _P	600	V
V _{RRM}	Repetitive Peak Reverse Voltage of FRD	Breakdown Voltage between P – P _X , P – P _Y	600	V
V _{RRMR}	Repetitive Peak Reverse Voltage of Rectifier	Breakdown Voltage between P _R – R, P _R – S, R – N _R , S – N _R	900	V
*I _F	FRD Forward Current	T _C = 25°C, T _J < 125°C	50	A
*I _{FSM}	Peak Surge Current of FRD	Non-Repetitive, 60 Hz Single Half-Sine Wave	500	A
*I _{FR}	Rectified Forward Current	T _C = 25°C, T _J < 125°C	50	A
*I _{FSMR}	Peak Surge Current of Rectifier	Non-Repetitive, 60 Hz Single Half-Sine Wave	500	A
± *I _C	Each IGBT Collector Current	T _C = 25°C, T _J < 125°C	50	A
± *I _{CP}	Each IGBT Collector Current (Peak)	T _C = 25°C, T _J < 125°C, Under 1 ms Pulse Width	100	A
*P _C	Collector Dissipation	T _C = 25°C per IGBT	588	W
T _J	Operating Junction Temperature	(Note 1)	-40 ~ 125	°C

CONTROL PART

V _{CC}	Control Supply Voltage	Applied between V _{CC} – COM	20	V
V _{IN}	Input Signal Voltage	Applied between IN _X , IN _Y – COM	-0.3 ~ V _{CC} + 0.3	V
V _{FO}	Fault Output Supply Voltage	Applied between V _{FO} – COM	-0.3 ~ V _{CC} + 0.3	V
I _{FO}	Fault Output Current	Sink Current at V _{FO} Pin	1	mA
V _{SC}	Current Sensing Input Voltage	Applied between C _{SC} – COM	-0.3 ~ V _{CC} + 0.3	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Marking “” is calculation value or design factor.

1. The maximum junction temperature rating of the power chips integrated within the PFC SPM product is 125°C.

TOTAL SYSTEM

Symbol	Parameter	Conditions	Rating	Unit
T _{STG}	Storage Temperature		-40 ~ 125	°C
V _{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat-Sink Plate	2500	V _{RMS}

THERMAL RESISTANCE

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
R _{TH(J-C)Q}	Junction to Case Thermal Resistance	Each IGBT under Operating Condition	-	-	0.17	°C/W
R _{TH(J-C)D}		Each Diode under Operating Condition	-	-	0.34	°C/W
R _{TH(J-C)R}		Each Rectifier under Operating Condition	-	-	0.22	°C/W

FPAM50LH60G

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
CONVERTER PART						
V _{CE(SAT)}	IGBT Saturation Voltage	V _{CC} = 15 V, V _{IN} = 5 V, I _C = 50 A	-	1.7	2.2	V
V _{FF}	FRD Forward Voltage	I _F = 50 A	-	1.9	2.4	V
V _{FR}	Rectifier Forward Voltage	I _{FR} = 50 A	-	1.13	1.35	V
IRR	Switching Characteristic	V _{PN} = 400 V, V _{CC} = 15 V, I _C = 25 A, V _{IN} = 0 V ↔ 5 V, Inductive Load (Note 2), per IGBT	-	27	-	A
t _{RR}			-	55	-	ns
t _{ON}			-	772	-	ns
t _{OFF}			-	1117	-	ns
t _{C(ON)}			-	110	-	ns
t _{C(OFF)}			-	125	-	ns
I _{CES}			Collector - Emitter Leakage Current	V _{CES} = 600 V	-	-

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. t_{ON} and t_{OFF} include the propagation delay of the internal drive IC. t_{C(ON)} and t_{C(OFF)} are the switching time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 3.

