



Is Now Part of



ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor's system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.

ON Semiconductor and the ON Semiconductor logo 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.

FBA42060

PFC SPM® 45 Series for Single-Phase Boost PFC

Features

- UL Certified No. E209204 (UL1557)
- 600 V - 20 A Single-Phase Boost PFC with Integral Gate Driver and Protection
- Low Thermal Resistance Using Ceramic Substrate
- Full-Wave Bridge Rectifier and High-Performance Output Diode
- Optimized for 20kHz Switching Frequency
- Built-in NTC Thermistor for Temperature Monitoring
- Isolation Rating: 2000 Vrms/min.

Applications

- Single-Phase Boost PFC Converter

Related Source

- [AN-9091 - Boost PFC Inductor Design Guide](#)
- [AN-9072 - Motion SPM® 45 Series Mounting Guidance](#)

General Description

The FBA42060 is an advanced PFC SPM® 45 module providing a fully-featured, high-performance Boost PFC (Power Factor Correction) input power stage for consumer, medical, and industrial applications. These modules integrate optimized gate drive of the built-in IGBT 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 full-wave rectifier and high-performance output diode for additional space savings and mounting convenience.



Figure 1. Package Overview

Package Marking & Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FBA42060	FBA42060	SPMAA-F26	Rail	12

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 NTC thermistor: temperature monitoring
- Input interface: active-HIGH interface, works with 3.3 / 5 V logic, Schmitt trigger input

Pin Configuration

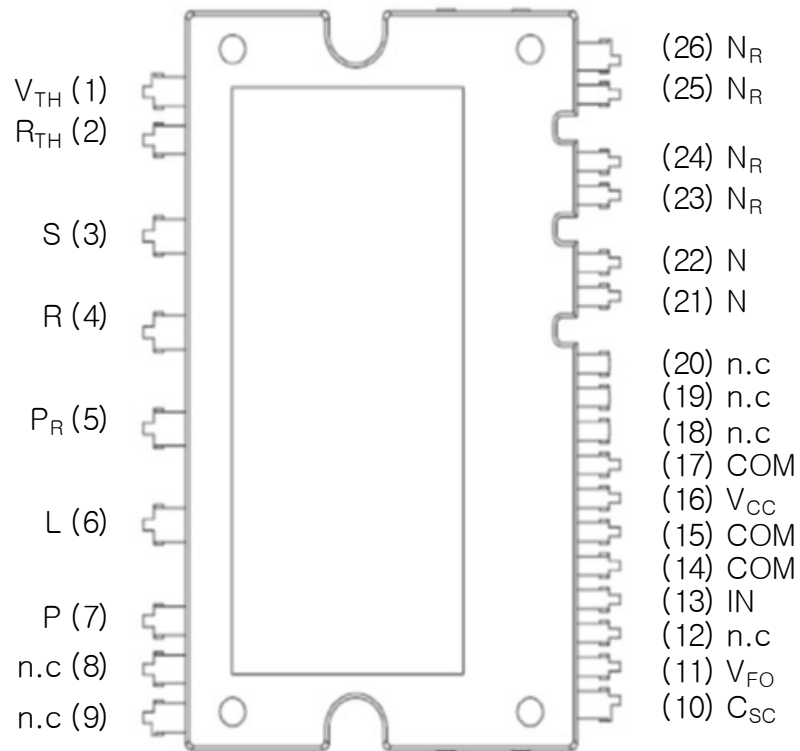


Figure 2. Top View

Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V_{TH}	Thermistor Bias Voltage
2	R_{TH}	Series Resistor for The Use of Thermistor
3	S	AC Input for S-Phase
4	R	AC Input for R-Phase
5	P_R	Positive DC-Link of Rectifier
6	L	Inductor Connection
7	P	Positive DC-Link Input
8, 9	N.C	-
10	C_{OC}	Signal Input for Over-Current Detection
11	V_{FO}	Fault Output
12	N.C	-
13	IN	PWM Input for IGBT Drive
14	COM	Common Supply Ground
15	COM	Common Supply Ground
16	V_{CC}	Common Supply Voltage of IC for IGBT Drive
17	COM	Common Supply Ground
18 ~ 20	N.C	-
21, 22	N	Negative DC-Link Input
23 ~ 26	N_R	Negative DC-Link of Rectifier Diode

