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# FPAB20BH60B

## PFC SPM® 3 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
- Very Low Thermal Resistance Using Al<sub>2</sub>O<sub>3</sub> DBC Substrate
- Full-Wave Bridge Rectifier and High-Performance Output Diode
- Built-in NTC Thermistor for Temperature Monitoring
- Optimized for 20kHz Switching Frequency
- Isolation Rating: 2500 Vrms/min.

### Applications

- Single-Phase Boost PFC Converter

### Related Source

- [AN-9090 - PFC SPM 3 Series User's Guide](#)
- [AN-9091 - Boost PFC Inductor Design Guide](#)

### General Description

The FPAB20BH60B is an advanced PFC SPM® 3 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.

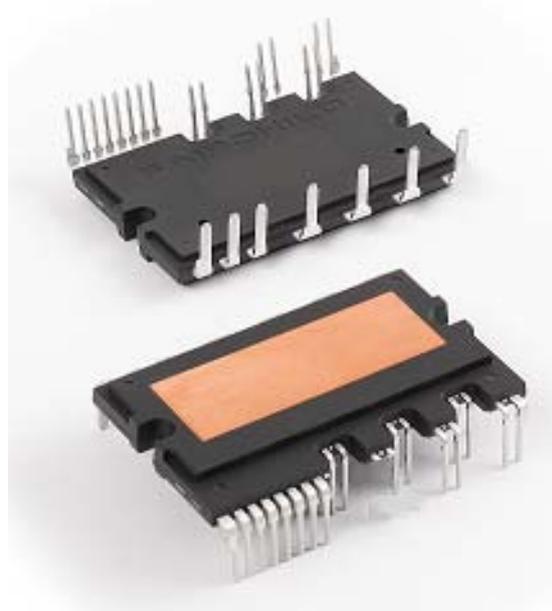


Figure 1. Package Overview

### Package Marking & Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FPAB20BH60B	FPAB20BH60B	SPMIC-027	Rail	10

### Integrated Power Functions

- PFC converter for single-phase AC / DC power conversion (please refer to Figure 3)

