



## FPDB60PH60B PFC SPM<sup>®</sup> 3 Series for 2-Phase Bridgeless PFC

### Features

- Low Thermal Resistance Thanks to AIN-DBC Substrate
- 600 V - 60 A 2-Phase Bridgeless PFC Including A Drive IC for Gate Driving and Protection
- Built-In NTC Thermistor for Monitoring Over-Temperature
- Built-In Shunt Resistor for Current Sensing
- Typical Switching Frequency of 20 kHz
- Isolation Rating of 2500 Vrms/min.

### Applications

- 2-Phase Bridgeless PFC Converter for Air Conditioner

### General Description

FPDB60PH60B Is An Advanced PFC SPM 3 Series for 2-Phase Bridgeless PFC (Power Factor Correction) that Fairchild Has Newly Developed for Mid-Power Applications such as Air Conditioners. It Combines Optimized Circuit Protection and Drive IC Matched To High Frequency Switching IGBTs. The System Reliability Is Further Enhanced by The Integrated Under-Voltage Lock-Out and Over-Current Protection Function.

### Related Source

- [AN-9041 - Bridgeless PFC SPM 3 Series Design Guide](#)

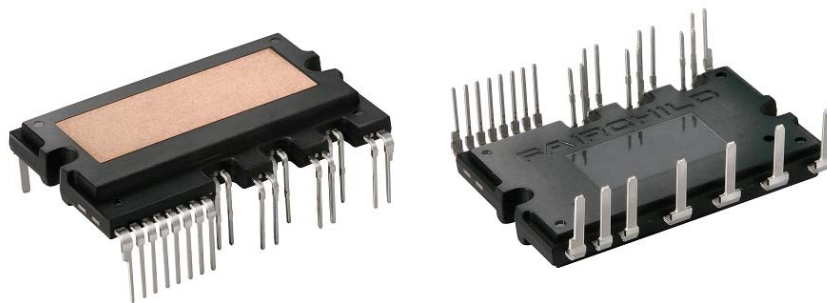


Fig. 1. Package Overview

### Package Marking & Ordering Information

Device Marking	Device	Package	Packing Type	Reel Size	Tape Width	Quantity
FPDB60PH60B	FPDB60PH60B	SPMHC-027	RAIL	-	-	10

### Integrated Power Functions

- PFC converter for single-phase AC/DC power conversion (Please refer to Fig. 3)

### Integrated Drive, Protection and System Control Functions

- For IGBTs : Gate drive circuit, Over Current(OC) protection, Control supply circuit Under-Voltage(UV) protection
- Fault signal : Corresponding to OC and UV fault
- Built-in thermistor: Over-temperature monitoring
- Input interface : Active-high interface, can work with 3.3 / 5 V Logic, Schmitt trigger input