Internal Equivalent Circuit

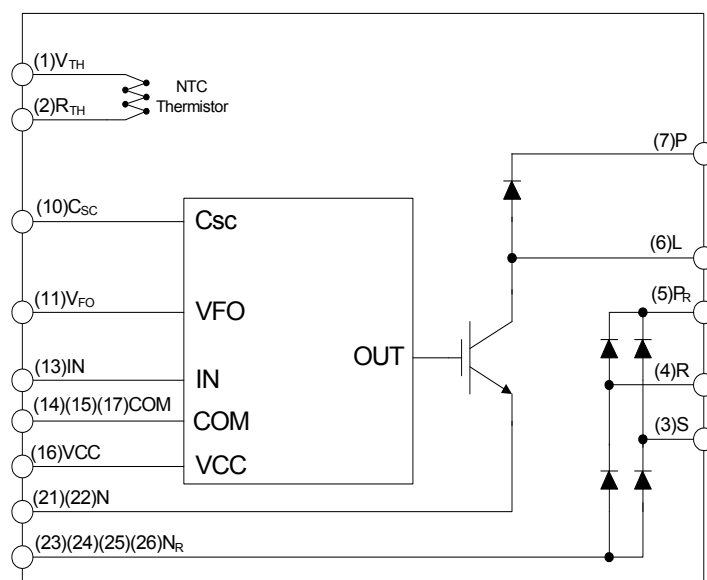


Figure 3. Internal Block Diagram

Absolute Maximum Ratings

Converter Part

Symbol	Parameter	Conditions	Rating	Unit
V_i	Input Supply Voltage	Applied between R - S	276	V_{rms}
$V_{i(Surge)}$	Input Supply Voltage (Surge)	Applied between R - S	500	V
V_{PN}	Output Voltage	Applied between P_R - N_R	450	V
$V_{PN(Surge)}$	Output Supply Voltage (Surge)	Applied between P_R - N_R	500	V
V_{CES}	Collector - Emitter Voltage		600	V
V_{RRM}	Repetitive Peak Reverse Voltage		600	V
$\pm I_C$	Each IGBT Collector Current	$T_C = 25^\circ\text{C}$, $V_{CC} = 15\text{ V}$	20	A
$\pm I_{CP}$	Each IGBT Collector Current (Peak)	$T_C = 25^\circ\text{C}$, Under 1 ms Pulse Width	30	A
I_{FSM}	Peak Forward Surge Current	Single Half Sine-Wave	200	A
T_J	Operating Junction Temperature		-40 ~ 150	$^\circ\text{C}$

Control Part

Symbol	Parameter	Conditions	Rating	Unit
V_{CC}	Control Supply Voltage	Applied between V_{CC} - COM	20	V
V_{IN}	Input Signal Voltage	Applied between IN - 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

Total System

Symbol	Parameter	Conditions	Rating	Unit
T_{STG}	Storage Temperature		-40 ~ 125	$^\circ\text{C}$
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat Sink Plate	2000	V_{rms}

Thermal Resistance

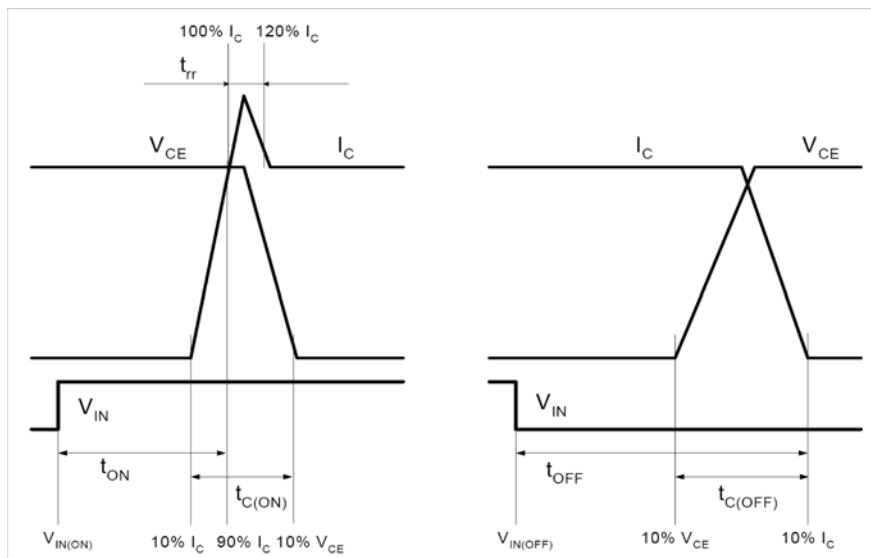
Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
$R_{th(j-c)Q}$	Junction to Case Thermal Resistance at Chip Center	IGBT	-	-	2.5	$^\circ\text{C/W}$
$R_{th(j-c)D}$		FRD	-	-	2.5	$^\circ\text{C/W}$
$R_{th(j-c)R}$		Rectifier	-	-	2.5	$^\circ\text{C/W}$

