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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.

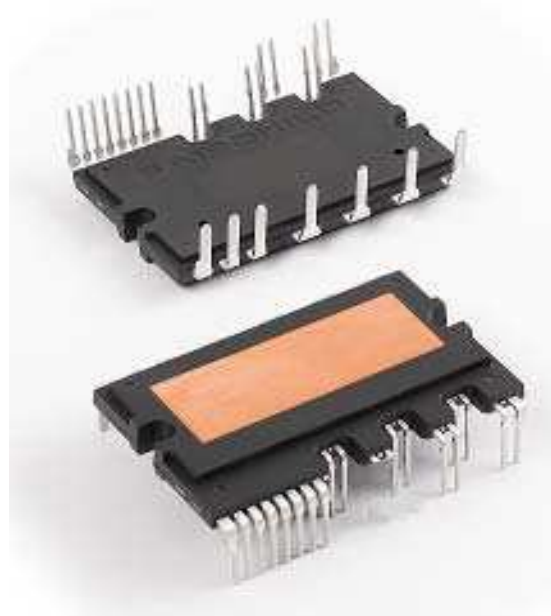


Figure 1. Package Overview

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

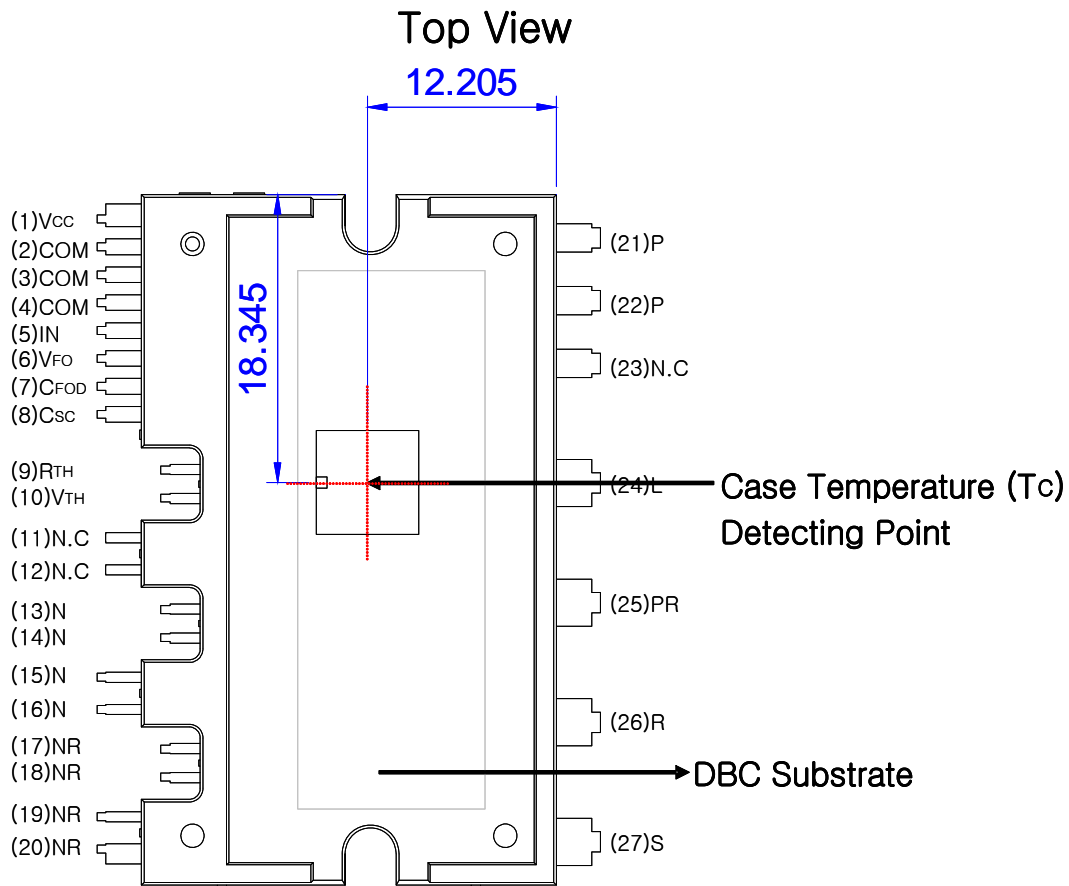


Figure 2. Top View

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

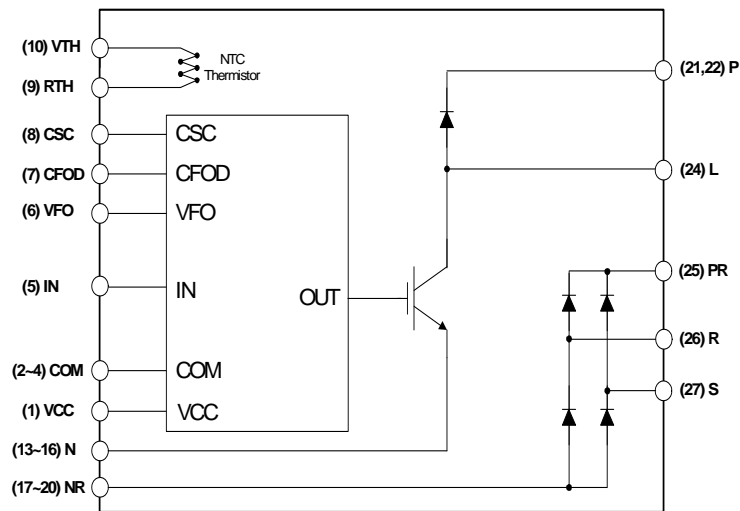


Figure 3. Internal Block Diagram

Absolute Maximum Ratings ($T_J = 25^\circ\text{C}$, 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.

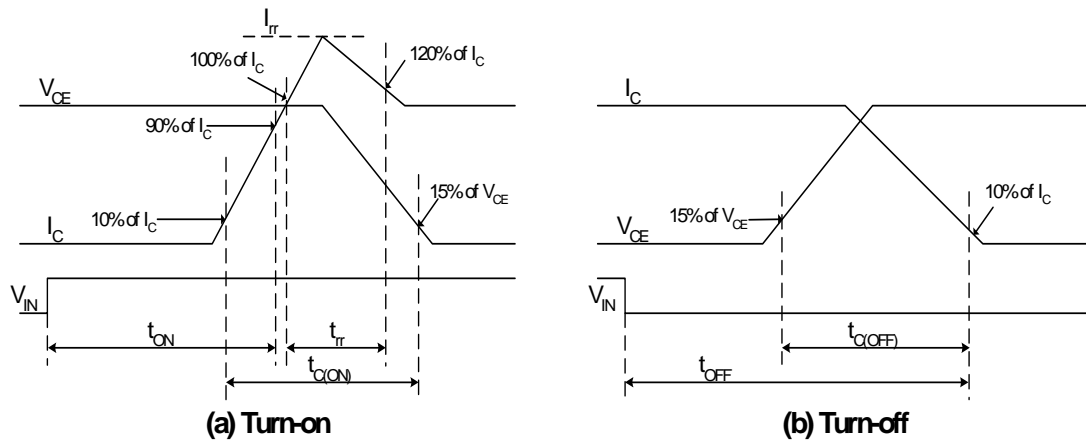


Figure 4. Switching Time Definition

Control Part

