PFC SPM® 3 Series for 2-Phase Bridgeless PFC

FPDB60PH60B

General Description

The FPDB60PH60B is an advanced PFC SPM 3 module providing a fully−featured, high−performance Bridgeless PFC (Power Factor Correction) input power stage for consumer, medical, and industrial applications. These modules integrate optimized gate drive of the built−in IGBTs 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 high−performance output diodes and shunt resistor for additional space savings and mounting convenience.

Features

- UL Certified No. E209204 (UL1557)
- 600 V − 60 A 2−Phase Bridgeless PFC with Integral Gate Driver and Protection
- Very Low Thermal Resistance Using AlN DBC Substrate
- Built−in NTC Thermistor for Temperature Monitoring
- Built−in Shunt Resistor for Current Sensing
- Optimized for 20 kHz Switching Frequency
- Isolation Rating: 2500 V_{rms} / min
- This is a Pb−Free Device

Applications

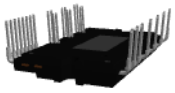
- 2−Phase Bridgeless PFC Converter

Related Source

- AN−9041 − Bridgeless PFC SPM 3 Series Design Guide

Integrated Drive, Protection and System Control Functions

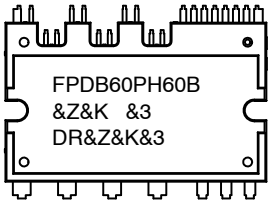
- For IGBTs: Gate Drive Circuit, Over−Current Protection (OCP), Control Supply Circuit Under−Voltage Lock−Out (UVLO) Protection
- Fault Signal: Corresponding to OC and UV Fault
- Built−in Thermistor: Temperature Monitoring
- Input Interface: Active−HIGH Interface, Works with 3.3 / 5 V Logic, Schmitt−trigger Input



3D Package Drawing
(Click to Activate 3D Content)

SPMCA−027 / PDD STD, SPM27−CA, DBC TYPE CASE MODFJ

MARKING DIAGRAM



&Z	= Assembly Plant Code
&K	= 2−Digits Lot Run Traceability Code
&3	= 3−Digit Date Code
FPDB60PH60B	= Specific Device Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

PIN CONFIGURATION

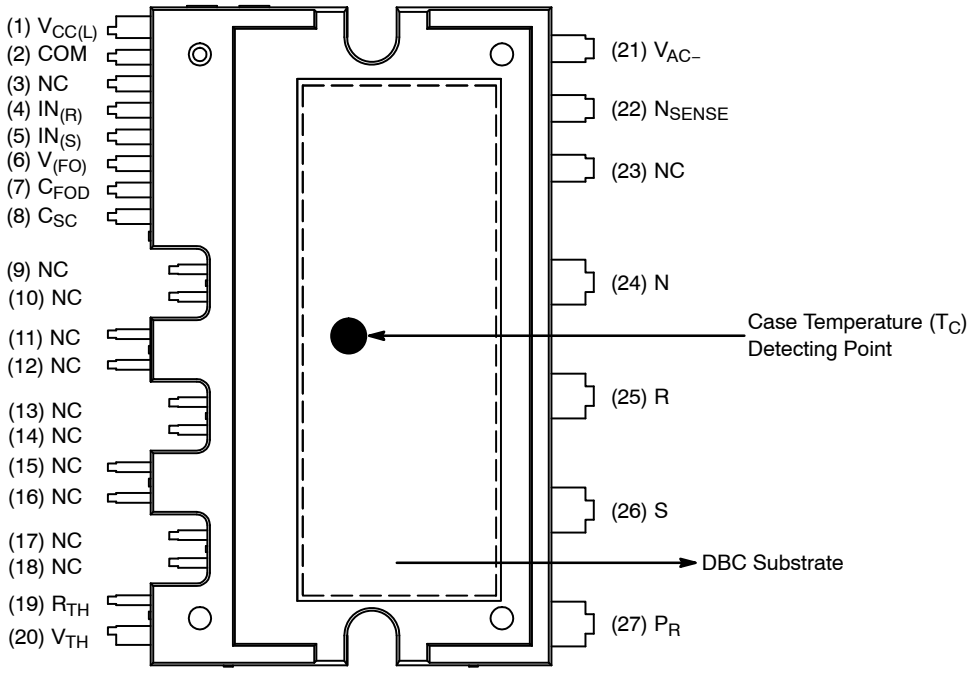
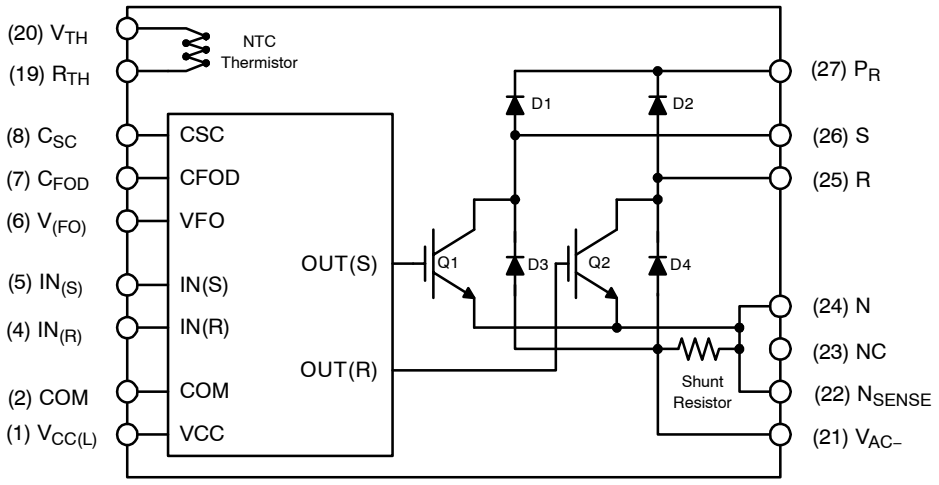