### 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

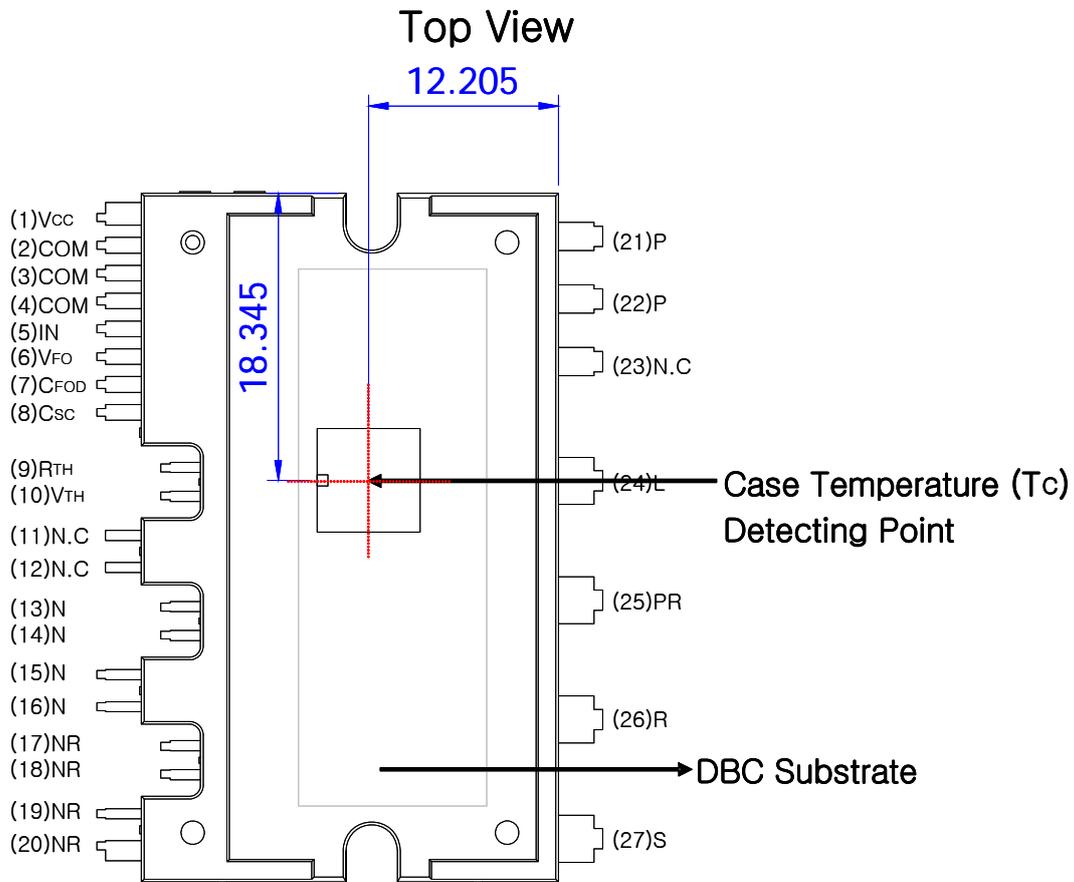


Figure 2. Top View

**Notes :**

1. For the measurement point of case temperature( $T_c$ ), please refer to Figure 2.

### Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V <sub>CC</sub>	Common Bias Voltage for IC and IGBT Driving
2,3,4	COM	Common Supply Ground
5	IN	Signal Input for IGBT
6	V <sub>FO</sub>	Fault Output
7	C <sub>FOD</sub>	Capacitor for Fault Output Duration Selection
8	C <sub>SC</sub>	Capacitor (Low-Pass Filter) for Over-Current Detection
9	R <sub>(TH)</sub>	Series Resistor for The Use of Thermistor
10	V <sub>(TH)</sub>	Thermistor Bias Voltage
11,12	N.C	No Connection*
13~16	N	IGBT Emitter
17~20	N <sub>R</sub>	Negative DC-Link of Rectifier
21,22	P	Positive Rail of DC-Link
23	N.C	No Connection
24	L	Reactor Connection Pin
25	P <sub>R</sub>	Positive DC-Link of Rectifier
26	R	AC Input for R-Phase
27	S	AC Input for S-Phase

\* 11th and 12th pins are cut. Please refer to package outline drawings for more detail.