| Symbol | Item | Condition | Min. | Typ. | Max. | Unit |
|---------------|---|---|------|------|------|------------|
| I_{QCCL} | Quiescent V_{CC} Supply Current | $V_{CC} = 15\text{ V}$, $I_N = 0\text{ V}$ $V_{CC} - \text{COM}$ | - | - | 26 | mA |
| V_{FOH} | Fault Output Voltage | $V_{SC} = 0\text{ V}$, V_{FO} Circuit: 4.7 k 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:

- 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.

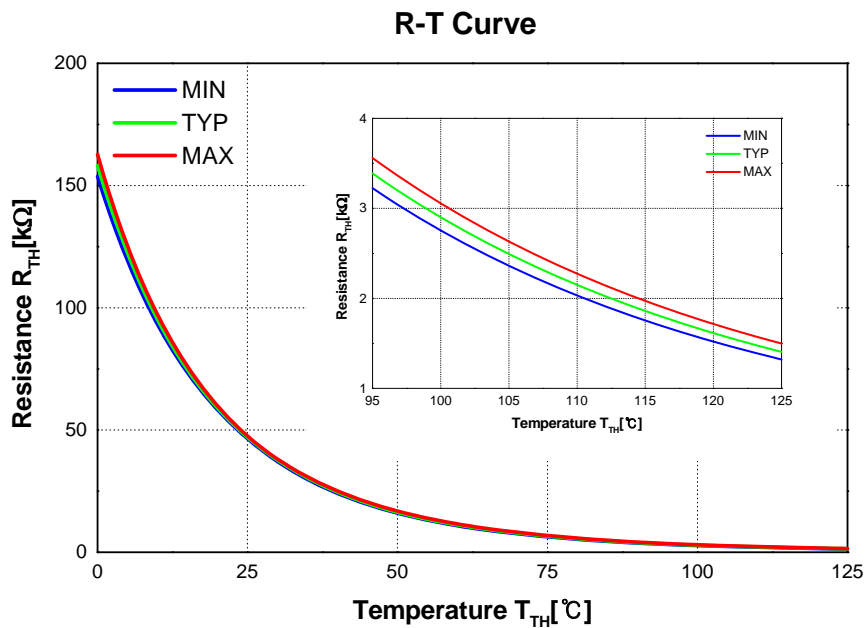


Figure 5. R-T Curve of the Built-In Thermistor

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 | μm |
| Weight | | | - | 15.00 | - | g |