### Pin Configuration

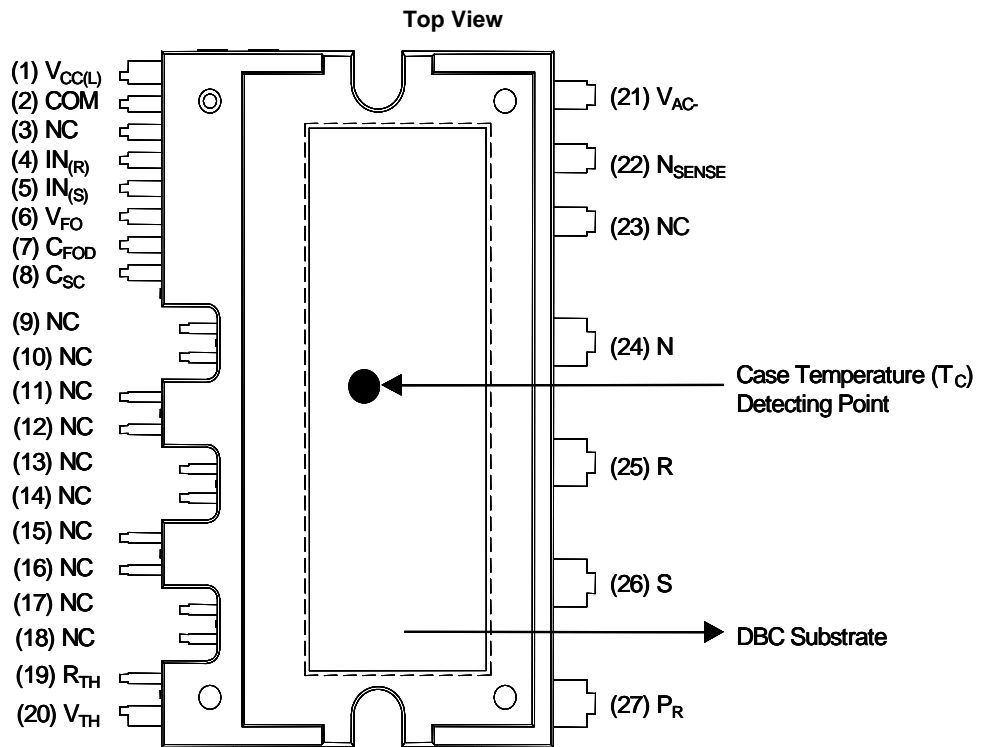
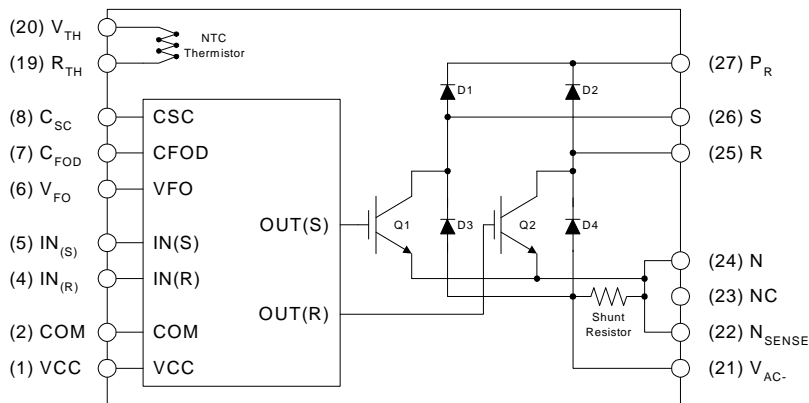


Fig. 2.

### Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V <sub>CC</sub>	Common Bias Voltage for IC and IGBTs Driving
2	COM	Common Supply Ground
4	IN <sub>(R)</sub>	Signal Input for Low-side R-phase IGBT
5	IN <sub>(S)</sub>	Signal Input for Low-side S-phase IGBT
6	V <sub>FO</sub>	Fault Output
7	C <sub>FOD</sub>	Capacitor for Fault Output Duration Time Selection
8	C <sub>SC</sub>	Capacitor (Low-pass Filter) for Over Current Detection
19	R <sub>(TH)</sub>	NTC Thermistor terminal
20	V <sub>(TH)</sub>	NTC Thermistor terminal
21	V <sub>AC-</sub>	Current Sensing Terminal
22	N <sub>SENSE</sub>	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 <sub>R</sub>	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.

**Fig. 3.**

**Absolute Maximum Ratings** ( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)**Converter Part**

Item	Symbol	Condition	Rating	Unit
Supply Voltage	$V_i$	Applied between R-S	264	$V_{RMS}$
Supply Voltage (Surge)	$V_{i(Surge)}$	Applied between R-S	500	V
Output Voltage	$V_{PN}$	Applied between P- N	450	V
Output Voltage (Surge)	$V_{PN(Surge)}$	Applied between P- N	500	V
Collector-emitter Voltage	$V_{CES}$		600	V
Each IGBT collector current	$\pm I_C$	$T_C = 25^\circ\text{C}$	60	A
Each IGBT collector current (Peak)	$\pm I_{CP}$	$T_C = 25^\circ\text{C}$ , Under 1 ms pulse width	90	A
Collector Dissipation	$P_C$	$T_C = 25^\circ\text{C}$ per One IGBT	178	W
Repetitive Peak Reverse Voltage	$V_{RRM}$		600	V
Peak Forward Surge Current	$I_{FSM}$	Single half sine-wave	350	A
Power Rating of Shunt Resistor	$P_{RSH}$	$T_C < 125^\circ\text{C}$	2	W
Operating Junction Temperature	$T_J$	(Note 1)	-40 ~ 150	$^\circ\text{C}$