### Internal Equivalent Circuit and Input/Output Pins

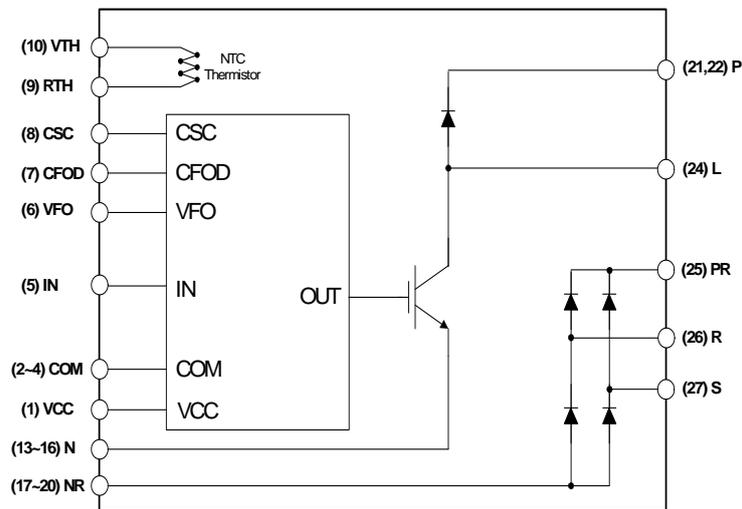


Figure 3. Internal Block Diagram

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

Symbol	Item	Condition	Rating	Unit
$V_i$	Supply Voltage	Applied between R - S	264	$V_{rms}$
$V_{i(Surge)}$	Supply Voltage (Surge)	Applied between R - S	500	V
$V_{PN}$	Output Voltage	Applied between P - N	450	V
$V_{PN(Surge)}$	Output Voltage (Surge)	Applied between P - N	500	V
$V_{CES}$	Collector - Emitter Voltage		600	V
$I_C$	Each IGBT Collector Current	$T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$	20	A
$I_{CP}$	Each IGBT Collector Current (Peak)	$T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$ , Under 1ms Pulse Width	40	A
$P_C$	Collector Dissipation	$T_C = 25^\circ\text{C}$	89	W
$V_{RRM}$	Repetitive Peak Reverse Voltage		600	V
$I_{FSM}$	Peak Forward Surge Current	Single Half Sine-Wave	250	A
$T_J$	Operating Junction Temperature		-40 ~ 150	$^\circ\text{C}$

**Control Part**

Symbol	Item	Condition	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	5	mA
$V_{SC}$	Current Sensing Input Voltage	Applied between $C_{SC}$ - COM	-0.3 ~ $V_{CC}+0.3$	V

**Total System**

Symbol	Item	Condition	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	2500	$V_{rms}$

**Thermal Resistance**

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$R_{\theta(j-c)Q}$	Junction to Case Thermal Resistance	IGBT	-	-	1.4	$^\circ\text{C}/\text{W}$
$R_{\theta(j-c)F}$		FRD	-	-	1.4	$^\circ\text{C}/\text{W}$
$R_{\theta(j-c)R}$		Rectifier (per 1 / 4 module)	-	-	2.1	$^\circ\text{C}/\text{W}$

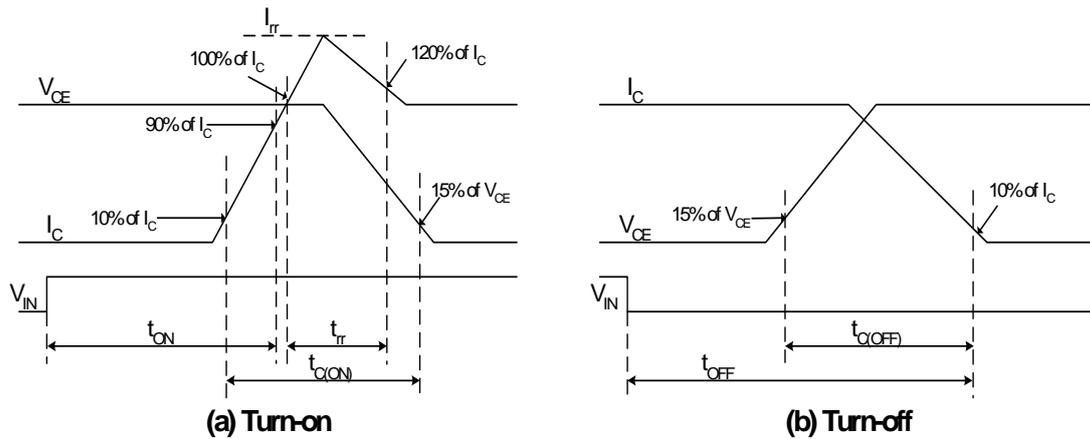
**Electrical Characteristics** ( $T_J = 25^\circ\text{C}$ , unless otherwise specified.)

**Converter Part**

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	IGBT Saturation Voltage	$V_{CC} = 15\text{ V}$ , $V_{IN} = 5\text{ V}$ , $I_C = 20\text{ A}$	-	2.3	3.0	V
$V_{FF}$	FRD Forward Voltage	$I_F = 20\text{ A}$	-	1.8	2.5	V
$V_{FR}$	Rectifier Forward Voltage	$I_F = 20\text{ A}$	-	1.2	1.5	V
$t_{ON}$	Switching Times	$V_{PN} = 400\text{ V}$ , $V_{CC} = 15\text{ V}$ , $I_C = 20\text{ A}$ $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , Inductive Load (Note 2)	-	450	-	ns
$t_{C(ON)}$			-	200	-	ns
$t_{OFF}$			-	350	-	ns
$t_{C(OFF)}$			-	80	-	ns
$t_{rr}$			-	70	-	ns
$I_{rr}$			-	6	-	A
$I_{CES}$	Collector - Emitter Leakage Current	$V_{CE} = V_{CES}$	-	-	250	$\mu\text{A}$

**Notes:**

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 4.



