FAIRCHILD SEMICONDUCTOR®

April 2013

FBA42060

PFC SPM® 45 Series for 1-Phase Boost PFC

Features

- Low Thermal Resistance Thanks to Ceramic Substrate
- 600 V - 20 A 1-Phase Boost PFC Including A Drive IC for Gate Driving and Protection
- Typical Switching Frequency of 20 kHz
- Open Emitter Terminal for IGBT Current Sensing
- Built-in NTC Thermistor for Monitoring Over-Temperature
- Isolation Rating of 2000 Vrms/min.

Applications

- 1-Phase Boost PFC Converter for Air Conditioner

General Description

FBA42060 is A PFC SPM 45 Series for 1-Phase Boost PFC(Power Factor Correction) that Fairchild Has Newly Developed for Low-Power Application such as Air Conditioner. It Combines Optimized Circuit Protections and Drive IC Matched to High Frequency Switching IGBT. The System Reliability is Further Enhanced by The Integrated Under-Voltage Lock-Out and Over-Current Protection Function.

Related Source

- *Will Be Released*

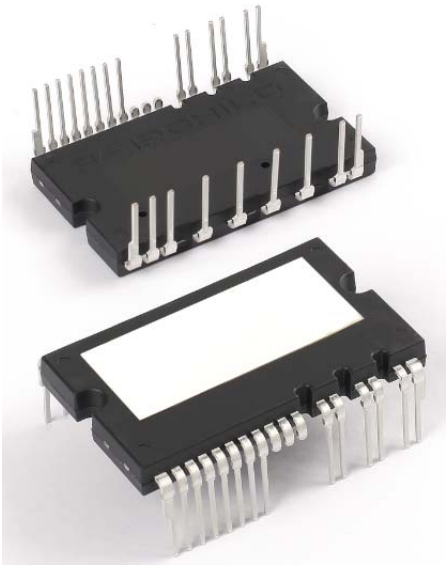

Figure 1. Package Overview

Package Marking & Ordering Information

Device Marking	Device	Package	Packing Type	Reel Size	Tape Width	Quantity
FBA42060	FBA42060	S26AC-023	RAIL	-	-	12

Integrated Drive, Protection and System Control Functions

- For IGBTs : Gate drive circuit, Over Current(OC) protection, Control supply circuit Under-Voltage(UV) protection
- Fault signal : Corresponding to OC and UV fault
- Built-in thermistor: Over-temperature monitoring
- Input interface : Active-high interface, can work with 3.3 / 5 V Logic