Figure 1. Pin Configuration – Top View

PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Description
1	V_{CC}	Common Bias Voltage for IC and IGBTs Driving
2	COM	Common Supply Ground
4	$IN_{(R)}$	Signal Input for Low−Side R−Phase IGBT
5	$IN_{(S)}$	Signal Input for Low−Side S−Phase 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
19	$R_{(TH)}$	Series Resistor for The Use of Thermistor
20	$V_{(TH)}$	Thermistor Bias Voltage
21	V_{AC-}	Current Sensing Terminal
22	N_{SENSE}	Current Sensing Reference Terminal
24	N	Negative Rail of DC−Link
25	R	Output for R−Phase
26	S	Output for S−Phase
27	P_R	Positive Rail of DC−Link
3, 9 ~ 18, 23	NC	No Connection

INTERNAL EQUIVALENT CIRCUIT AND INPUT/OUTPUT PINS



NOTE:
1. Converter is composed of two IGBTs including four diodes and one IC which has gate driving and protection functions.

Figure 2. Internal Block Diagram

ABSOLUTE MAXIMUM RATINGS (T_J = 25°C unless otherwise specified)

Symbol	Parameter	Conditions	Rating	Unit
INVERTER PART				
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
$\pm I_C$	Each IGBT Collector Current	T_C = 25°C	60	A
$\pm I_{CP}$	Each IGBT Collector Current (Peak)	T_C = 25°C, Under 1 ms Pulse Width	90	A
P_C	Collector Dissipation	T_C = 25°C per IGBT	178	W
V_{RRM}	Repetitive Peak Reverse Voltage		600	V
I_{FSM}	Peak Forward Surge Current	Single Half Sine−Wave	350	A
P_{RSH}	Power Rating of Shunt Resistor	T_C < 125°C	2	W
T_J	Operating Junction Temperature	(Note 2)	−40 ~ 150	°C
CONTROL PART				
V_{CC}	Control Supply Voltage	Applied between V_{CC} – COM	20	V
V_{IN}	Input Signal Voltage	Applied between IN – COM	−0.3 ~ 17.0	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				
T_C	Module Case Operation Temperature		−30 ~ 100	°C
T_{STG}	Storage Temperature		−40 ~ 150	°C
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat−Sink Plate	2500	V_{rms}

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

2. The maximum junction temperature rating of the power chips integrated within the PFC SPM product is 150°C(@ $T_C \le 100°C$).