Electrical Characteristics ($T_J = 25^\circ\text{C}$, unless otherwise specified.)**Converter Part**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	IGBT Collector - Emitter Saturation Voltage	$V_{CC} = 15\text{ V}$, $V_{IN} = 5\text{ V}$, $I_C = 20\text{ A}$	-	2.2	2.7	V
V_{FF}	FRD Forward Voltage	$I_F = 20\text{ A}$	-	2.1	2.6	V
V_{FR}	Rectifier Forward Voltage	$I_F = 20\text{ A}$	-	1.1	1.4	V
t_{ON}	Switching Characteristic	$V_{PN} = 300\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 20\text{ A}$, $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$, Inductive Load (1st Note 1)	-	770	-	ns
t_{OFF}			-	640	-	ns
$t_{C(ON)}$			-	130	-	ns
$t_{C(OFF)}$			-	50	-	ns
t_{rr}			-	40	-	ns
I_{rr}			-	4.0	-	A
I_{CES}	Collector - Emitter Leakage Current	$V_{CE} = V_{CES}$	-	-	1	mA

1st Notes:

1. 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 4.

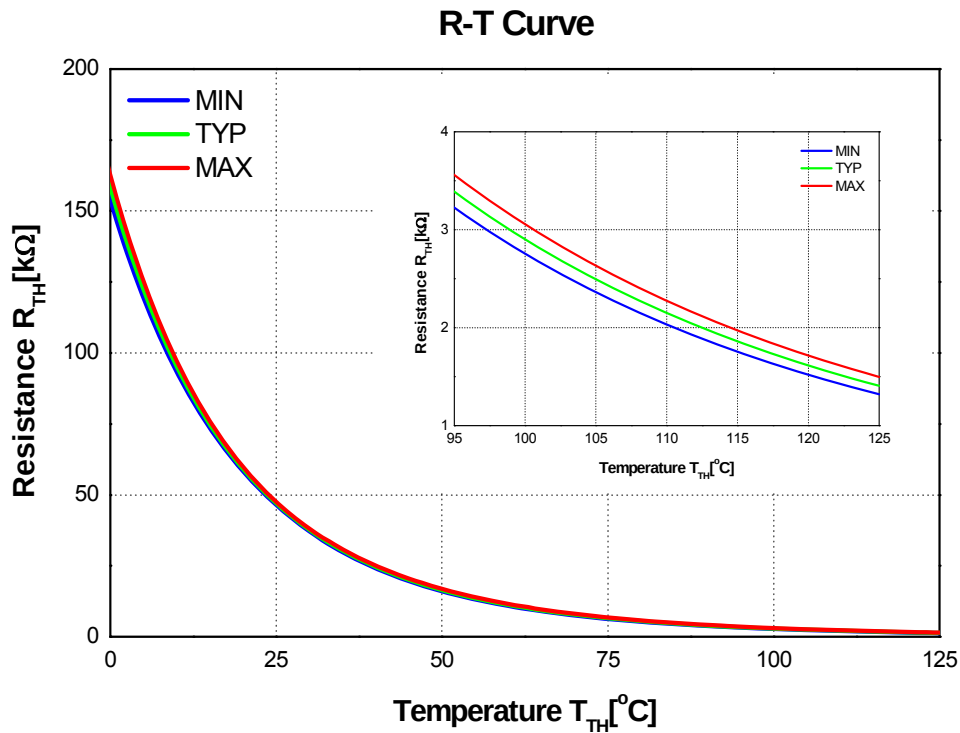
**Figure 4. Switching Time Definitions**