Pin Configuration

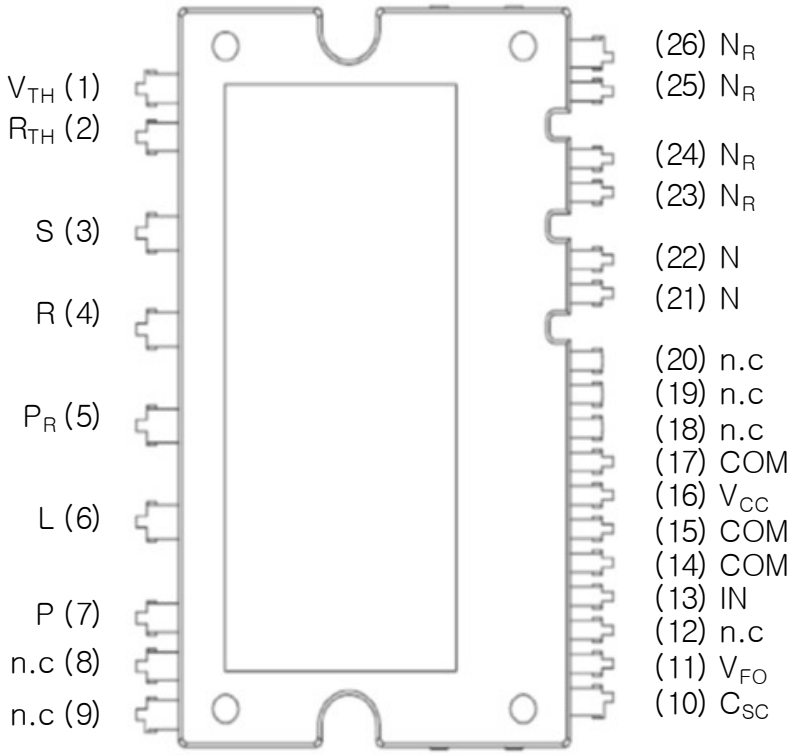

Figure 2. Top View

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

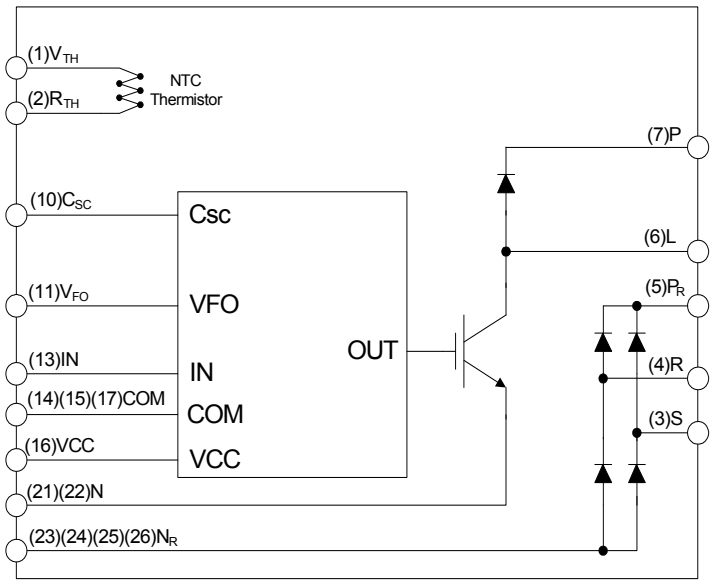

Figure 3. Internal Block Diagram

Absolute Maximum Ratings

Converter Part

Symbol	Parameter	Conditions	Rating	Unit
V_i	Input Supply Voltage	Applied between R-S	276	V
$V_{i(Surge)}$	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
± I_C	Each IGBT Collector Current	T_C = 25°C, V_{CC} = 15 V	20	A
± I_{CP}	Each IGBT Collector Current(Peak)	T_C = 25°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	°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	°C
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 minute, Connection 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	°C/W
$R_{th(j-c)D}$		FRD	-	-	2.5	°C/W
$R_{th(j-c)R}$		Rectifier	-	-	2.5	°C/W

Electrical Characteristics (T_J = 25°C, Unless Otherwise Specified)

Converter Part

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

Note:

1. t_{ON} and t_{OFF} include the propagation delay time 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.