THERMAL RESISTANCE

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{\theta(j-c)Q}$	Junction to Case Thermal Resistance (Referenced to PKG Center)	IGBT	–	–	0.7	°C/W
$R_{\theta(j-c)HD}$		High−Side Diode	–	–	1.5	°C/W
$R_{\theta(j-c)LD}$		Low−Side Diode	–	–	0.85	°C/W

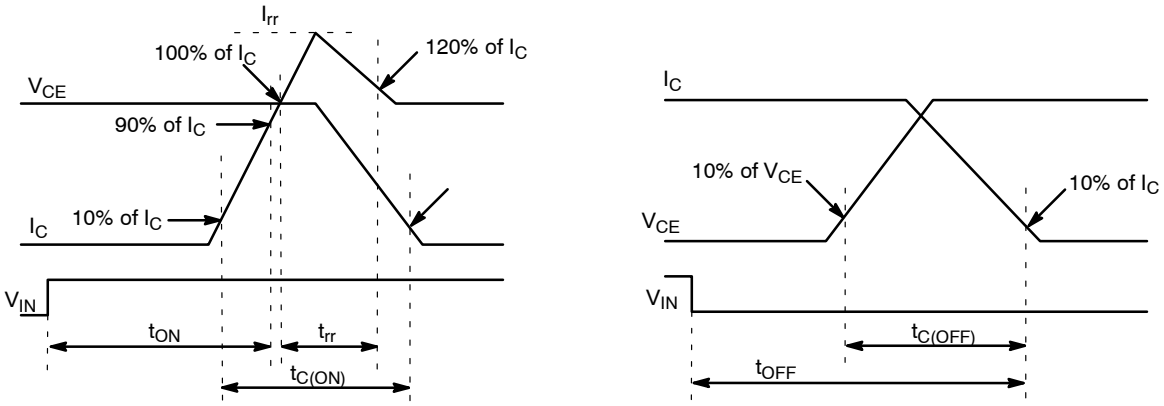
3. For the measurement point of case temperature (T_C), please refer to Figure 1.

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
CONVERTER PART						
$V_{CE(SAT)}$	IGBT Saturation Voltage	V_{CC} = 15 V, V_{IN} = 5 V, I_C = 50 A	–	2.0	2.5	V
V_{FH}	High−Side Diode Voltage	I_F = 50 A	–	2.4	2.9	V
V_{FL}	Low−Side Diode Voltage	I_F = 50 A	–	1.2	1.6	V
t_{ON}	Switching Times	V_{PN} = 400 V, V_{CC} = 15 V, I_C = 60 A, V_{IN} = 0 V ↔ 5 V, Inductive load (Note 4)	–	560	–	ns
$t_{C(ON)}$			–	270	–	ns
t_{OFF}			–	520	–	ns
$t_{C(OFF)}$			–	110	–	ns
t_{rr}			–	44	–	ns
I_{rr}			–	6.5	–	A
R_{SENSE}	Current−Sensing Resistor		1.8	2.0	2.2	mΩ
I_{CES}	Collector − Emitter Leakage Current	V_{CE} = V_{CES}	–	–	250	μA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. 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 times of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 3.



a) Turn−on **b) Turn−off**

Figure 3. Switching Time Definition

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified.) (continued)

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
CONTROL PART							
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
$V_{SC(ref)}$	Short Circuit Trip Level	V_{CC} = 15 V		0.45	0.50	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 5)		1.4	1.8	2.0	ms
$V_{IN(ON)}$	ON Threshold Voltage	Applied between IN – COM		3.0	–	–	V
$V_{IN(OFF)}$	OFF Threshold Voltage			–	–	0.8	V
R_{TH}	Resistance of Thermistor	At T_C = 25°C (See Figure 4)		–	50	–	kΩ
		At T_C = 80°C (See Figure 4)		–	5.76	–	kΩ

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

5. The fault–out pulse width t_{FOD} depends on the capacitance value of C_{FOD} according to the following approximate equation:
   $C_{FOD} = 18.3 \times 10^{-6}\ t_{FOD}$[F]