**Note :**

1. The maximum junction temperature rating of the power chips integrated within the PFC SPM® product is  $150^\circ\text{C} (@T_C \leq 100^\circ\text{C})$ .

**Control Part**

Item	Symbol	Condition	Rating	Unit
Control Supply Voltage	$V_{CC}$	Applied between $V_{CC}$ - COM	20	V
Input Signal Voltage	$V_{IN}$	Applied between IN - COM	-0.3~17	V
Fault Output Supply Voltage	$V_{FO}$	Applied between $V_{FO}$ - COM	-0.3~ $V_{CC}+0.3$	V
Fault Output Current	$I_{FO}$	Sink Current at $V_{FO}$ Pin	5	mA
Current Sensing Input Voltage	$V_{SC}$	Applied between $C_{SC}$ - COM	-0.3~ $V_{CC}+0.3$	V

**Total System**

Item	Symbol	Condition	Rating	Unit
Module Case Operation Temperature	$T_C$		-20 ~ 100	$^\circ\text{C}$
Storage Temperature	$T_{STG}$		-40 ~ 150	$^\circ\text{C}$
Isolation Voltage	$V_{ISO}$	60 Hz, Sinusoidal, AC 1 minute, Connection Pins to DBC	2500	$V_{rms}$

**Thermal Resistance**

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Junction to Case Thermal Resistance (Referenced to PKG center)	$R_{\theta(j-c)Q}$	IGBT	-	-	0.7	$^\circ\text{C/W}$
	$R_{\theta(j-c)HD}$	High-side diode	-	-	1.5	$^\circ\text{C/W}$
	$R_{\theta(j-c)LD}$	Low-side diode	-	-	0.85	$^\circ\text{C/W}$

**Note :**

2. For the measurement point of case temperature( $T_C$ ), please refer to Fig. 2.

**Electrical Characteristics** ( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)**Converter Part**

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
IGBT saturation voltage	$V_{CE(sat)}$	$V_{CC} = 15\text{ V}$ , $V_{IN} = 5\text{ V}$ ; $I_C = 50\text{ A}$	-	2.0	2.5	V
High-side diode voltage	$V_{FH}$	$I_F = 50\text{ A}$	-	2.4	2.9	V
Low-side diode voltage	$V_{FL}$	$I_F = 50\text{ A}$	-	1.2	1.6	V
Switching Times	$t_{ON}$	$V_{PN} = 400\text{ V}$ , $V_{CC} = 15\text{ V}$ , $I_C = 60\text{ A}$ $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , Inductive Load (Note 3)	-	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
Current sensing resistor	$R_{SENSE}$		1.8	2.0	2.2	$\text{m}\Omega$
Collector - emitter Leakage Current	$I_{CES}$	$V_{CE} = V_{CES}$	-	-	250	$\mu\text{A}$

**Note**

3.  $t_{ON}$  and  $t_{OFF}$  include the propagation delay time of the internal drive IC.  $t_{C(ON)}$  and  $t_{C(OFF)}$  are the switching time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Fig. 4