Control Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{QCC}	Quiescent V_{CC} Supply Current	$V_{CC} = 15\text{ V}$, $V_{IN} = 0\text{ V}$, $V_{CC} - \text{COM}$	-	-	2.65	mA
V_{FOH}	Fault Output Voltage	$V_{SC} = 0\text{ V}$, V_{FO} Circuit: 4.7 k Ω to 5 V Pull-up	4.5	-	-	V
V_{FOL}		$V_{SC} = 1\text{ V}$, V_{FO} Circuit: 4.7 k Ω to 5 V Pull-up	-	-	0.8	V
$V_{SC(\text{ref})}$	Over-Current Protection Trip Level Voltage of C_{SC} pin	$V_{CC} = 15\text{ V}$ (1st Note 2)	0.45	0.50	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
$V_{IN(\text{ON})}$	ON Threshold Voltage	Applied between IN - COM	-	-	2.6	V
$V_{IN(\text{OFF})}$	OFF Threshold Voltage		0.8	-	-	V
R_{TH}	Resistance of Thermistor	$T_{TH} = 25^\circ\text{C}$ (1st Note 3)	-	47.0	-	k Ω
		$T_{TH} = 100^\circ\text{C}$	-	2.9	-	k Ω

1st Notes:

- Over-current protection is functioning on IGBT.
- T_{TH} is the temperature of thermistor itself. To know case temperature (T_C), please make the experiment considering your application.

**Figure 5. R-T Curve of The Built-in Thermistor**

Recommended Operating Conditions

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_i	Input Supply Voltage	Applied between R - S	198	220	242	V_{rms}
V_{PN}	Supply Voltage	Applied between P_R - N	-	360	400	V
I_i	Input Current	$V_{DC} = 360$ V, $F_{SW} = 20$ kHz, $V_{CC} = 15$ V, $T_C = 90^\circ\text{C}$, $T_J \leq 150^\circ\text{C}$	-	20	-	A_{peak}
V_{CC}	Supply Voltage for inverter	Applied between V_{CC} - COM	13.5	15.0	16.5	V
$P_{WIN(ON)}$	Minimum Input Pulse Width	(1st Note 4)	0.5	-	-	μs
$P_{WIN(OFF)}$			0.5	-	-	μs
dV_{CC}/dt	Supply Variation		-1	-	1	V/ μs
f_{PWM}	PWM Input Frequency	$T_J \leq 150^\circ\text{C}$	-	20	-	kHz
V_{SEN}	Voltage for Current Sensing	Applied between N - COM (Including surge voltage)	-4	-	4	V

1st Notes:

4. The PFC SPM® product might not make response if input pulse width is less than the recommended value.

Mechanical Characteristics and Ratings

Parameter	Conditions		Min.	Typ.	Max.	Unit
Mounting Torque	Mounting Screw: M3	Recommended 0.7 N•m	0.6	0.7	0.8	N•m
Device Flatness		See Figure 6	0	-	+120	μm
Weight			-	11	-	g

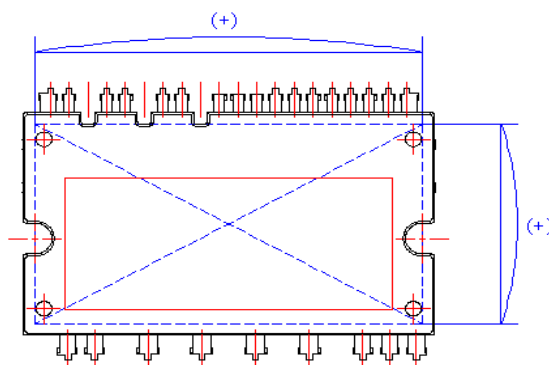
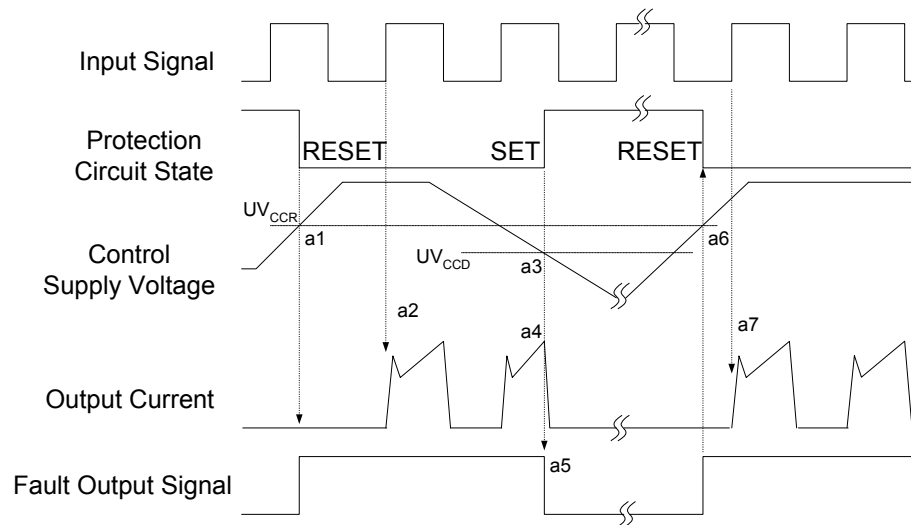