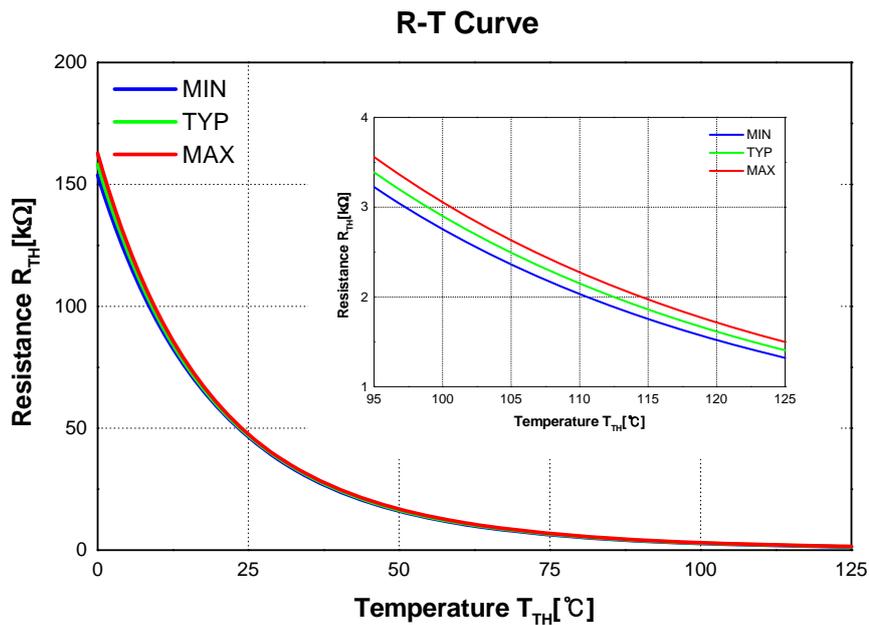
**Figure 4. Switching Time Definition**

**Control Part**

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$I_{QCCL}$	Quiescent $V_{CC}$ Supply Current	$V_{CC} = 15\text{ V}$ , $I_N = 0\text{ V}$   $V_{CC} - \text{COM}$	-	-	26	mA
$V_{FOH}$	Fault Output Voltage	$V_{SC} = 0\text{ V}$ , $V_{FO}$ Circuit: 4.7 k $\Omega$ to 5 V Pull-up	4.5	-	-	V
$V_{FOL}$		$V_{SC} = 1\text{ V}$ , $V_{FO}$ Circuit: 4.7 k $\Omega$ to 5 V Pull-up	-	-	0.8	V
$V_{SC(ref)}$	Over-Current Trip Level	$V_{CC} = 15\text{ V}$	0.45	0.5	0.55	V
$UV_{CCD}$	Supply Circuit Under-Voltage Protection	Detection Level	10.7	11.9	13.0	V
$UV_{CCR}$		Reset Level	11.2	12.4	13.2	V
$t_{FOD}$	Fault-Out Pulse Width	$C_{FOD} = 33\text{ nF}$ (Note 3)	1.4	1.8	2.0	ms
$V_{IN(ON)}$	ON Threshold Voltage	Applied between IN - COM	2.8	-	-	V
$V_{IN(OFF)}$	OFF Threshold Voltage		-	-	0.8	V
$R_{TH}$	Resistance of Thermistor	@ $T_{TH} = 25^\circ\text{C}$ (Note 4, Figure 5)	-	47.0	-	k $\Omega$
		@ $T_{TH} = 100^\circ\text{C}$ (Note 4, Figure 5)	-	2.9	-	k $\Omega$

**Notes:**

- The fault-out pulse width  $t_{FOD}$  depends on the capacitance value of  $C_{FOD}$  according to the following approximate equation:  $C_{FOD} = 18.3 \times 10^{-6} \times t_{FOD}$  [F].
- $T_{TH}$  is the temperature of know case temperature( $T_C$ ), please make the experiment considering your application.



