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FAIRCHILD SEMICONDUCTOR®

December 2013

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_2O_3 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.

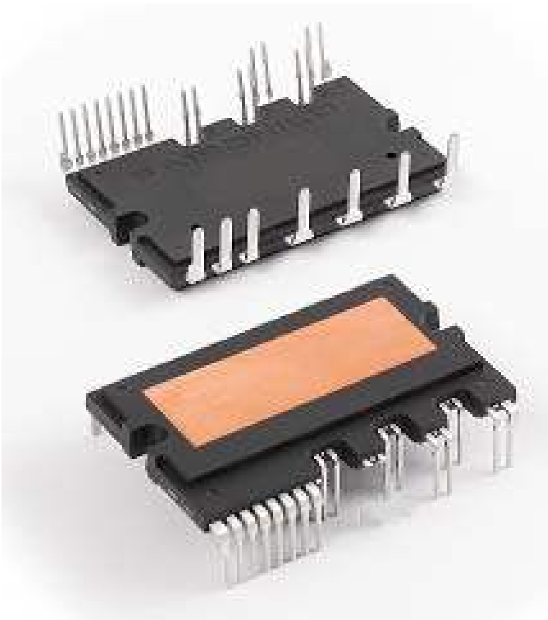


Figure 1. Package Overview

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

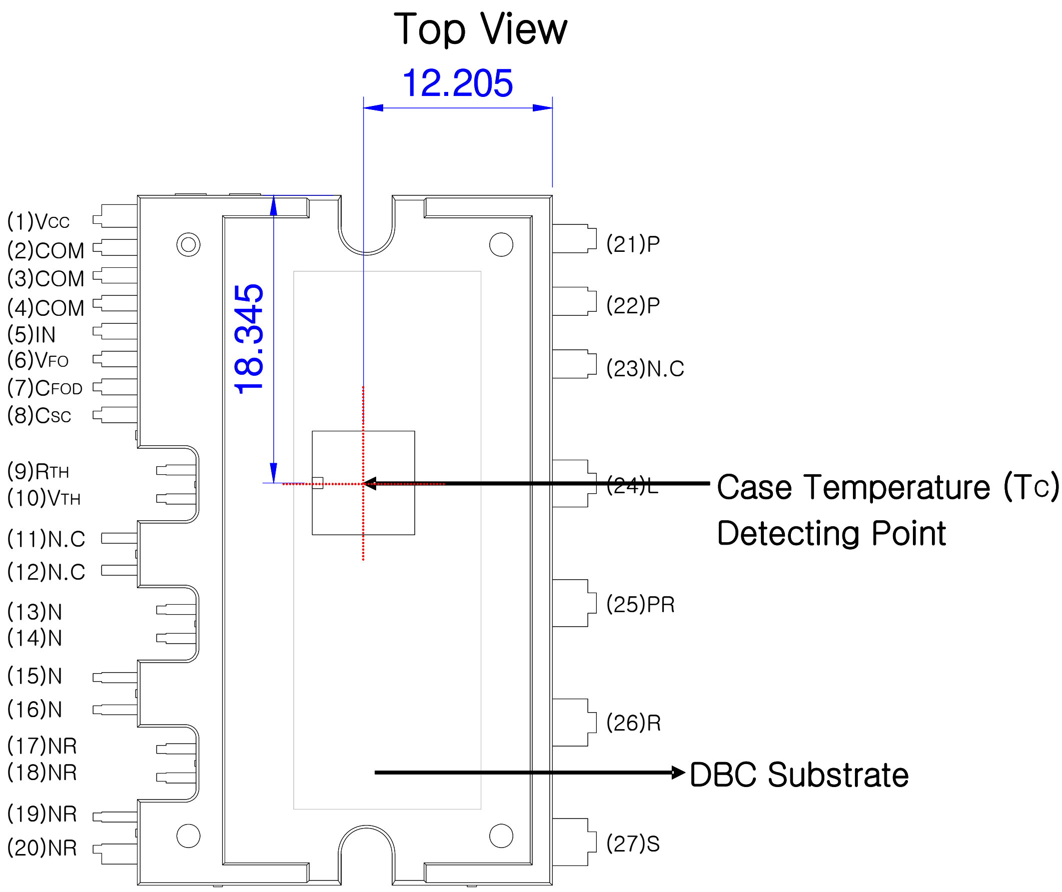


Figure 2. Top View

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_{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