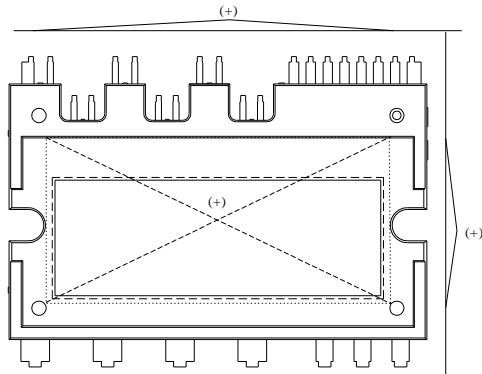
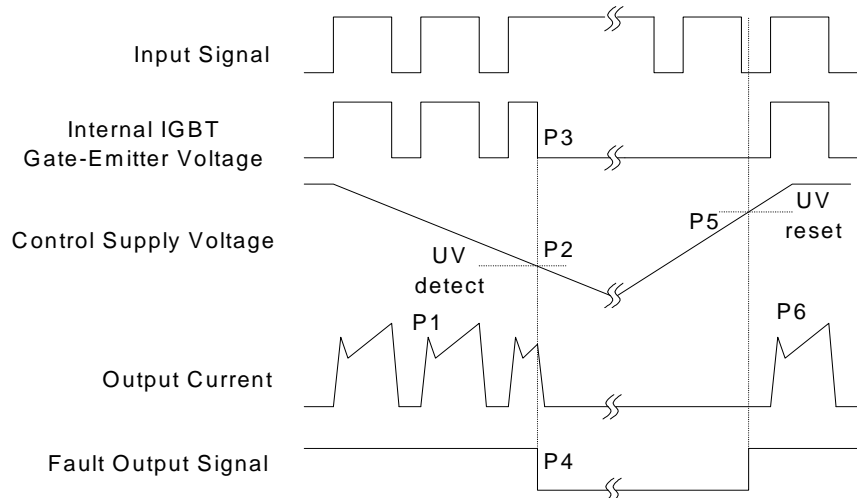