**Figure 5. R-T Curve of the Built-In Thermistor**

### Recommended Operating Condition

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$V_i$	Input Supply Voltage	Applied between R - S	187	220	253	$V_{rms}$
$V_{PN}$	Output Voltage	Applied between P - N	-	380	400	V
$V_{CC}$	Control Supply Voltage	Applied between $V_{CC(L)}$ - COM	13.5	15.0	16.5	V
$dV_{CC}/dt$	Control Supply Variation		-1	-	1	$V/\mu s$
$f_{PWM}$	PWM Input Frequency	$T_J \leq 150^\circ C$	-	20	-	kHz
$I_i$	Allowable Input Current	$T_C < 90^\circ C$ , $V_i = 220 V$ , $V_{PN} = 380 V$ $V_{PWM} = 20 kHz$	-	-	20	$A_{peak}$

### Mechanical Characteristics and Ratings

Item	Condition		Min.	Typ.	Max.	Unit
Mounting Torque	Mounting Screw: M3	Recommended 0.62 N•m	0.51	0.62	0.72	N•m
Device Flatness	See Figure 6		0	-	+120	$\mu m$
Weight			-	15.00	-	g

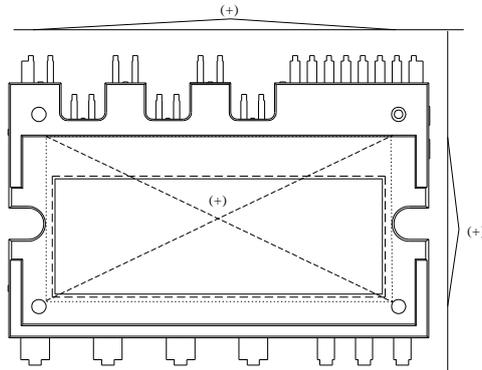
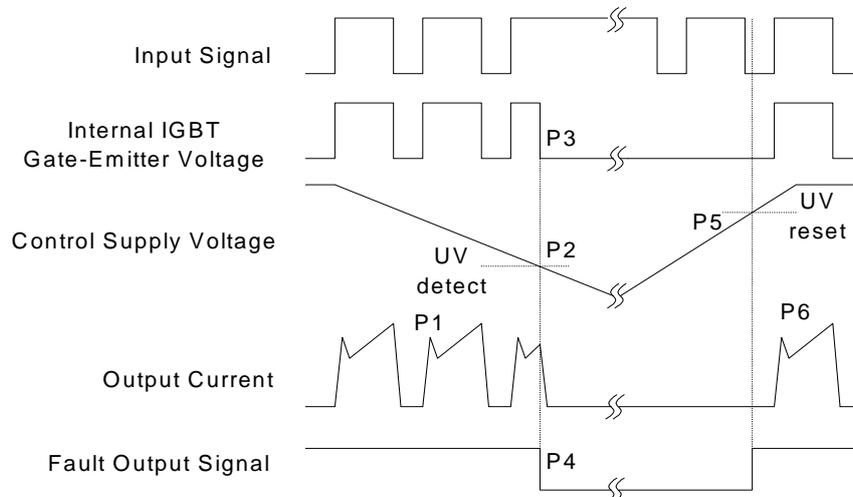