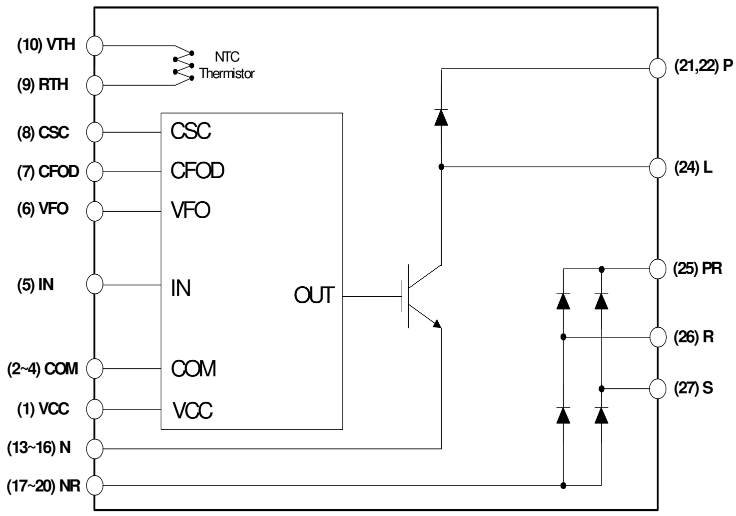


Figure 3. Internal Block Diagram

Absolute Maximum Ratings (T_J = 25°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°C, T_J < 150°C	20	A
I_{CP}	Each IGBT Collector Current (Peak)	T_C = 25°C, T_J < 150°C, Under 1ms Pulse Width	40	A
P_C	Collector Dissipation	T_C = 25°C	89	W
V_{RRM}	Repititive Peak Reverse Voltage		600	V
I_{FSM}	Peak Forward Surge Current	Single Half Sine-Wave	250	A
T_J	Operating Junction Temperature		-40 ~ 150	°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	°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	°C/W
$R_{\theta(j-c)F}$		FRD	-	-	1.4	°C/W
$R_{\theta(j-c)R}$		Rectifier (per 1 / 4 module)	-	-	2.1	°C/W

Electrical Characteristics (T_J = 25°C, unless otherwise specified.)

Converter Part

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	IGBT Saturation Voltage	V_{CC} = 15 V, V_{IN} = 5 V, I_C = 20 A	-	2.3	3.0	V
V_{FF}	FRD Forward Voltage	I_F = 20 A	-	1.8	2.5	V
V_{FR}	Rectifier Forward Voltage	I_F = 20 A	-	1.2	1.5	V
t_{ON}	Switching Times	V_{PN} = 400 V, V_{CC} = 15V, I_C = 20 A V_{IN} = 0 V ↔ 5 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.