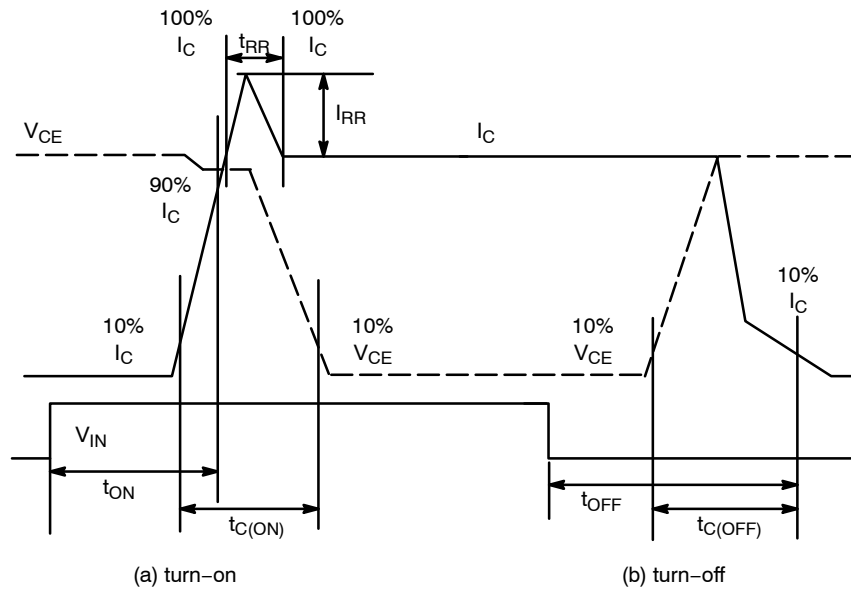


Figure 3. Switching Time Definition

FPAM50LH60G

CONTROL PART

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{QCC}	Quiescent V_{CC} Supply Current	$V_{CC} = 15\text{ V}$, IN_X , $IN_Y - COM = 0\text{ V}$, Supply current between V_{CC} and COM	-	-	2.65	mA
I_{PCC}	Operating V_{CC} Supply Current	$V_{CC} = 15\text{ V}$, $f_{PWM} = 20\text{ kHz}$, Duty = 50% Applied to One PWM Signal Input per IGBT Supply Current between V_{CC} and COM	-	-	7.0	mA
V_{FOH}	Fault Output Voltage	$V_{SC} = 0\text{ V}$, V_{FO} Circuit: 10 k Ω to 5 V Pull-up	4.5	-	-	V
V_{FOL}		$V_{SC} = 1\text{ V}$, V_{FO} Circuit: 10 k Ω to 5 V Pull-up	-	-	0.5	V
$V_{SC(Ref)C(Ref)}$	Over-Current Protection Trip Level Voltage of CSC Pin	$V_{CC} = 15\text{ V}$	0.45	0.5	0.55	V
UV_{CCD}	Supply Circuit Under-Voltage Protection	Detection Level	10.5	-	13.0	V
UV_{CCR}		Reset Level	11.0	-	13.5	V
t_{FOD}	Fault-Out Pulse Width		30	-	-	μs
$V_{IN(ON)}$	ON Threshold Voltage	Applied between IN_X , $IN_Y - COM$	2.6	-	-	V
$V_{IN(OFF)}$	OFF Threshold Voltage	Applied between IN_X , $IN_Y - COM$	-	-	0.8	V
R_{TH}	Resistance of Thermistor	at $T_{TH} = 25^\circ\text{C}$ (Note 3, Figure 4)	-	47	-	k Ω
		at $T_{TH} = 100^\circ\text{C}$ (Note 3, Figure 4)	-	2.9	-	