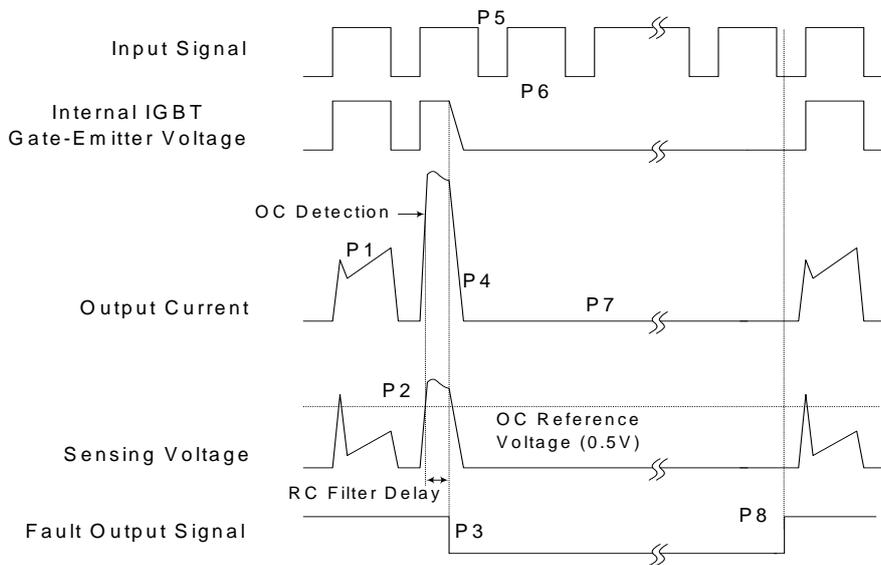
Figure 6. Flatness Measurement Position

### Time Charts of Protective Function



- P1 : Normal operation: IGBT ON and conducting current
- P2 : Under-voltage detection
- P3 : IGBT gate interrupt
- P4 : Fault signal generation
- P5 : Under-voltage reset
- P6 : Normal operation: IGBT ON and conducting current

**Figure 7. Under-Voltage Protection**



- P1 : Normal operation: IGBT ON and conducting current
- P2 : Over current detection
- P3 : IGBT gate interrupt / fault signal generation
- P4 : IGBT is slowly turned off
- P5 : IGBT OFF signal
- P6 : IGBT ON signa: but IGBT cannot be turned on during the fault output activation
- P7 : IGBT OFF state
- P8 : Fault output reset and normal operation start

**Figure 8. Over-Current Protection**

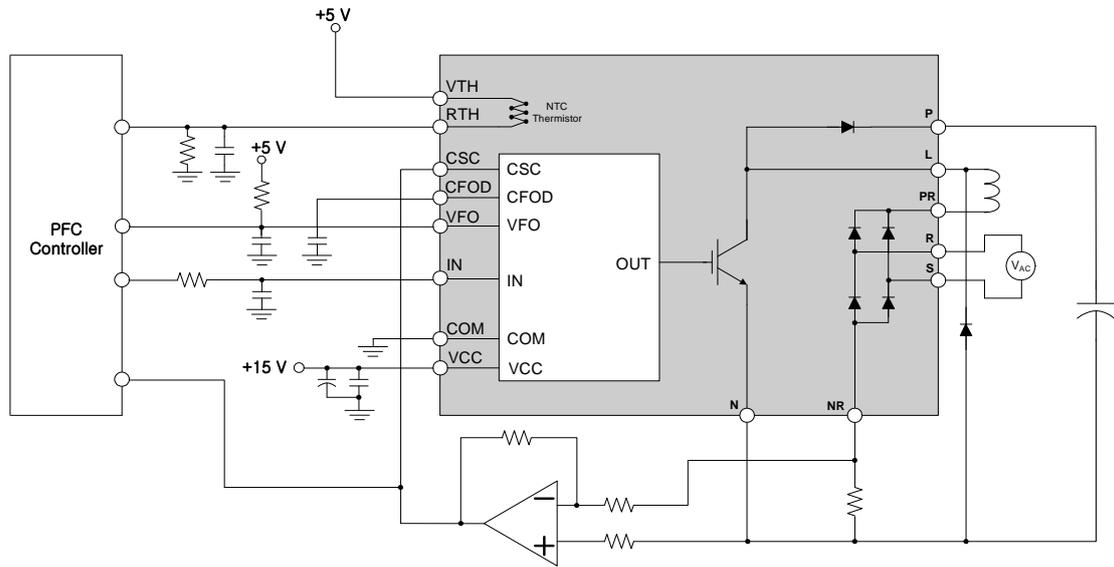
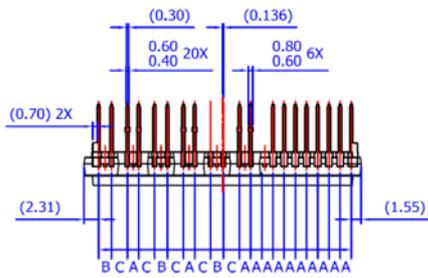