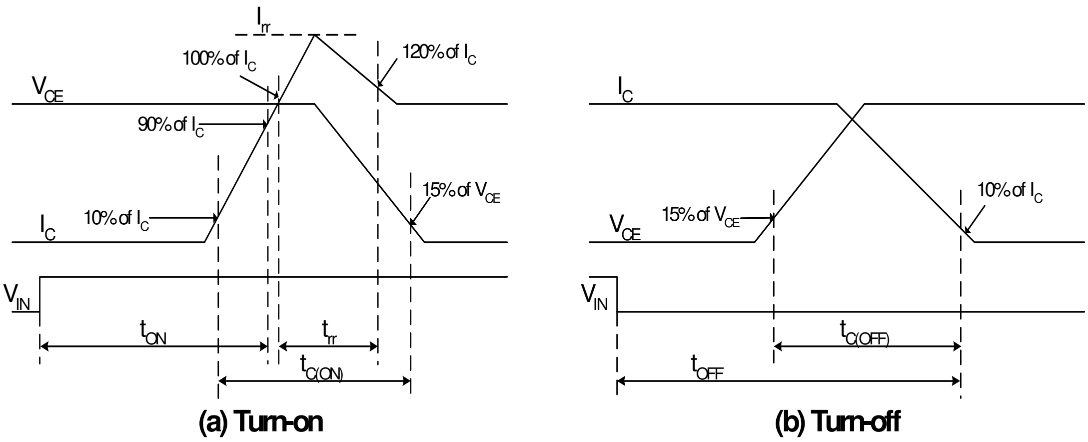


Figure 4. Switching Time Definition

Control Part

Symbol	Item	Condition	Min.	Typ.	Max.	Unit
I_{QCCL}	Quiescent V_{CC} Supply Current	V_{CC} = 15 V, IN = 0 V; V_{CC} - COM	-	-	26	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 Trip Level	V_{CC} = 15 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 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°C (Note 4, Figure 5)	-	47.0	-	kΩ
		@ T_{TH} = 100°C (Note 4, Figure 5)	-	2.9	-	kΩ

Notes:

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

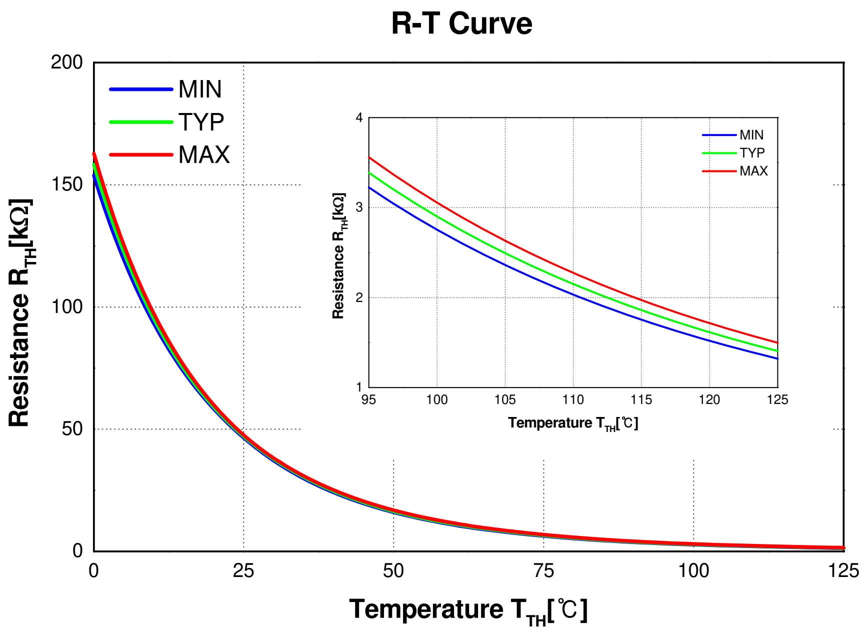


Figure 5. R-T Curve of the Built-In Thermistor

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/μs
f_{PWM}	PWM Input Frequency	$T_J \leq 150°C$	-	20	-	kHz
I_i	Allowable Input Current	$T_C < 90°C$, 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	μm
Weight			-	15.00	-	g

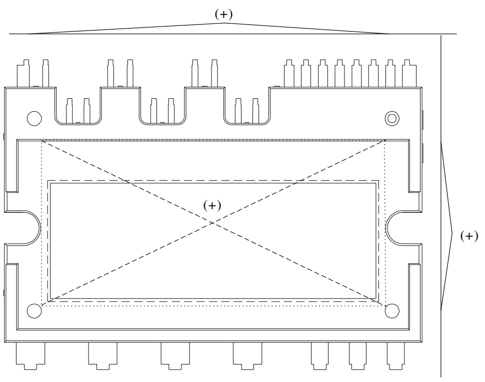
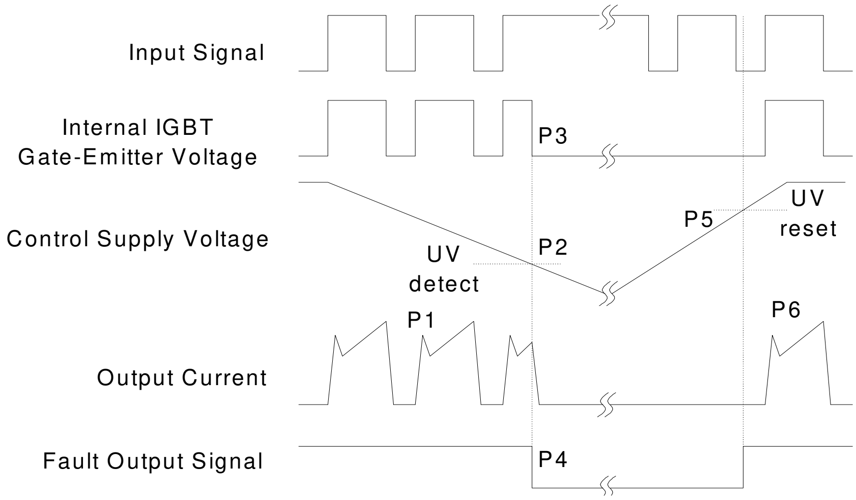