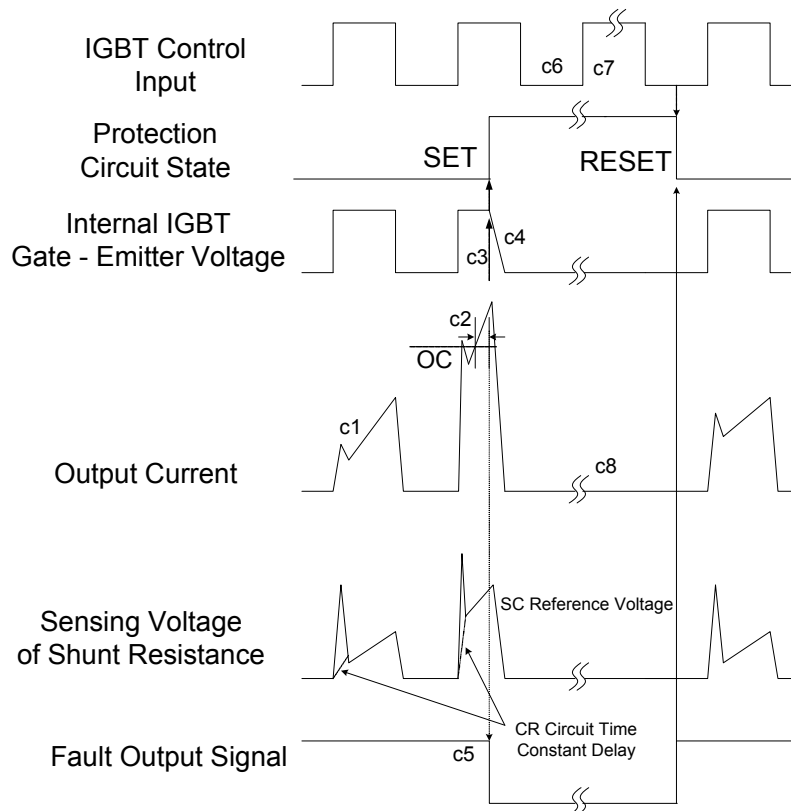
Figure 6. Flatness Measurement Position

Time Charts of Protective Function



- 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 7. Under-Voltage Protection



(with the external shunt resistance and CR connection)

- 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 8. Over Current Protection

