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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 Al₂O₃ 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.

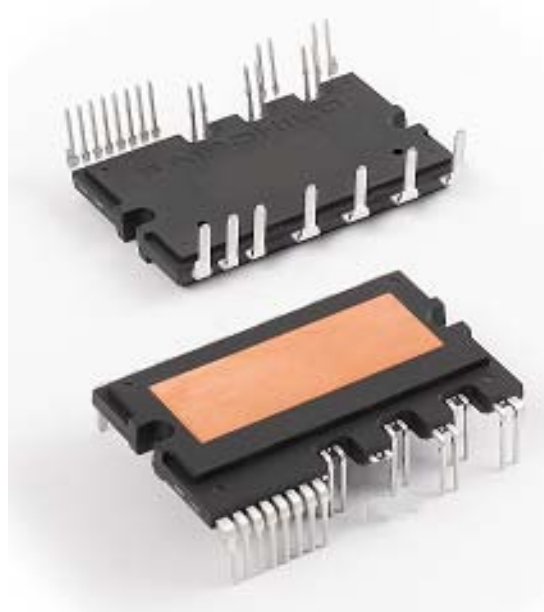


Figure 1. Package Overview

Package Marking & Ordering Information

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

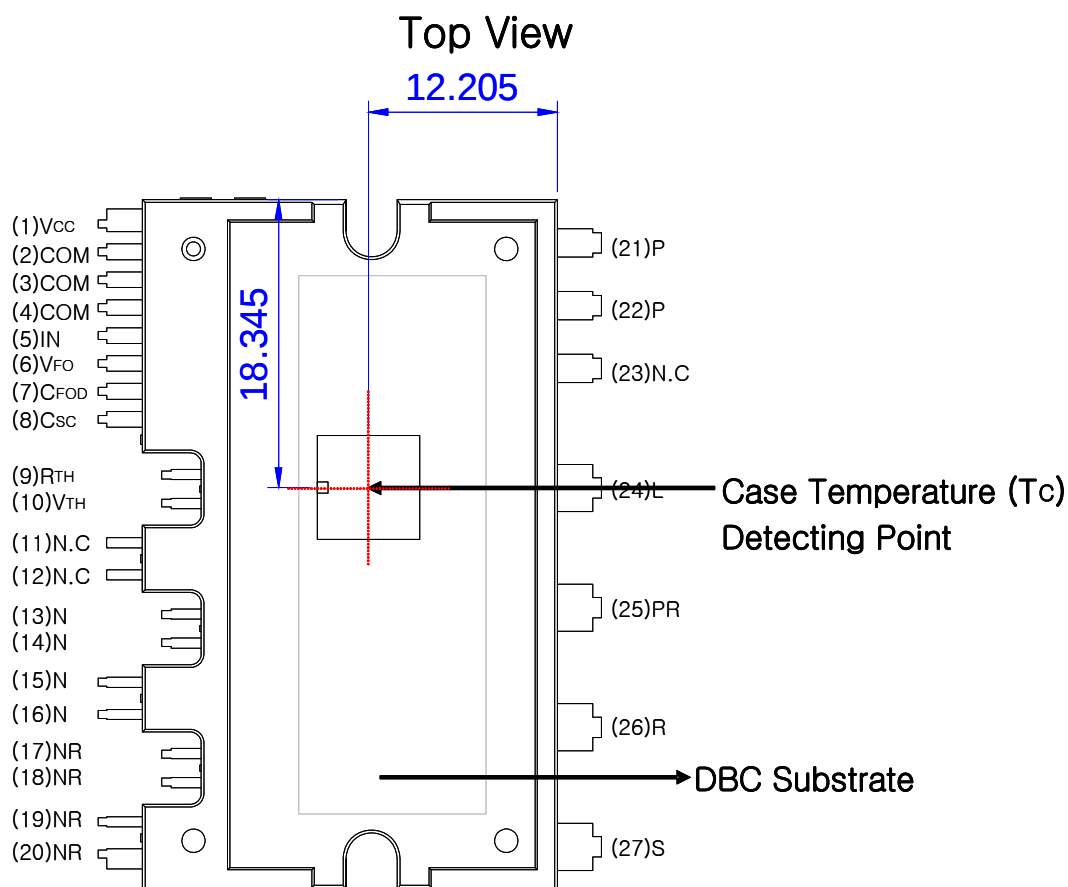
Integrated Power Functions

- 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



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 _{CC}	Common Bias Voltage for IC and IGBT Driving
2,3,4	COM	Common Supply Ground
5	IN	Signal Input for IGBT
6	V _{FO}	Fault Output
7	C _{FOD}	Capacitor for Fault Output Duration Selection
8	C _{SC}	Capacitor (Low-Pass Filter) for Over-Current Detection
9	R _(TH)	Series Resistor for The Use of Thermistor
10	V _(TH)	Thermistor Bias Voltage
11,12	N.C	No Connection*
13~16	N	IGBT Emitter