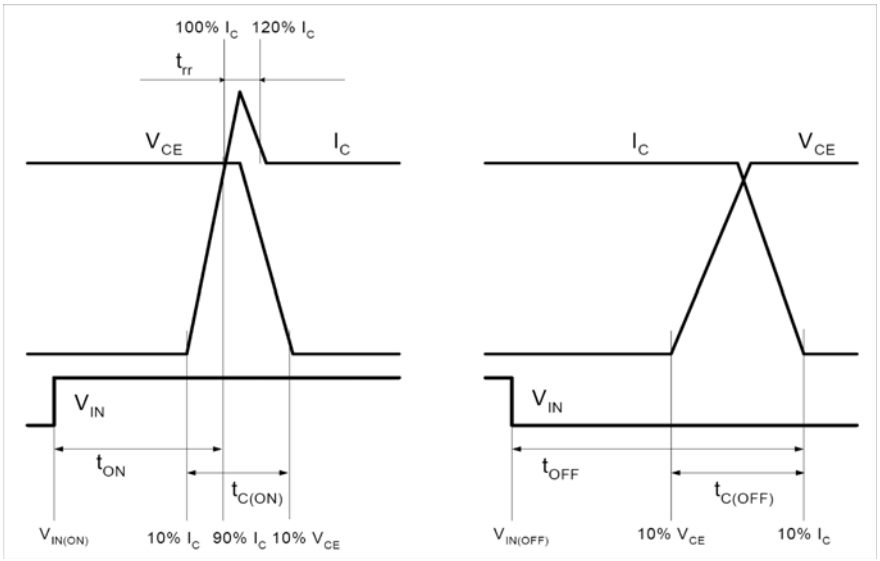

Figure 4. Switching Time Definitions

Control Part

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

Note:

2. Over-current protection is functioning on IGBT.

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

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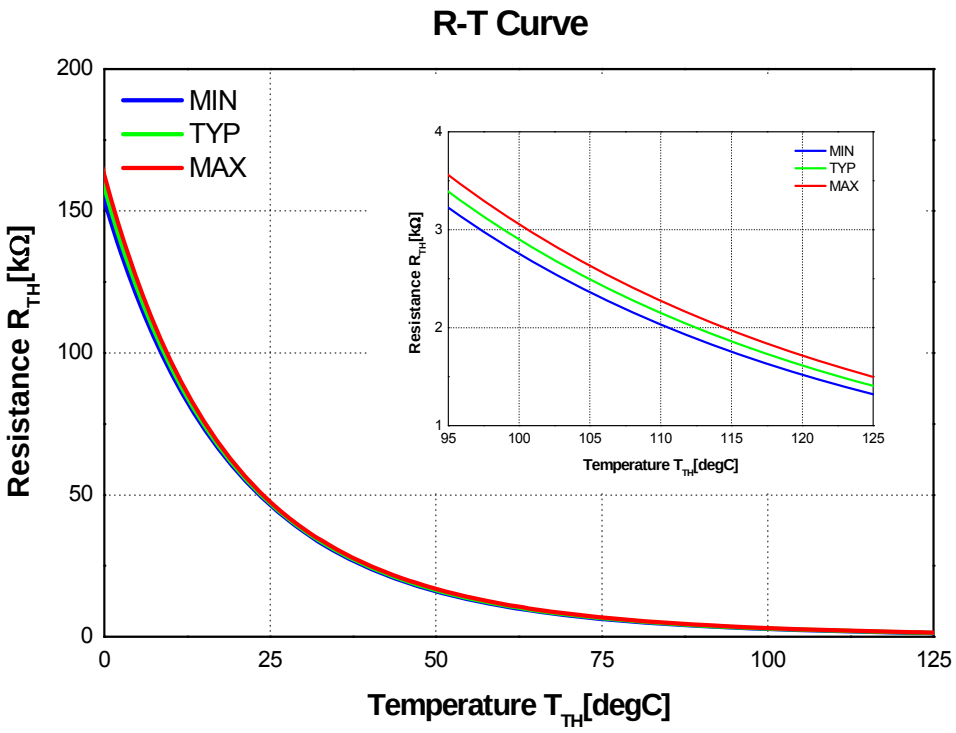


Figure 5. R-T Curve of The Built-in Thermistor

Recomended Operating Conditions

Symbol	Parameter	Conditions	Value			Units
			Min.	Typ.	Max.	
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°C, $T_J \leq$ 150°C	-	20	-	A_{peak}
V_{CC}	Supply Voltage for inverter	Applied between V_{CC} - COM	13.5	15	16.5	V
$P_{WIN(ON)}$	Minimum Input Pulse Width	(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°C	-	20	-	kHz
V_{SEN}	Voltage for Current Sensing	Applied between N - COM (Including surge voltage)	-4	-	4	V

Note:

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		Limits			Units
			Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: M3	Recommended 0.7 N•m	0.6	0.7	0.8	N•m
Device Flatness		Refer to Figure 6	0	-	+120	µm
Weight			-	11	-	g