**Control Part**

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Quiescent $V_{CC}$ Supply Current	$I_{QCCL}$	$V_{CC} = 15\text{ V}$ , $I_N = 0\text{ V}$   $V_{CC} - \text{COM}$	-	-	26	mA
Fault Output Voltage	$V_{FOH}$	$V_{SC} = 0\text{ V}$ , $V_{FO}$ 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
Over Current Trip Level	$V_{SC(ref)}$	$V_{CC} = 15\text{ V}$	0.45	0.5	0.55	V
Supply Circuit Under-Voltage Protection	$UV_{CCD}$	Detection Level	10.7	11.9	13.0	V
	$UV_{CCR}$	Reset Level	11.2	12.4	13.2	V
Fault-out Pulse Width	$t_{FOD}$	$C_{FOD} = 33\text{ nF}$ (Note 4)	1.4	1.8	2.0	ms
ON Threshold Voltage	$V_{IN(ON)}$	Applied between IN - COM	3.0	-	-	V
OFF Threshold Voltage	$V_{IN(OFF)}$		-	-	0.8	V
Resistance of Thermistor	$R_{TH}$	@ $T_C = 25^\circ\text{C}$ (Note Fig. 9)	-	50	-	k $\Omega$
		@ $T_C = 80^\circ\text{C}$ (Note Fig. 9)	-	5.76	-	k $\Omega$

**Note**

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

**Recommended Operating conditions**

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Input Supply Voltage	$V_I$	Applied between R - S	180	-	264	$V_{rms}$
Output Voltage	$V_{PN}$	Applied between P - N	-	280	400	V
Control Supply Voltage	$V_{CC}$	Applied between $V_{CC} - \text{COM}$	13.5	15	16.5	V
Control Supply Variation	$dV_{CC}/dt$	Applied between IN - COM	-1	-	1	V/ $\mu\text{s}$
PWM Input Signal	$f_{PWM}$	$T_C \leq 100^\circ\text{C}$ , $T_J \leq 125^\circ\text{C}$ , Per IGBT	-	20	-	kHz

### Electrical Characteristics

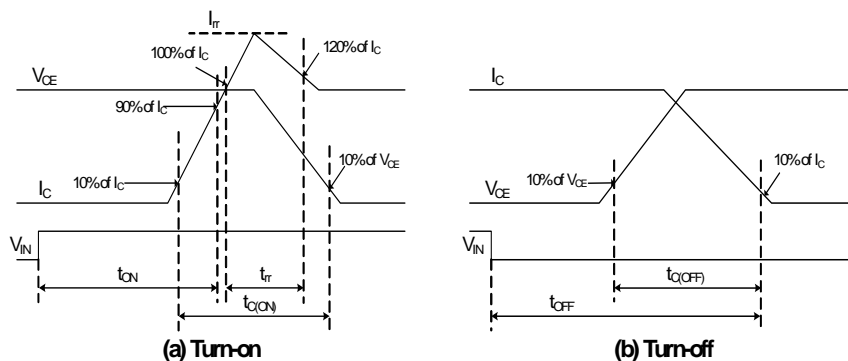


Fig. 4. Switching Time Definition

### Mechanical Characteristics and Ratings

Item	Condition	Limits			Units
		Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: M3   Recommended 0.62 N•m	0.51	0.62	0.72	N•m
Device Flatness	Note Fig. 5	0	-	+120	μm
Weight		-	15.00	-	g

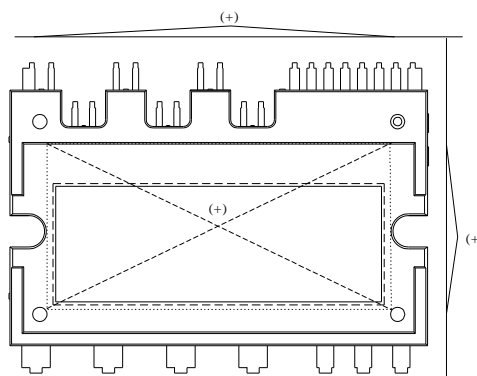
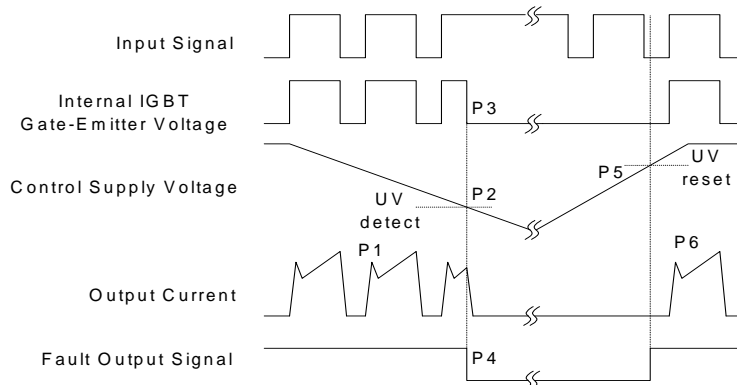