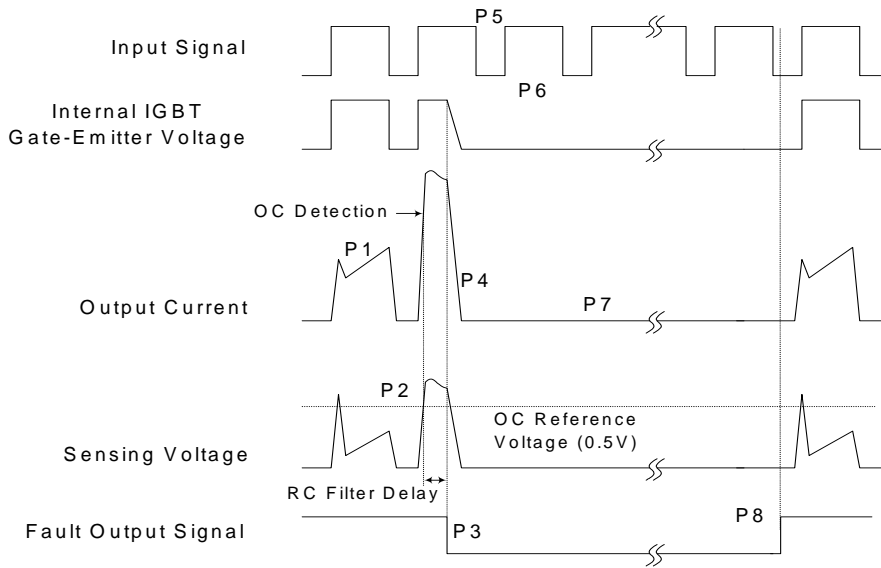
Figure 6. Flatness Measurement Position

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

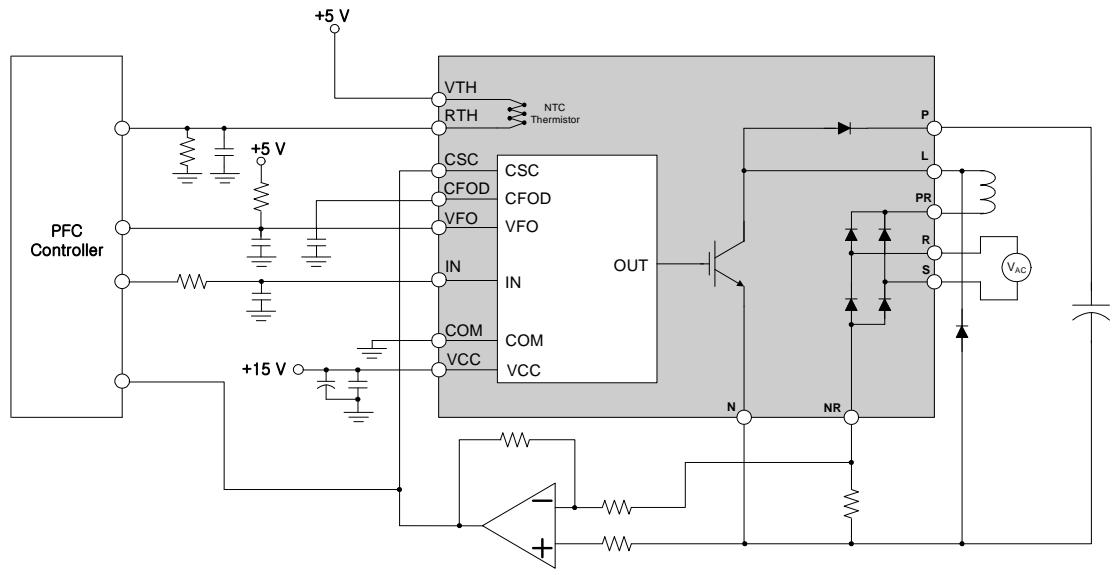
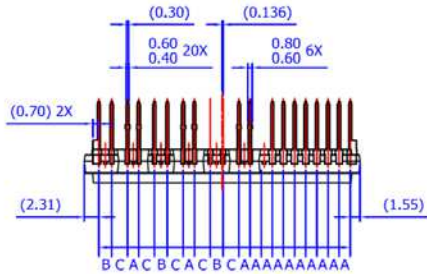


Fig. 9. Application Example

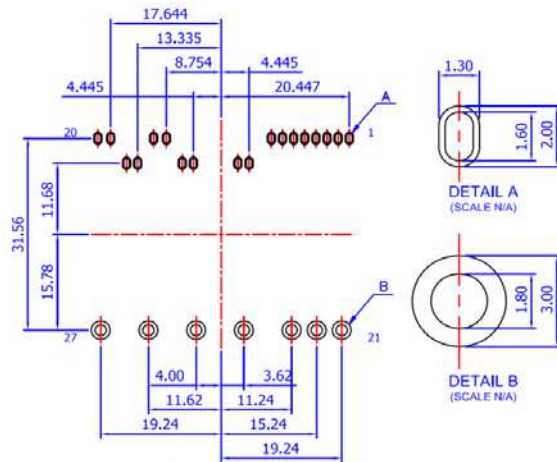
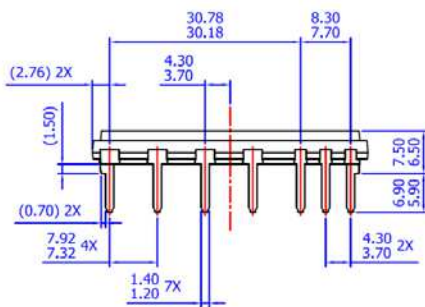
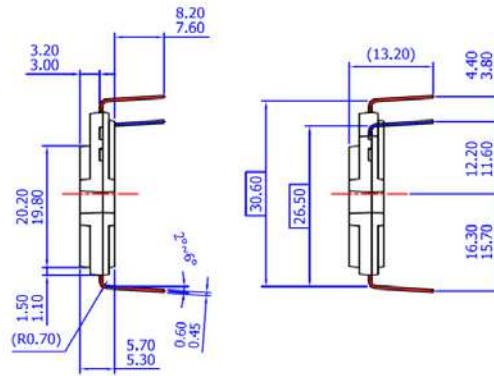
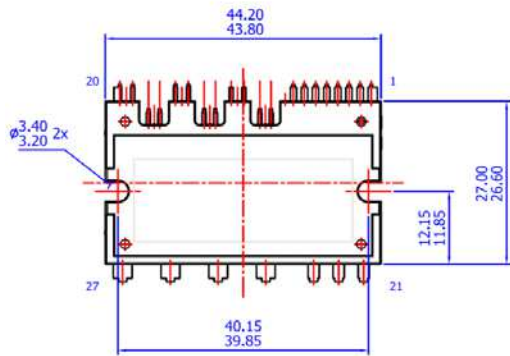
Notes:

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



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



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