17~20	N _R	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 _R	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

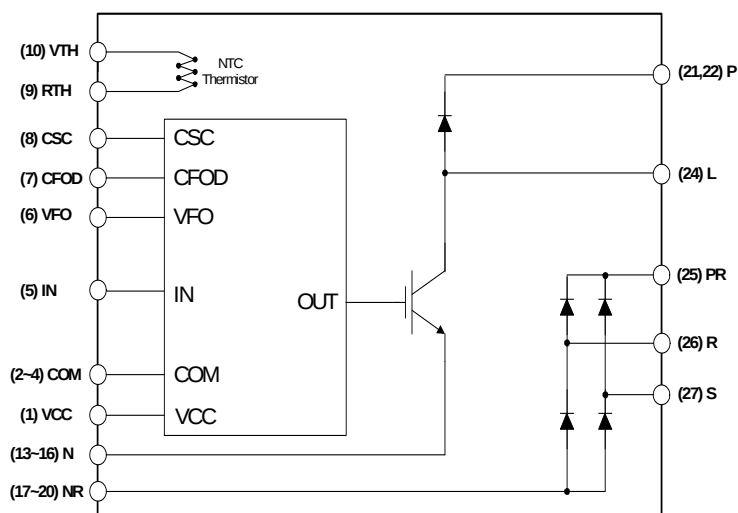


Figure 3. Internal Block Diagram

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

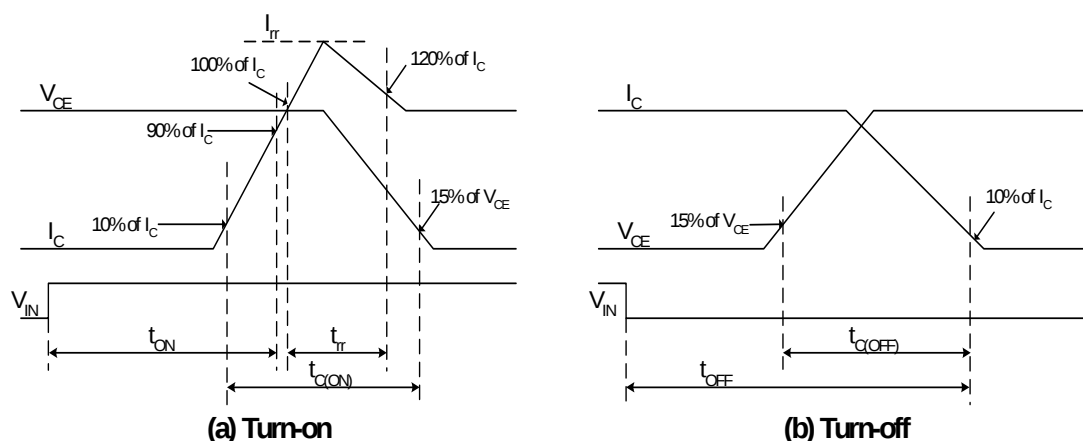
Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$R_{\theta(j-c)Q}$	Junction to Case Thermal Resistance	IGBT	-	-	1.4	$^\circ\text{C/W}$
$R_{\theta(j-c)F}$		FRD	-	-	1.4	$^\circ\text{C/W}$
$R_{\theta(j-c)R}$		Rectifier (per 1 / 4 module)	-	-	2.1	$^\circ\text{C/W}$

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	μA

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	$V_{CC} = 15\text{ V}$, $IN = 0\text{ V}$ $V_{CC} - COM$	-	-	26	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
$V_{SC(ref)}$	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 Ω
		@ $T_{TH} = 100^{\circ}\text{C}$ (Note 4, Figure 5)	-	2.9	-	k Ω