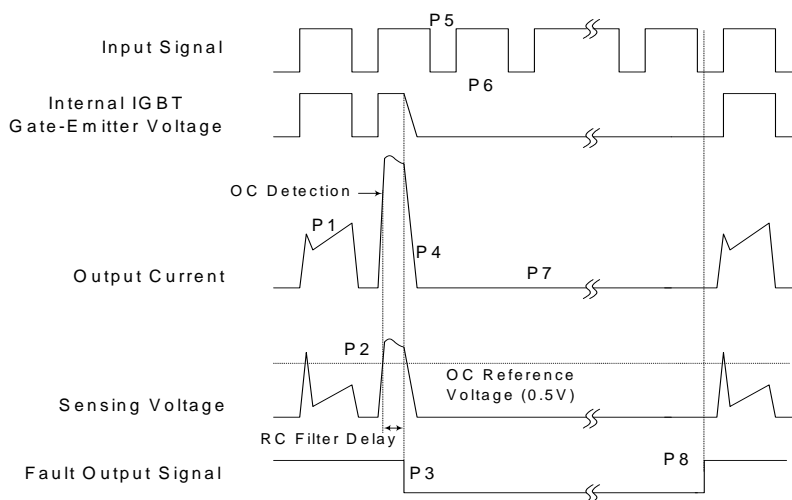
Fig. 5. Flatness Measurement Position

### Time Charts of SPMs Protective Function



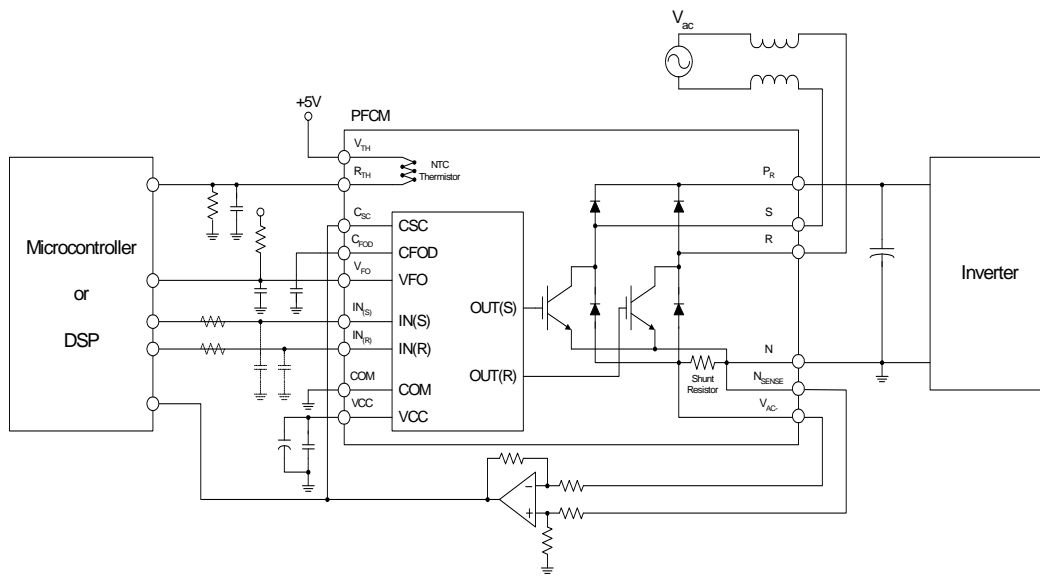
- P1 : Normal operation - IGBT ON and conducting current
- P2 : Under voltage detection
- P3 : IGBT gate interrupt
- P4 : Fault signal generation
- P5 : Under voltage reset
- P6 : Normal operation - IGBT ON and conducting current