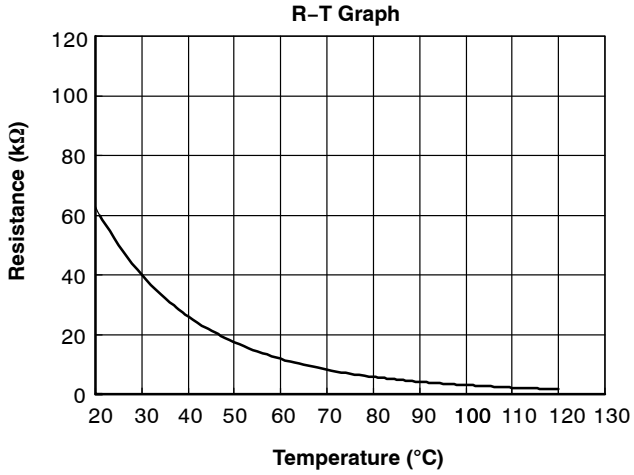


Figure 4. R–T Curve of the Built–in Thermistor

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_I	Input Supply Voltage	Applied between R – S	180	–	264	V_{rms}
V_{PN}	Output Voltage	Applied between P – N	–	280	400	V
V_{CC}	Control Supply Voltage	Applied between V_{CC} – COM	13.5	15	16.5	V
dV_{CC} / dt	Control Supply Variation	Applied between IN – COM	–1	–	1	V/μs
f_{PWM}	PWM Input Signal	$T_C \le 100°C$, $T_J \le 125°C$, per IGBT	–	20	–	kHz

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

MECHANICAL CHARACTERISTICS AND RATINGS

Item	Conditions		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 5		0	–	+120	μm
Weight			–	15.00	–	g

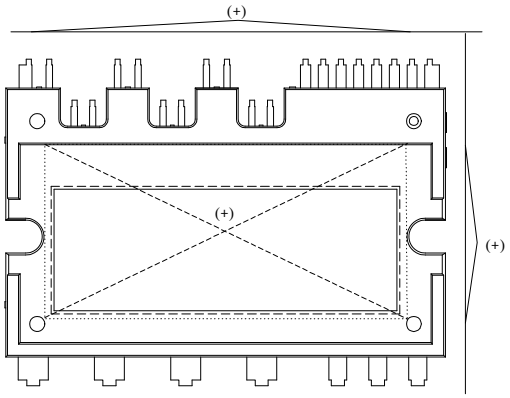
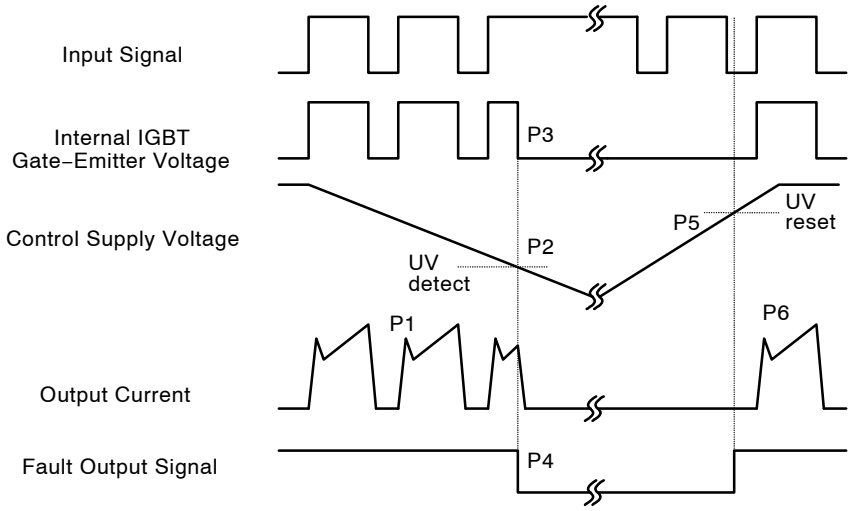