Notes:

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

R-T Curve

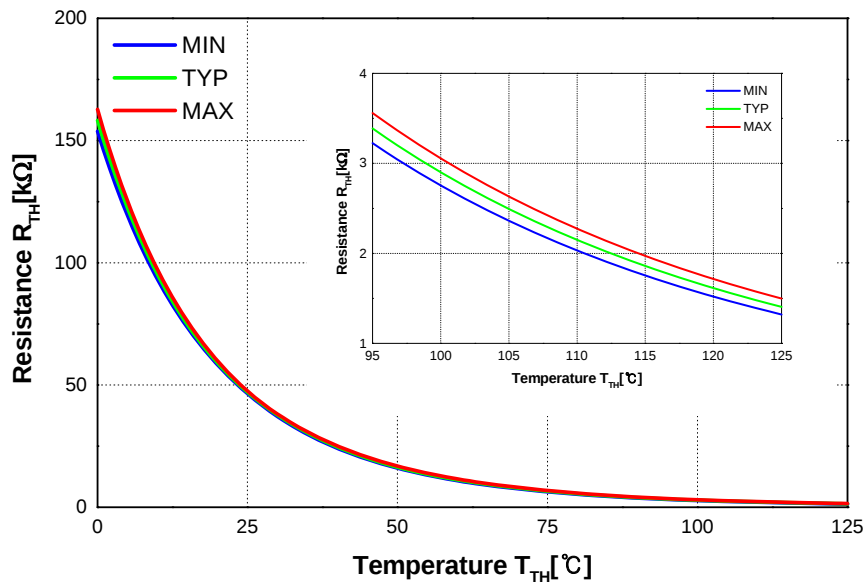


Figure 5. R-T Curve of the Built-In Thermistor

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/ μ s
f_{PWM}	PWM Input Frequency	$T_J \leq 150^\circ\text{C}$	-	20	-	kHz
I_i	Allowable Input Current	$T_C < 90^\circ\text{C}$, $V_i = 220\text{ V}$, $V_{PN} = 380\text{ V}$ $V_{PWM} = 20\text{ kHz}$	-	-	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	μm
Weight			-	15.00	-	g

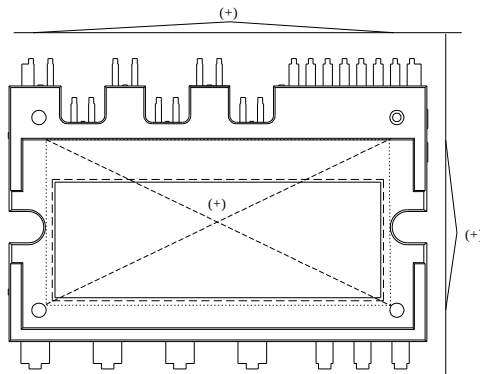
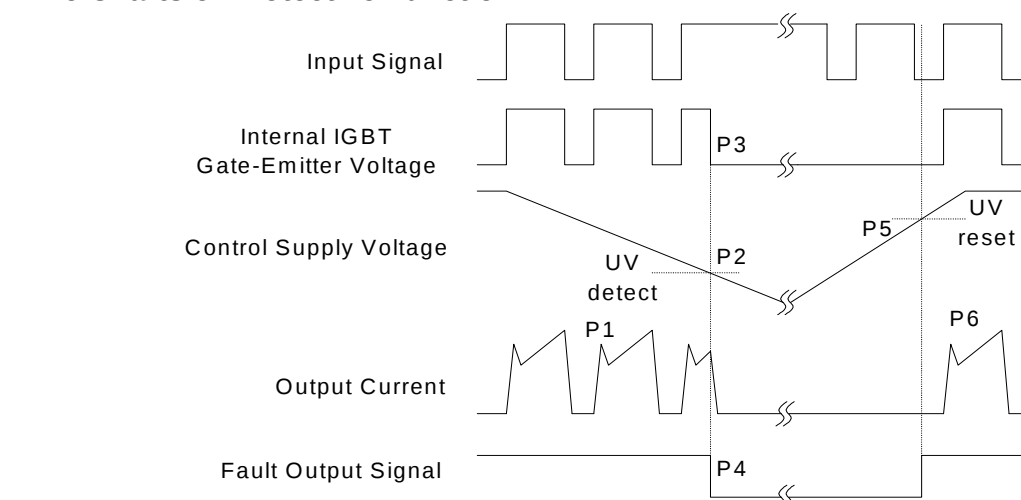