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

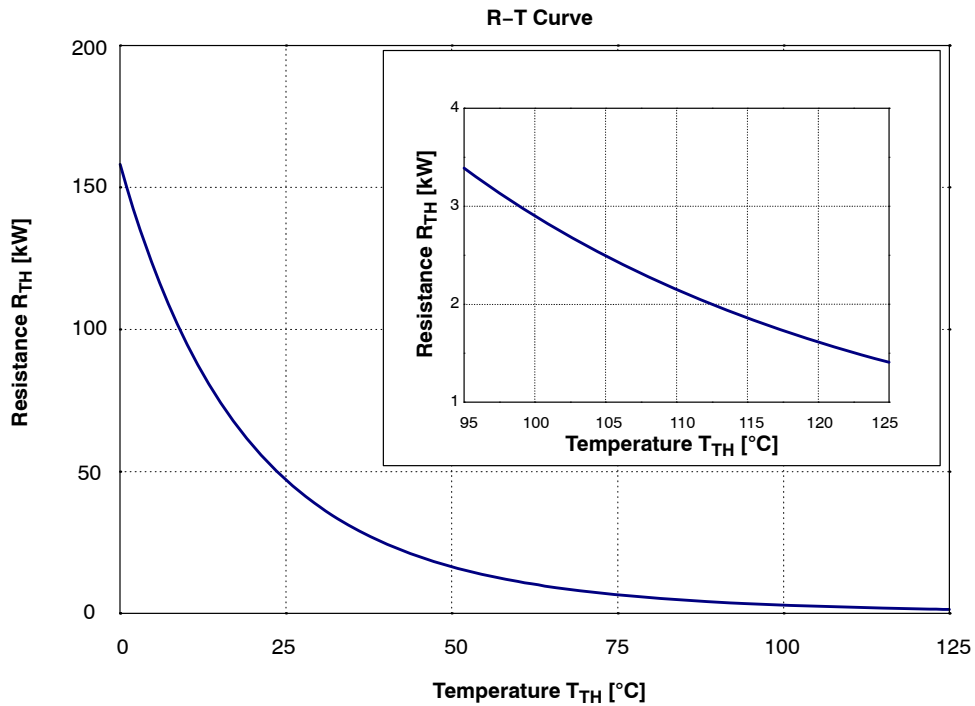


Figure 4. R-T Curve of the Built-in Thermistor

FPAM50LH60G

RECOMMENDED OPERATING CONDITIONS (T_J = 25°C, Unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V _i	Input Supply Voltage	Applied between R – S	187	–	253	V _{RMS}
I _i	Input Current	T _C < 100°C, V _i = 220 V, V _o = 360 V, f _{PWM} = 20 kHz per IGBT	–	–	42	A _{RMS}
V _{PN}	Supply Voltage	Applied between X – N _P , Y – N _P , P – P _X , P – P _Y	–	–	400	V
V _{CC}	Control Supply Voltage	Applied between V _{CC} – COM	13.5	15.0	16.5	V
dV _{CC} /dt	Supply Variation		–1	–	1	V/μs
I _{FO}	Fault Output Current	Sink Current at V _{FO} Pin	–	–	1	mA
f _{PWM}	PWM Input Frequency	–40°C < T _J < 125°C per IGBT	–	20	40	kHz

MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Conditions	Min.	Typ.	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 5	0	–	+150	μm	
Weight		–	32	–	g	

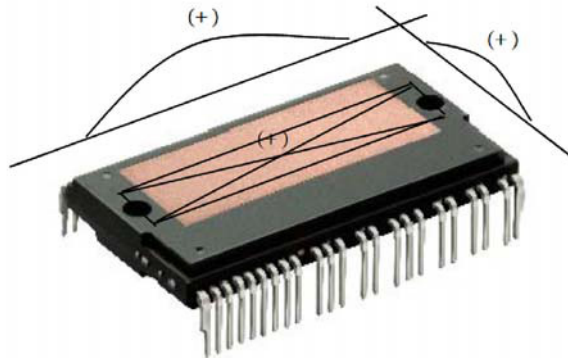
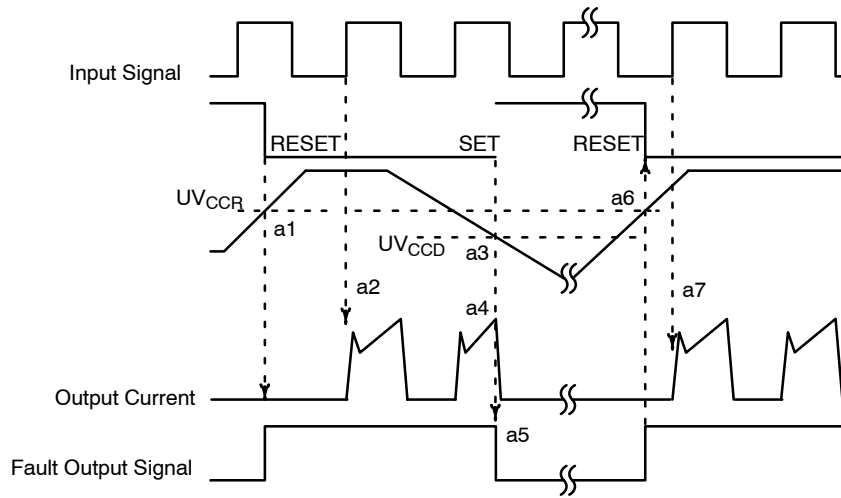