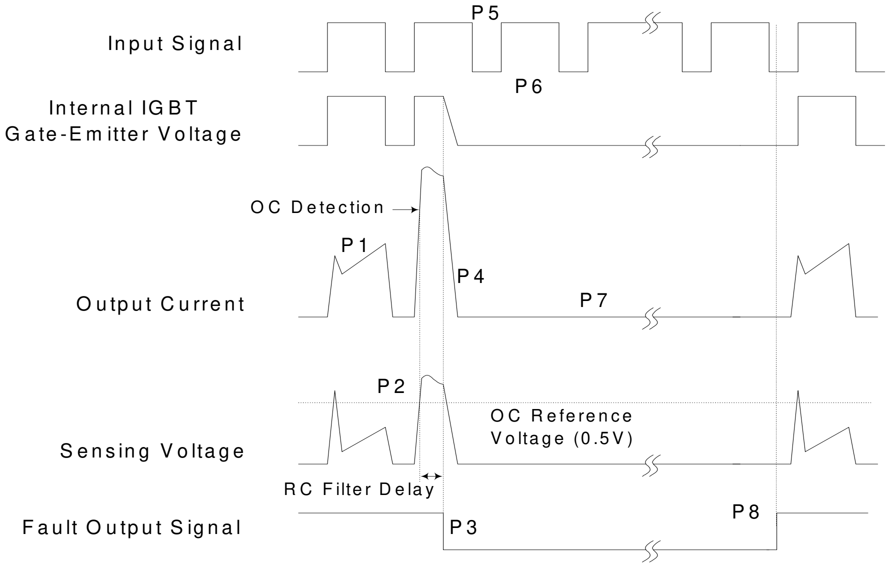
Figure 6. Flatness Measurement Position

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 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