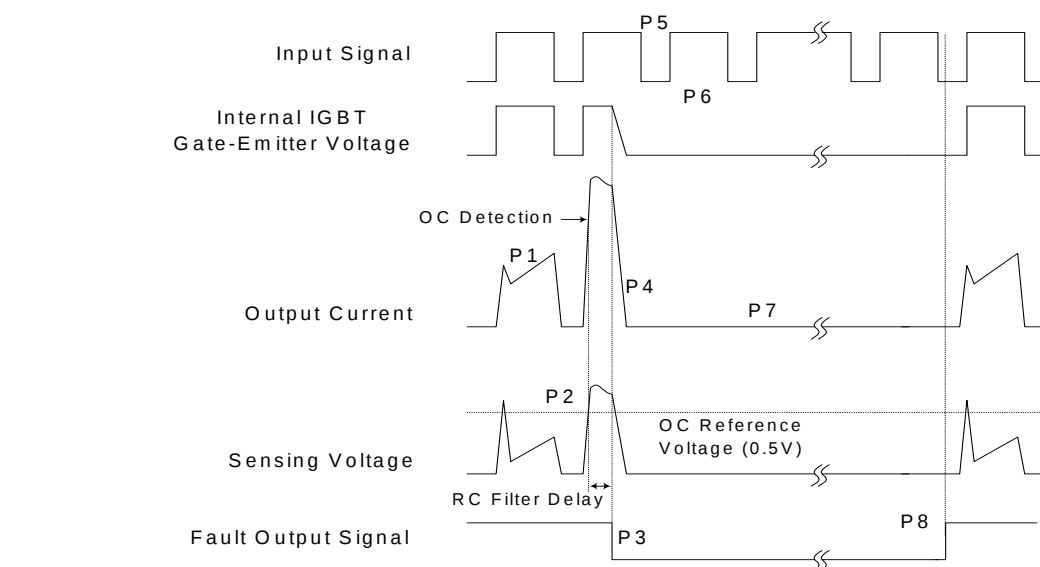
Figure 6. Flatness Measurement Position

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 signal: 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