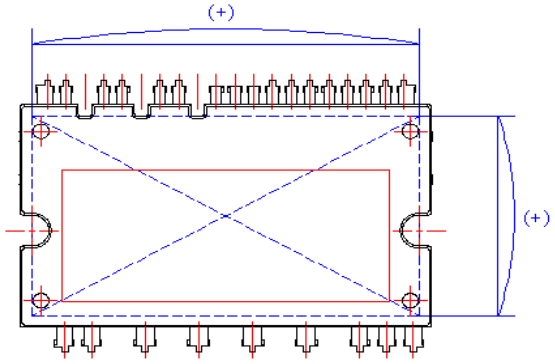
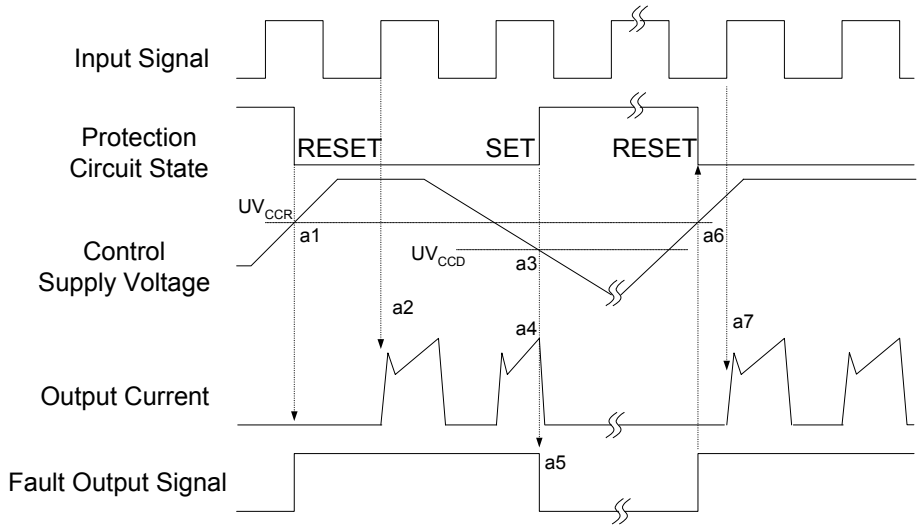


Figure 6. Flatness Measurement Position

Time Charts of PFC SPM®s 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}).

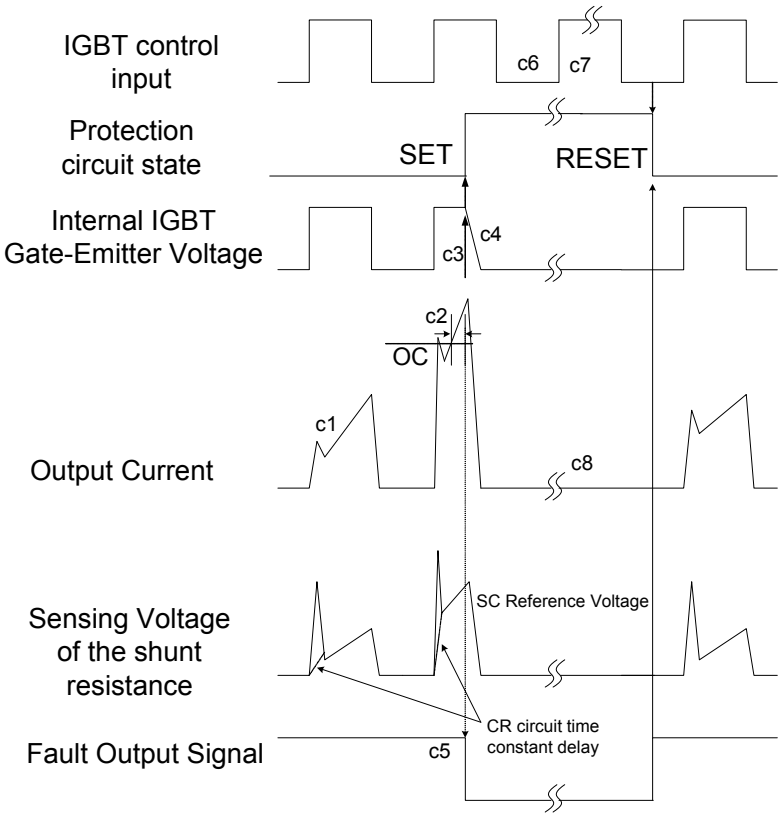
a4 : IGBT OFF in spite of control input condition.