Recommand circuit for Application

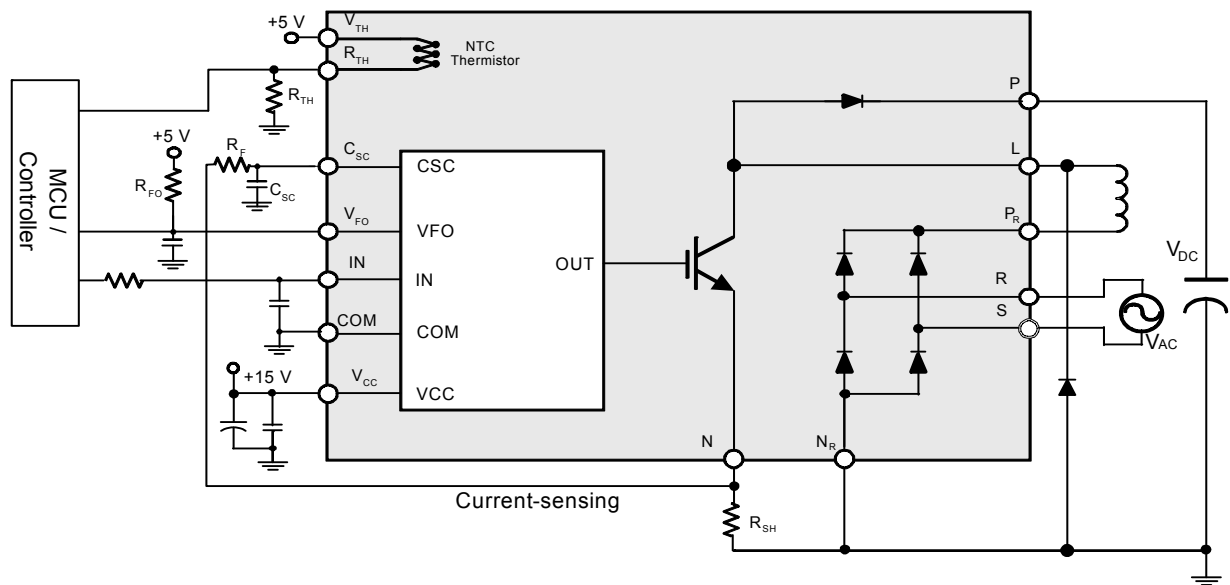


Figure 9. Typical Application Circuit

2nd Notes:

1. To avoid malfunction, the wiring of each input should be as short as possible (less than 2 - 3 cm).
2. V_{FO} output is open-drain type. This signal line should be pulled up to the positive side of the MCU or PFC controller power supply with a resistor that makes I_{FO} up to 1 mA.
3. Input signal is active-HIGH type. There is a 5 k Ω 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. $R_S C_{PS}$ time constant should be selected in the range 50 ~ 150 ns (recommended $R_S = 100 \Omega$, $C_{PS} = 1$ nF).
4. To prevent errors of the protection function, the wiring around R_F and C_{SC} should be as short as possible.
5. In the over-current protection circuit, please select the R_F , C_{SC} time constant in the range 1~2 μ s.
6. Each capacitors should be mounted as close to the pins as possible.
7. Relays are used in almost every systems of electrical equipment in home appliances. In these cases, there should be sufficient distance between the MCU and the relays.
8. Internal NTC thermistor can be used for monitoring the case temperature and protecting the device from the over-heating operation. Please select an appropriate resistor R_{TH} according to the application. For example, use $R_{TH} = 4.7$ k Ω that will make the voltage across R_{TH} to be 2.5 V at 85°C of the case temperature.
9. Please use an appropriate shunt resistor R_{SH} to protect the internal IGBT from the over-current operation.
10. It's recommended that anti-parallel diode should be connected with IGBT.



TRADEMARKS

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

AccuPower™	F-PFS™	PowerTrench®	Sync-Lock™
AX-CAP®*	FRFET™	PowerXS™	SYSTEM GENERAL®
BitSiC™	Global Power Resource™	Programmable Active Droop™	TinyBoost®
Build it Now™	GreenBridge™	QFET®	TinyBuck®
CorePLUS™	Green FPS™	QS™	TinyCalc™
CorePOWER™	Green FPS™ e-Series™	Quiet Series™	TinyLogic®
CROSSVOLT™	Gmax™	RapidConfigure™	TINYOPTO™
CTL™	GTO™	Saving our world, 1mW/W/kW at a time™	TinyPower™
Current Transfer Logic™	IntelliMAX™	SignalWise™	TinyPWM™
DEUXPEED®	ISOPLANAR™	SmartMax™	TinyWire™
Dual Cool™	Making Small Speakers Sound Louder and Better™	SMART START™	TranSiC™
EcoSPARK®	MegaBuck™	Solutions for Your Success™	TriFault Detect™
EfficientMax™	MICROCOUPLER™	SPM®	TRUECURRENT®*
ESBC™	MicroFET™	STEALTH™	µSerDes™
F [®]	MicroPak™	SuperFET®	UHC®
Fairchild®	MicroPak2™	SuperSOT™-3	Ultra FRFET™
Fairchild Semiconductor®	MillerDrive™	SuperSOT™-6	UniFET™
FACT Quiet Series™	MotionMax™	SuperSOT™-8	VCX™
FACT®	mWSaver®	SupreMOS®	VisualMax™
FAST®	OptoHiT™	SyncFET™	VoltagePlus™
FastvCore™	OPTOLOGIC®		XS™
FETBench™	OPTOPLANAR®		
FPS™			

* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I66

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

Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com

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

For additional information, please contact your local
Sales Representative