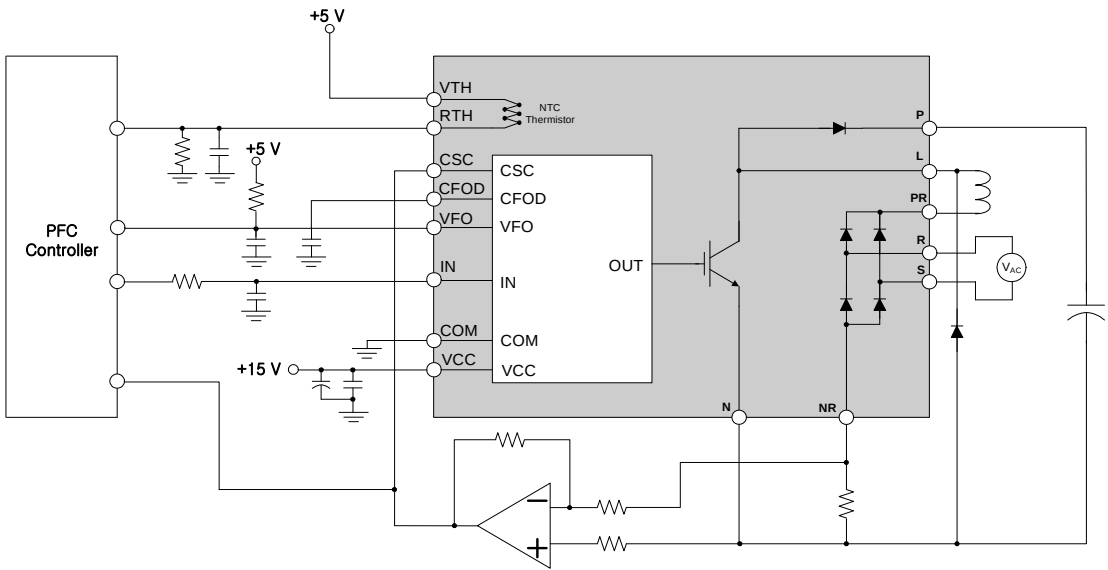
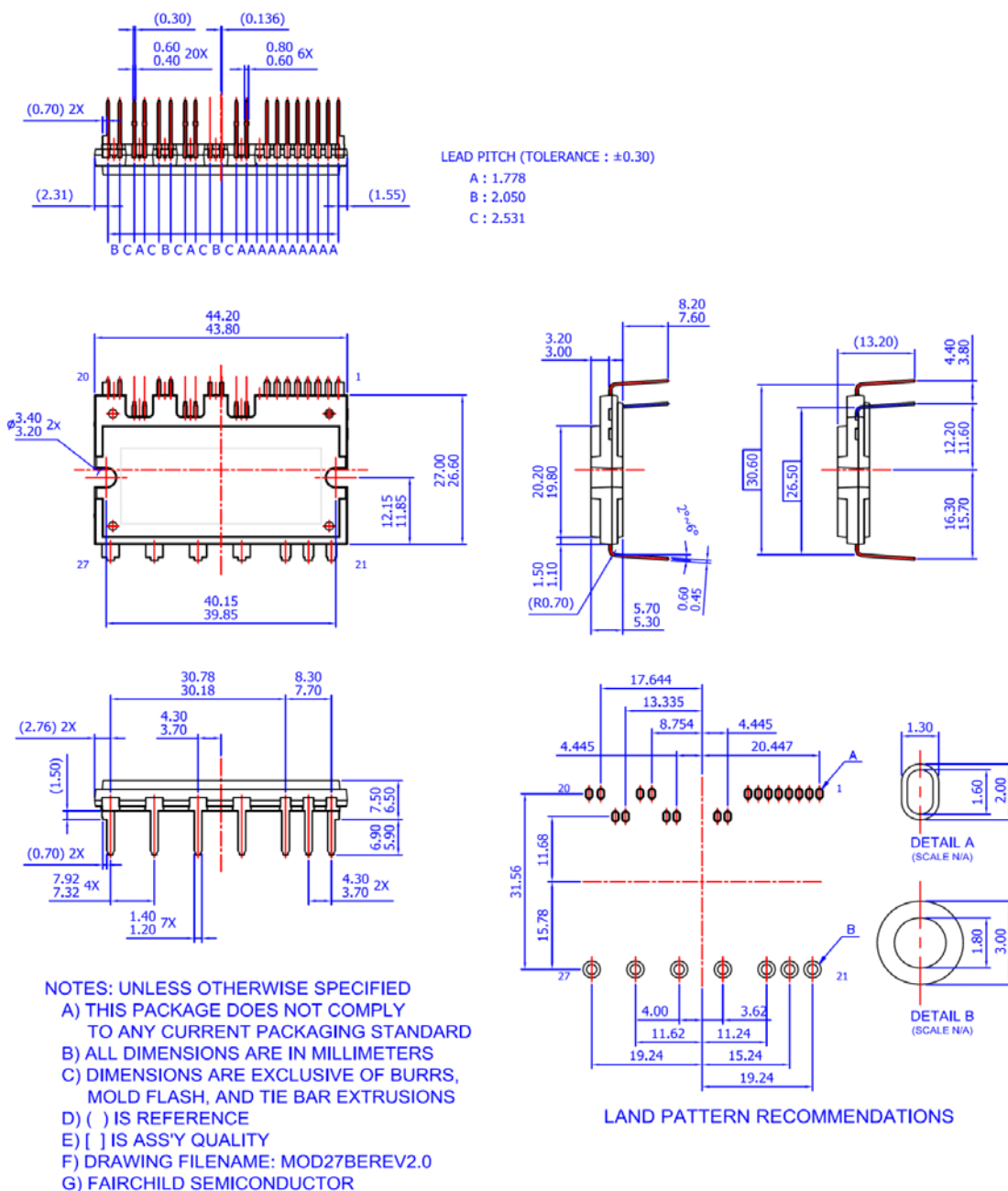


Fig. 9. Application Example

Notes:

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

Detailed Package Outline Drawings



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