**Fig. 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

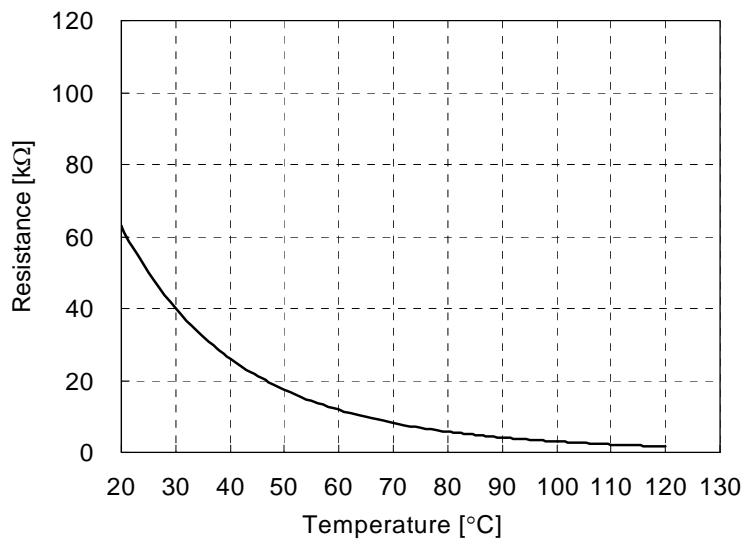
**Fig. 7. Over Current Protection**



**Note :**  
 1) For the over-current protection, please set the delay time in the range 3 ~ 4  $\mu$ s.

**Fig. 8. Application Example**

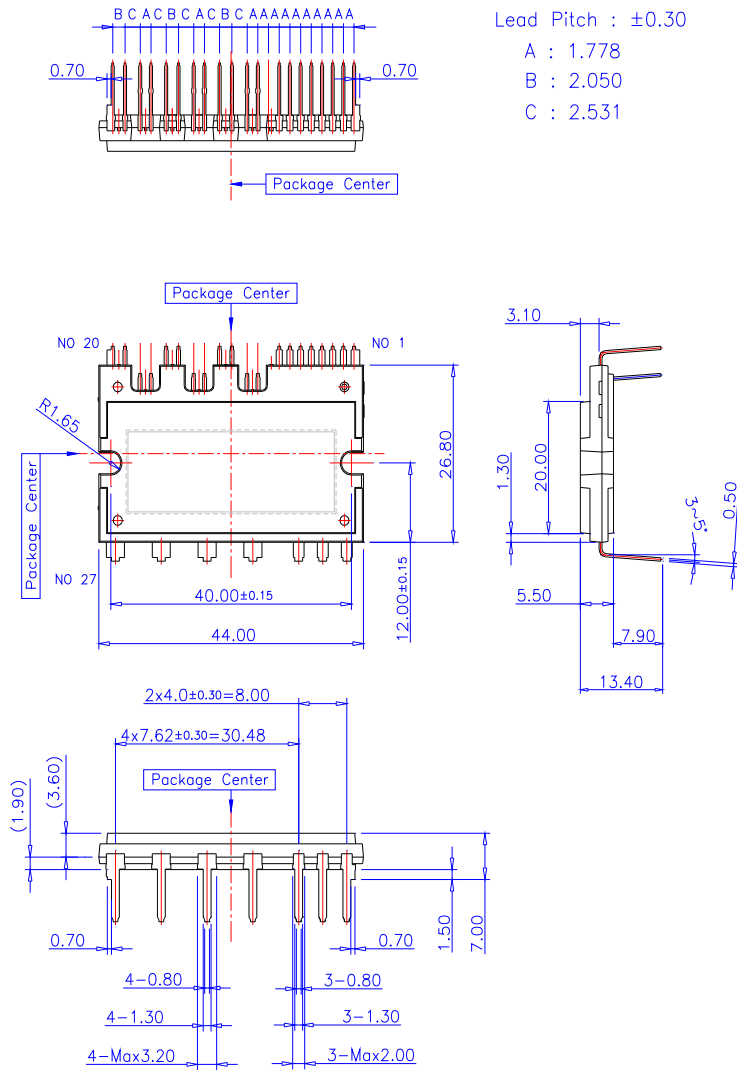
**R-T Graph**



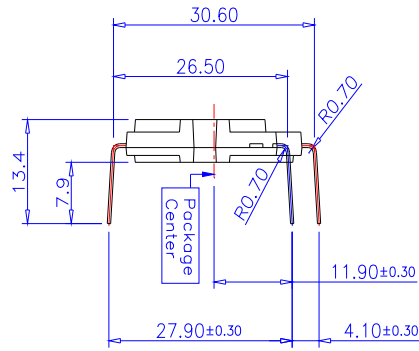