Figure 5. Flatness Measurement Position

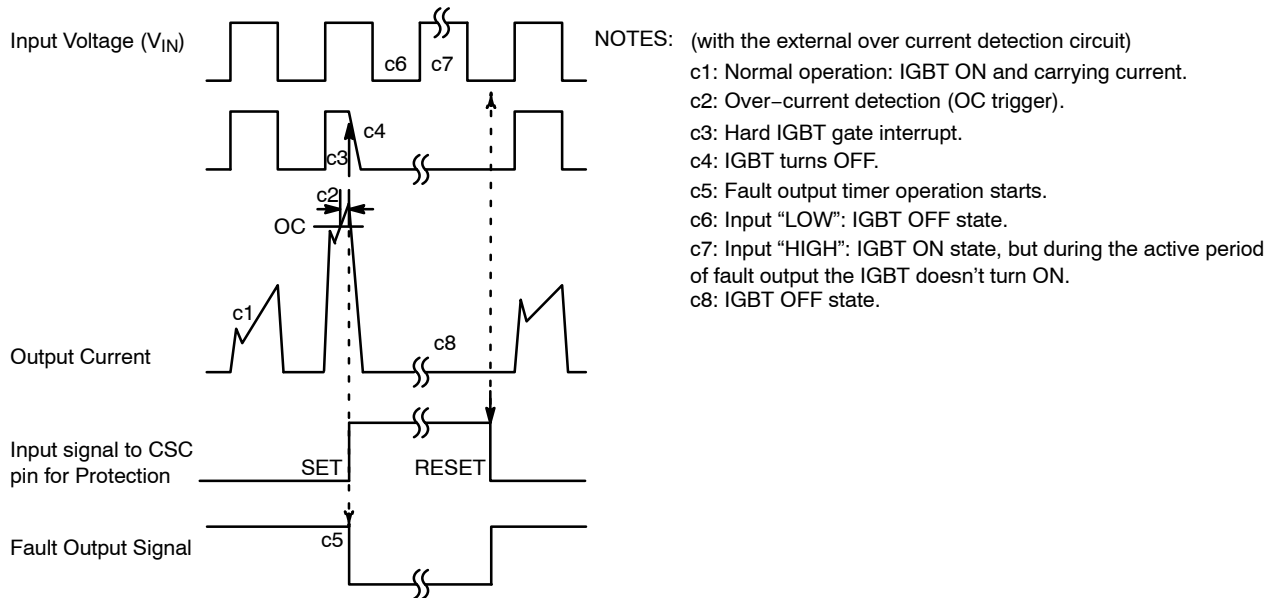
FPAM50LH60G

TIME CHARTS OF PROTECTIVE FUNCTION



- NOTES:
- a1: Control supply voltage rises: after the voltage rises UV_{CCR} , the circuits start to operate when the next input is applied.
 - a2: Normal operation: IGBT ON and carrying current.
 - a3: Under-voltage detection (UV_{CCD}).
 - a4: IGBT OFF in spite of control input condition.
 - a5: Fault output operation starts.
 - a6: Under-voltage reset (UV_{CCR}).
 - a7: Normal operation IGBT ON and carrying current.