Fig. 9. Application Example

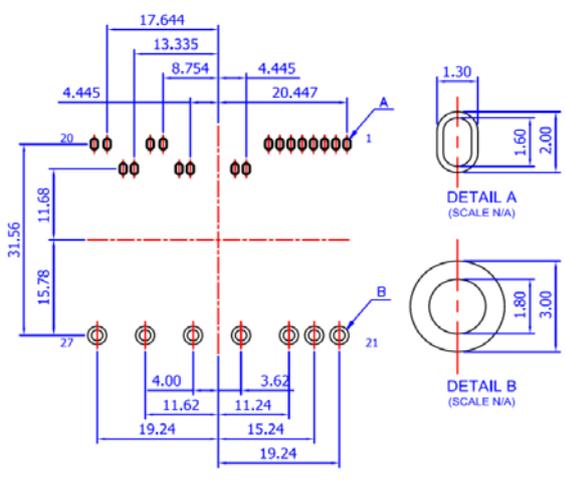
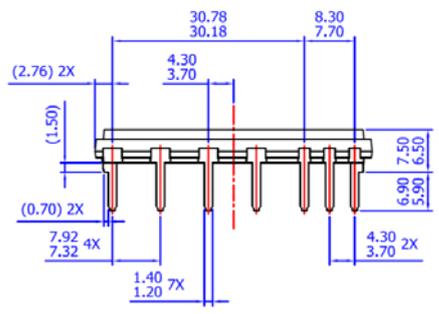
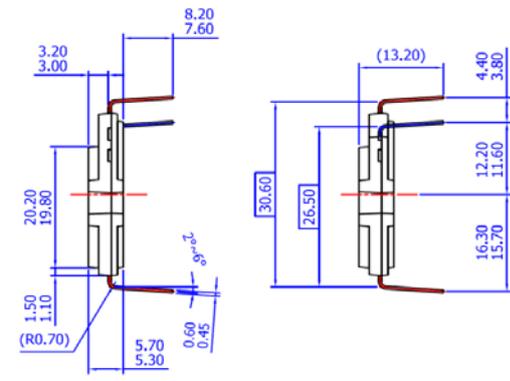
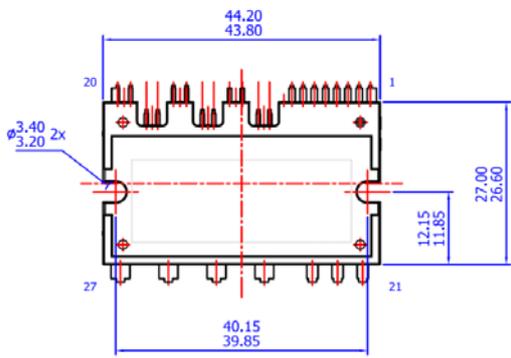
Notes:

5. Each capacitors should be located as close to PFC SPM® product pins as possible.
6. It's recommended that anti-parallel diode should be connected with IGBT.

### Detailed Package Outline Drawings



LEAD PITCH (TOLERANCE : ±0.30)  
 A : 1.778  
 B : 2.050  
 C : 2.531



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