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.

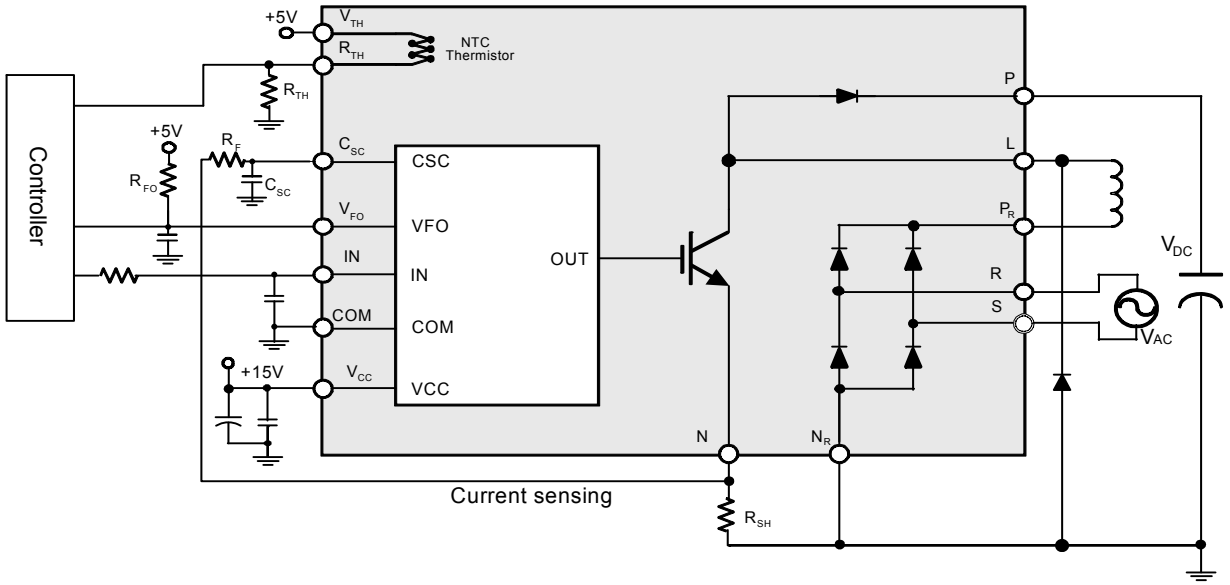
c6 : Input “L” : IGBT OFF state.