**Fig. 9. R-T Curve of the Built-in Thermistor**



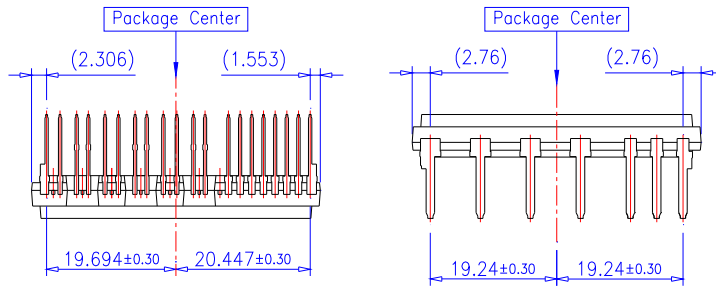
Detailed Package Outline Drawings



Detailed Package Outline Drawings

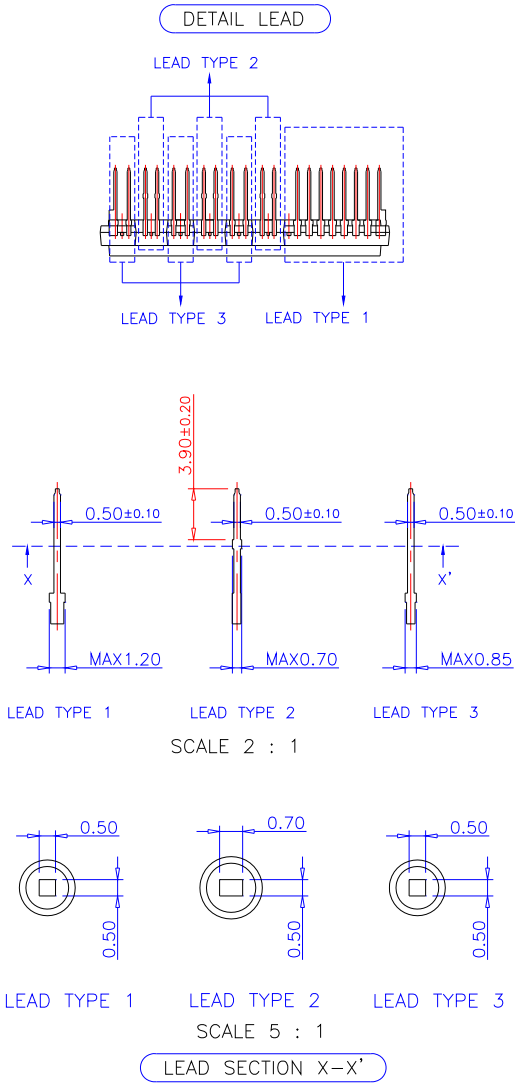


Lead Forming Dimension



PKG Center to Lead Distance

Detailed Package Outline Drawings





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