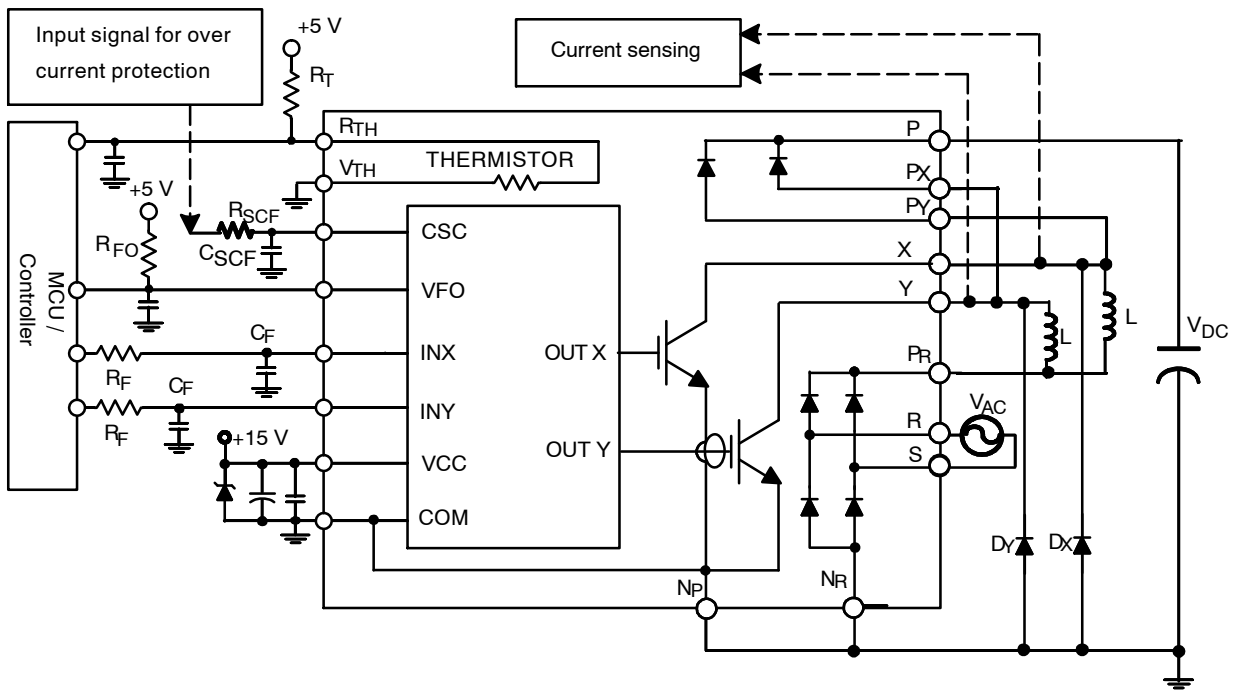
Figure 6. Under-Voltage Protection



- NOTES: (with the external over current detection circuit)
- c1: Normal operation: IGBT ON and carrying current.
 - c2: Over-current detection (OC trigger).
 - c3: Hard IGBT gate interrupt.
 - c4: IGBT turns OFF.
 - c5: Fault output timer operation starts.
 - c6: Input "LOW": IGBT OFF state.
 - c7: Input "HIGH": IGBT ON state, but during the active period of fault output the IGBT doesn't turn ON.
 - c8: IGBT OFF state.