c7 : Input “H”: 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

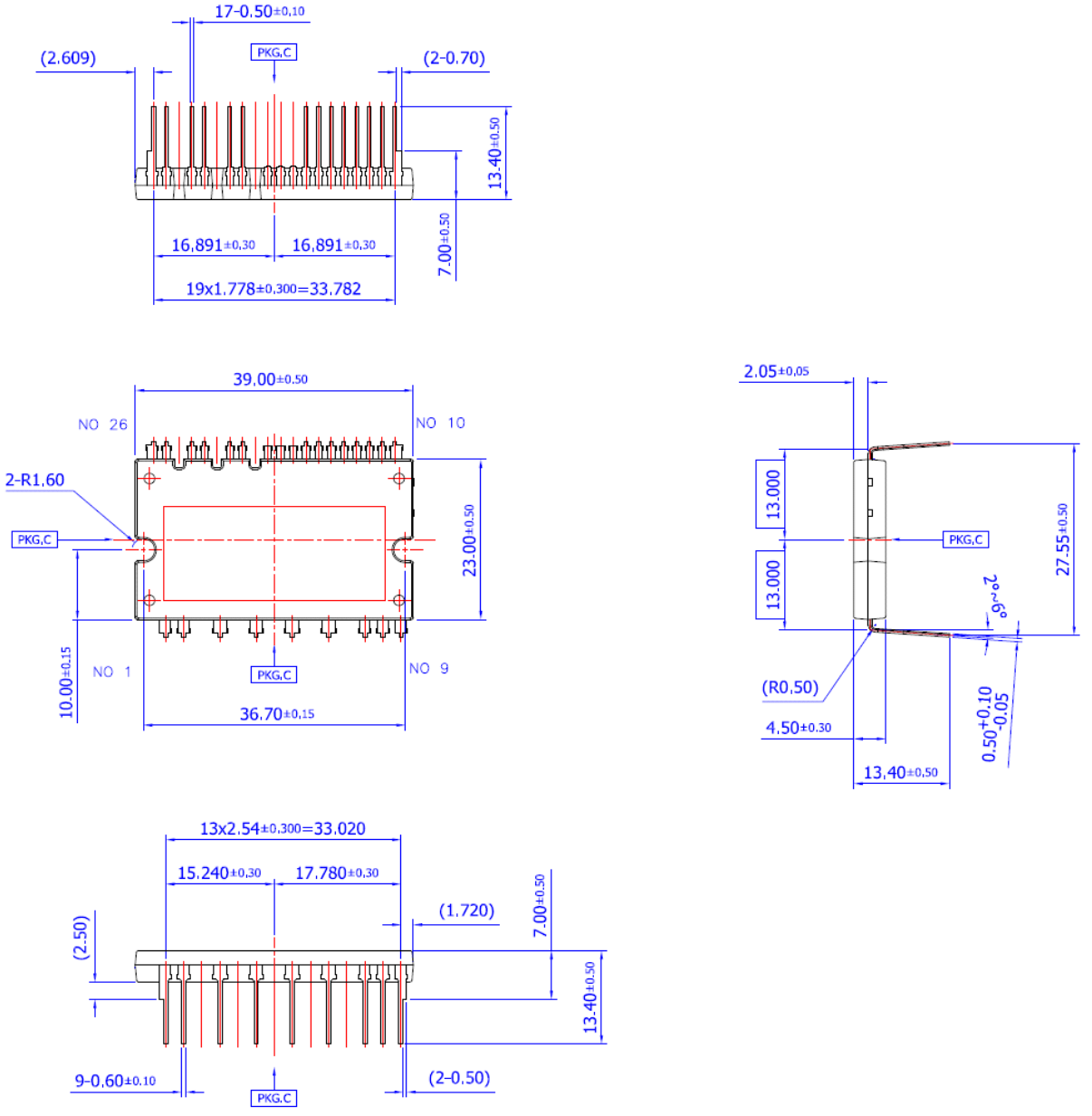


Note:

1. To avoid malfunction, the wiring of each input should be as short as possible. (less than 2-3cm)
2. V_{FO} output is open collector type. This signal line should be pulled up to the positive side of the 5V power supply with approximately 4.7kΩ resistance.
3. Input signal is High-Active type. There is a 3.3 kΩ resistor inside the IC to pull down each input signal line to GND. When employing RC coupling circuits, set up such RC couple that input signal agree with turn-off/turn-on threshold voltage.
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 μs.
6. Each capacitors should be mounted as close to the 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 CPU and the relays.
8. Internal NTC thermistor can be used for monitoring the case temperature and protecting the device from the overheating operation. Please select an appropriate resistor RTH according to the application. For example, use R_{TH}=4.7 kΩ that will make the voltage across R_{TH} to be 2.5V at 85°C of the case temperature.
9. Please use an appropriate shunt resistor R_{SH} to protect the intenal IGBT from the overcurrent operation.
10. It's recommended that anti-parallel diode should be connected with IGBT.

Figure 9. Typical Application Circuit

Detailed Package Outline Drawings



Dimension unit: millimeter

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