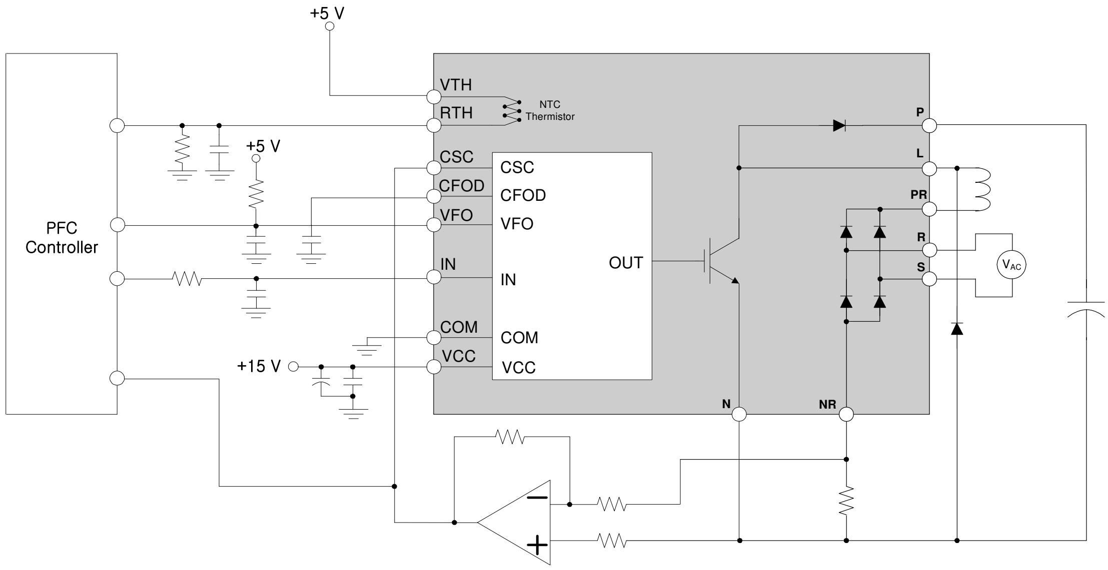
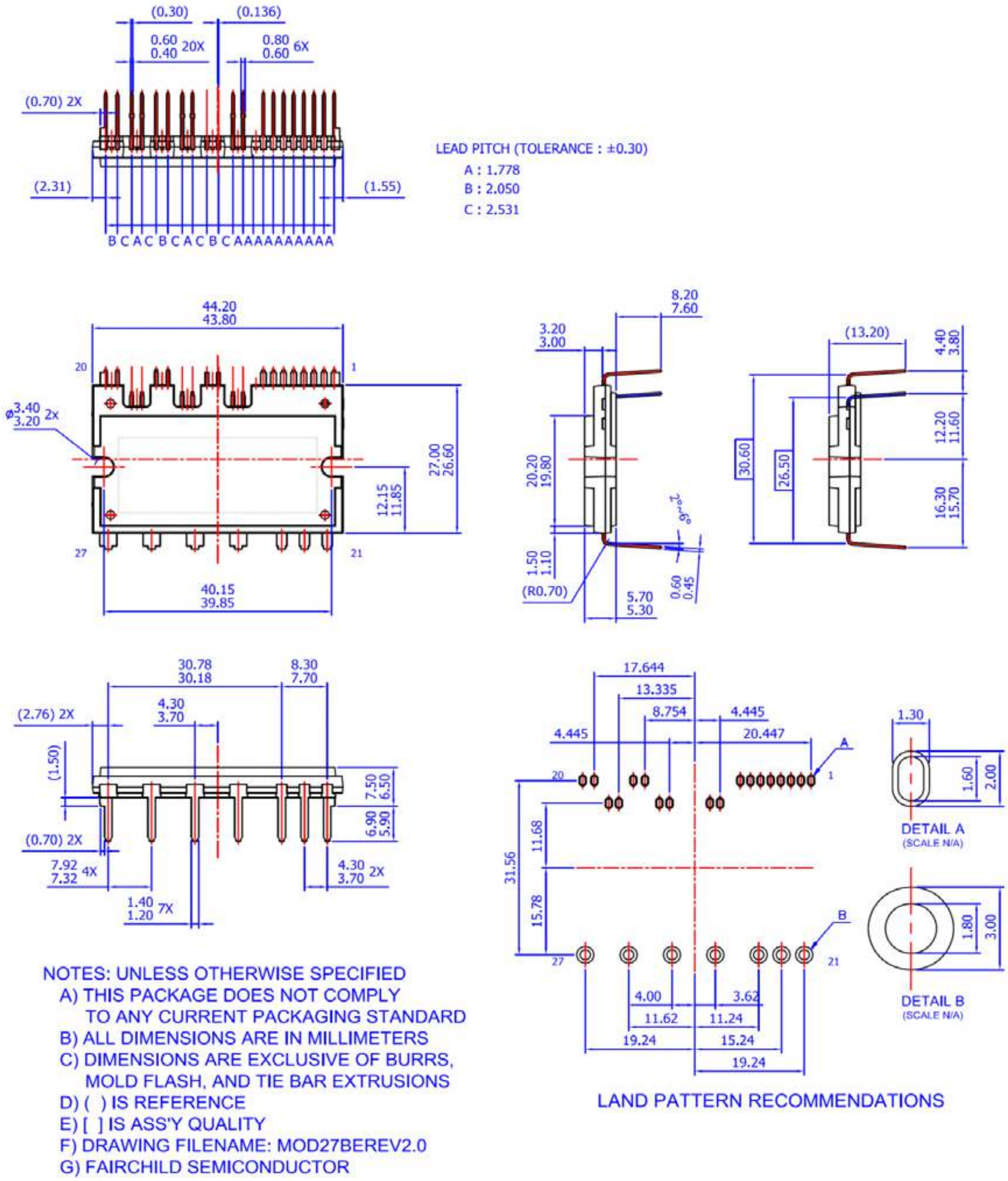


Fig. 9. Application Example

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



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