Figure 7. Over Current Protection

FPAM50LH60G



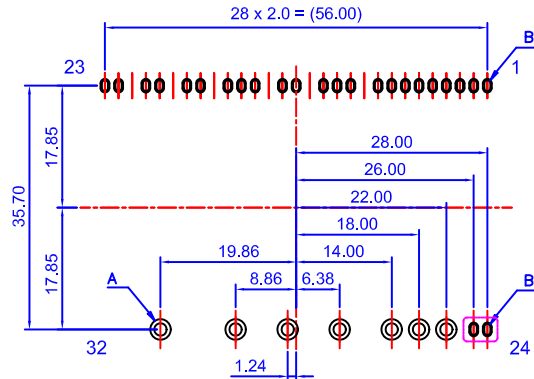
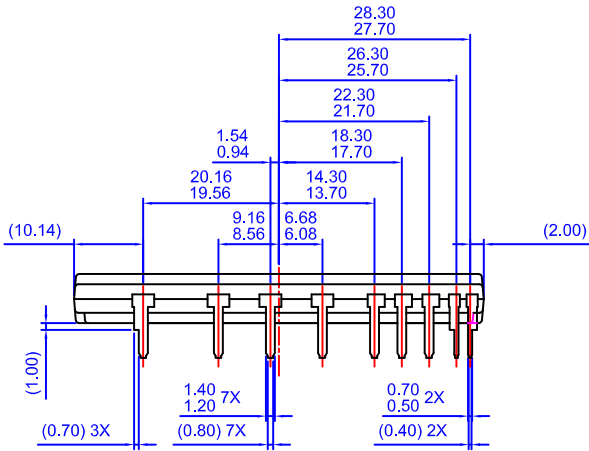
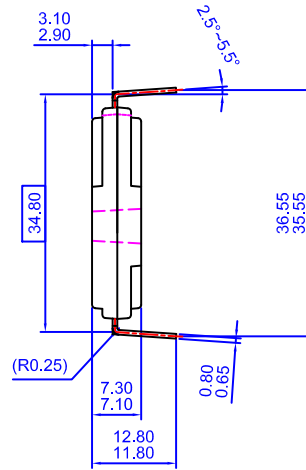
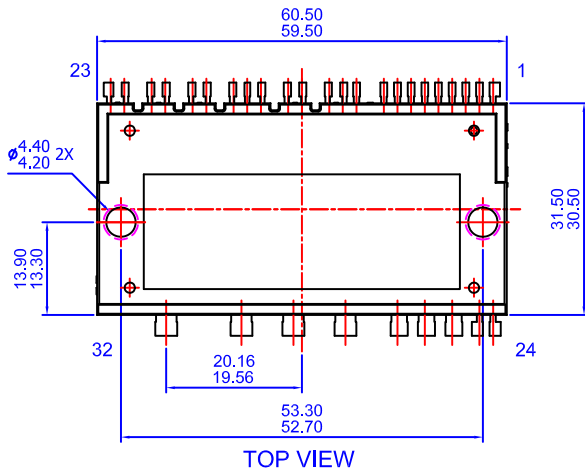
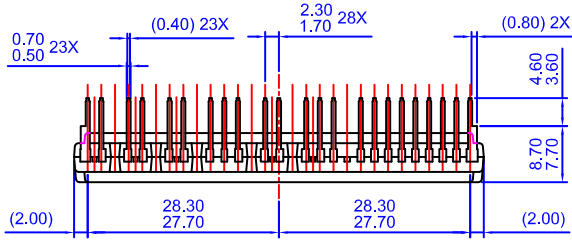
- NOTES:
4. To avoid malfunction, the wiring of each input should be as short as possible (less than 2 ~ 3 cm).
 5. V_{FO} output is open-drain type. This signal line should be pulled up to the positive-side of the MCU or control power supply with a resistor that makes I_{FO} up to 1 mA.
 6. Input signal is active-HIGH type. There is a 5 kΩ resistor inside the IC to pull-down each input signal line to GND. RC coupling circuits is recommended for the prevention of input signal oscillation. R_FC_F constant should be selected in the range 50 ~ 150 ns (recommended R_F = 100 Ω, C_F = 1 nF).
 7. To prevent error of the protection function, the wiring related with R_{SCF} and C_{SCF} should be as short as possible.
 8. In the over current protection circuit, please select the R_{SCF}, C_{SCF} time constant in the range 1.5 ~ 2 μs.
 9. Each capacitors should be mounted as close to the PFC SPM product pins as possible.
 10. 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.
 11. Internal NTC thermistor can be used for monitoring of the case temperature and protecting the device from the overheating operation. Select an appropriate resistor R_T according to the application.
 12. It is recommended that anti-parallel diode (D_X, D_Y) be connected with each IGBT.

Figure 8. Typical Application Circuit

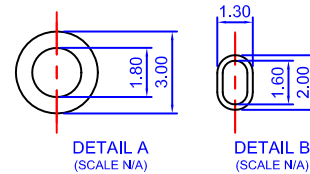
FPAM50LH60G

PACKAGE DIMENSIONS

S32CA-032 / 32LD, PDD STD, DBC, DIP TYPE (DBC AIN)
CASE MODEB
ISSUE O




- NOTES: UNLESS OTHERWISE SPECIFIED
A) THIS PACKAGE DOES NOT COMPLY TO ANY CURRENT PACKAGING STANDARD
B) ALL DIMENSIONS ARE IN MILLIMETERS
C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
D) () IS REFERENCE



LAND PATTERN RECOMMENDATIONS

FPAM50LH60G

SPM is registered trademark of Semiconductor Components Industries, LLC (SCILLC) or its subsidiaries in the United States and/or other countries.

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. 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

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910

ON Semiconductor Website: www.onsemi.com

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

For additional information, please contact your local Sales Representative