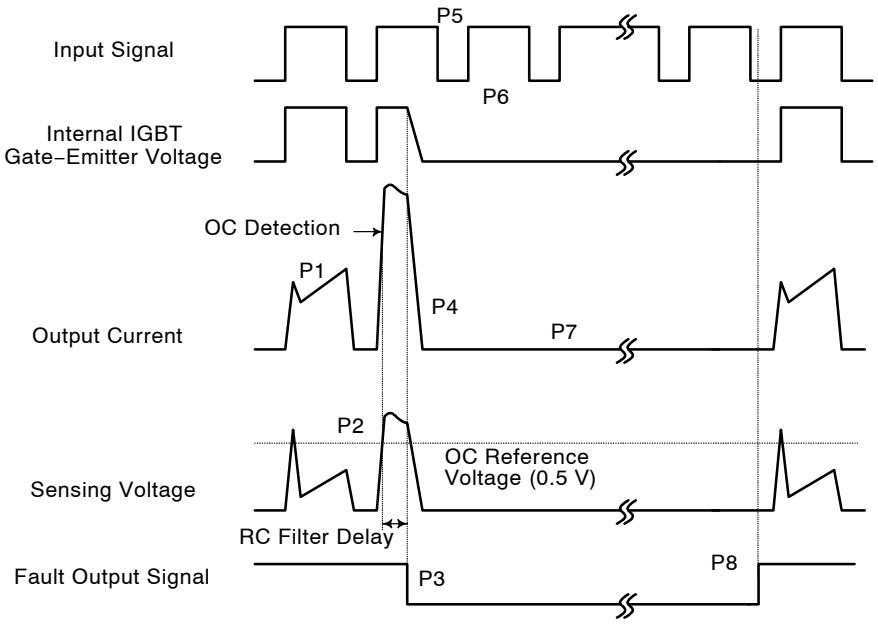
Figure 5. Flatness Measurement Position

TIME CHARTS OF PROTECTIVE FUNCTION



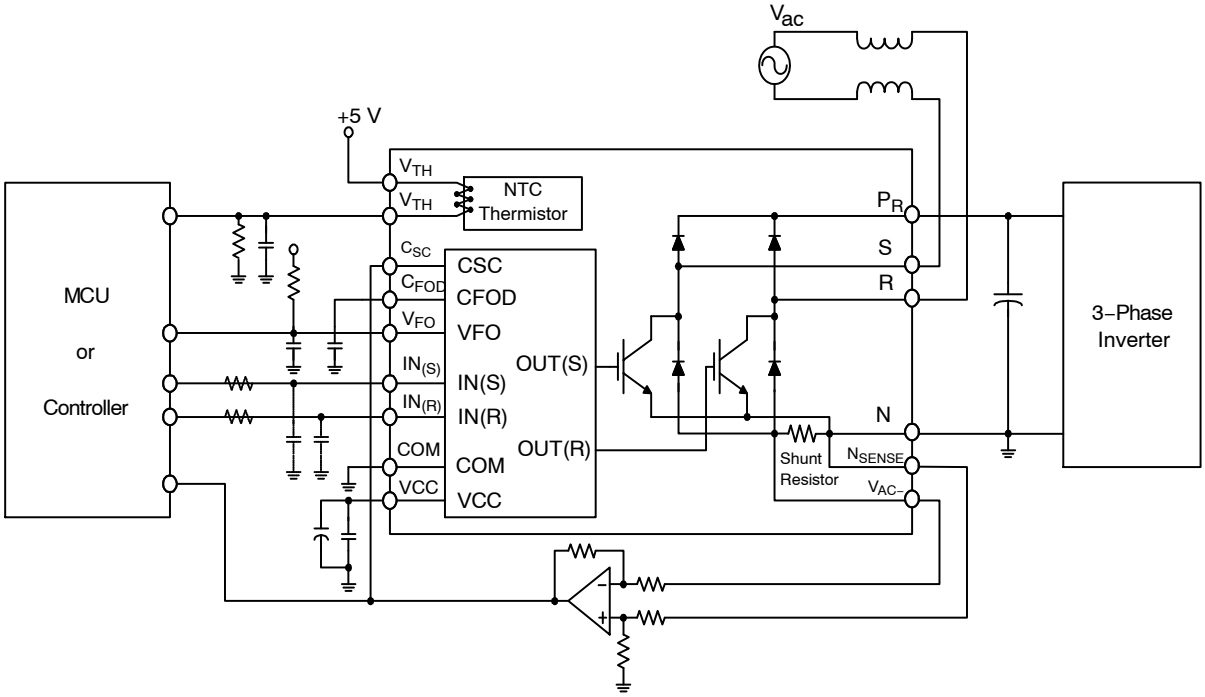
P1: Normal operation: IGBT ON and conducting current.
P2: Under−voltage detection.
P3: IGBT gate interrupt.
P4: Fault signal generation.
P5: Under−voltage reset.
P6: Normal operation: IGBT ON and conducting current.

Figure 6. 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 7. Over−Current Protection



NOTE:
6. For the over−current protection, please set time constant in the range 3 ~ 4 μs.

Figure 8. Application Example

PACKAGE MARKING AND ORDERING INFORMATION

Device	Device Marking	Package	Shipping
FPDB60PH60	FPDB60PH60B	SPMCA−027 / PDD STD, SPM27−CA, DBC TYPE (Pb−Free / Halide Free)	60 Units / Tube

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

ON Semiconductor®

SPMCA−027 / PDD STD, SPM27−CA, DBC TYPE
CASE MODFJ
ISSUE O

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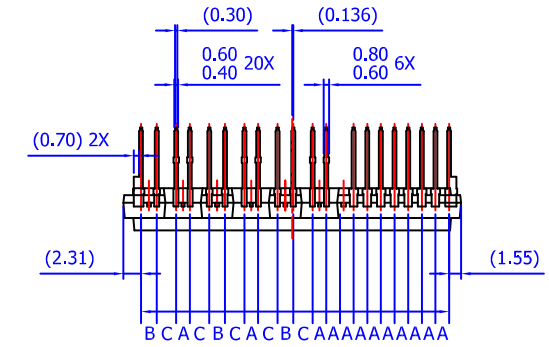
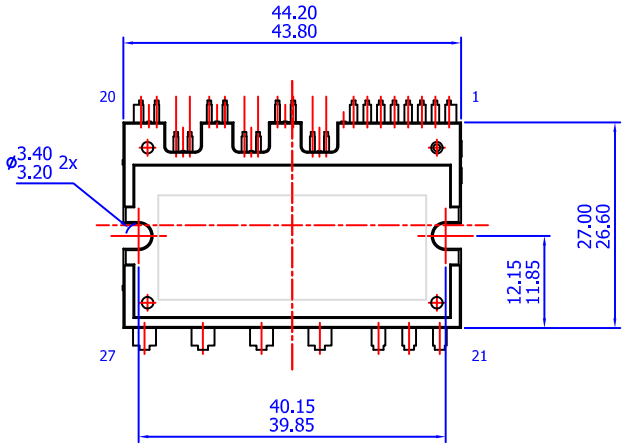
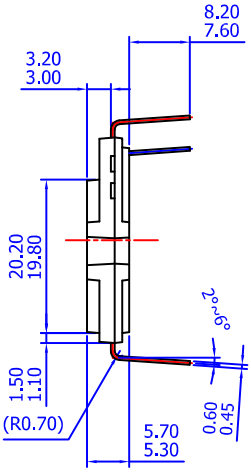
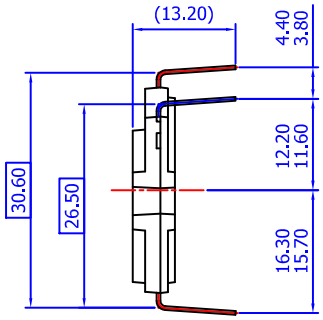
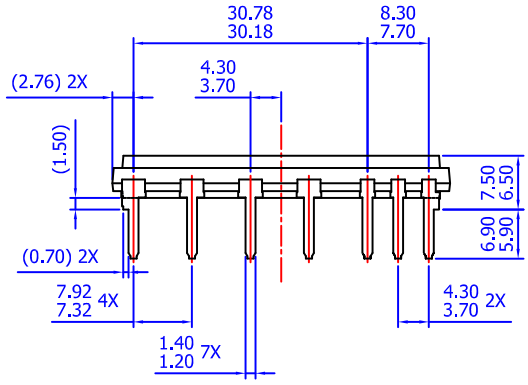


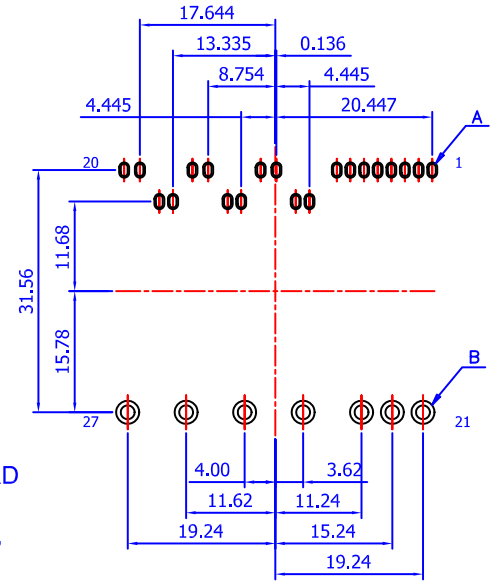
LEAD PITCH (TOLERANCE : ±0.30)
A : 1.778
B : 2.050
C : 2.531

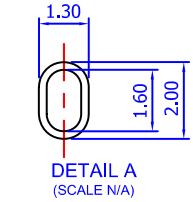


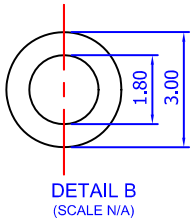












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C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
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