

## FPAB20BH60B

### Smart Power Module (SPM®) for Front-End Rectifier

#### General Description

FPAB20BH60B is an advanced smart power module (SPM®) of PFC (Power Factor Correction) that Fairchild has newly developed and designed mainly targeting mid-power application especially for an air conditioners. It combines optimized circuit protection and drive IC matched to high frequency switching IGBT. System reliability is further enhanced by the integrated under-voltage lock-out and over-current protection function.

#### Features

- Low thermal resistance due to  $Al_2O_3$ -DBC substrate
- 600V-20A Single phase IGBT PWM semi-converter including a drive IC for gate driving and protection
- Typical switching frequency of 20kHz
- Isolation rating of 2500Vrms/min.

#### Applications

- Home appliances application like air conditioner

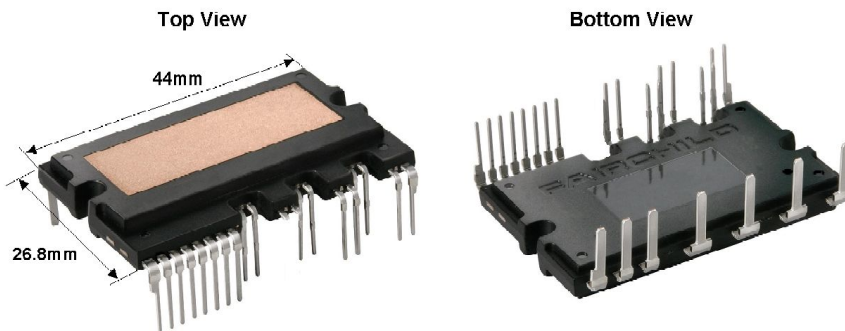


Fig. 1.

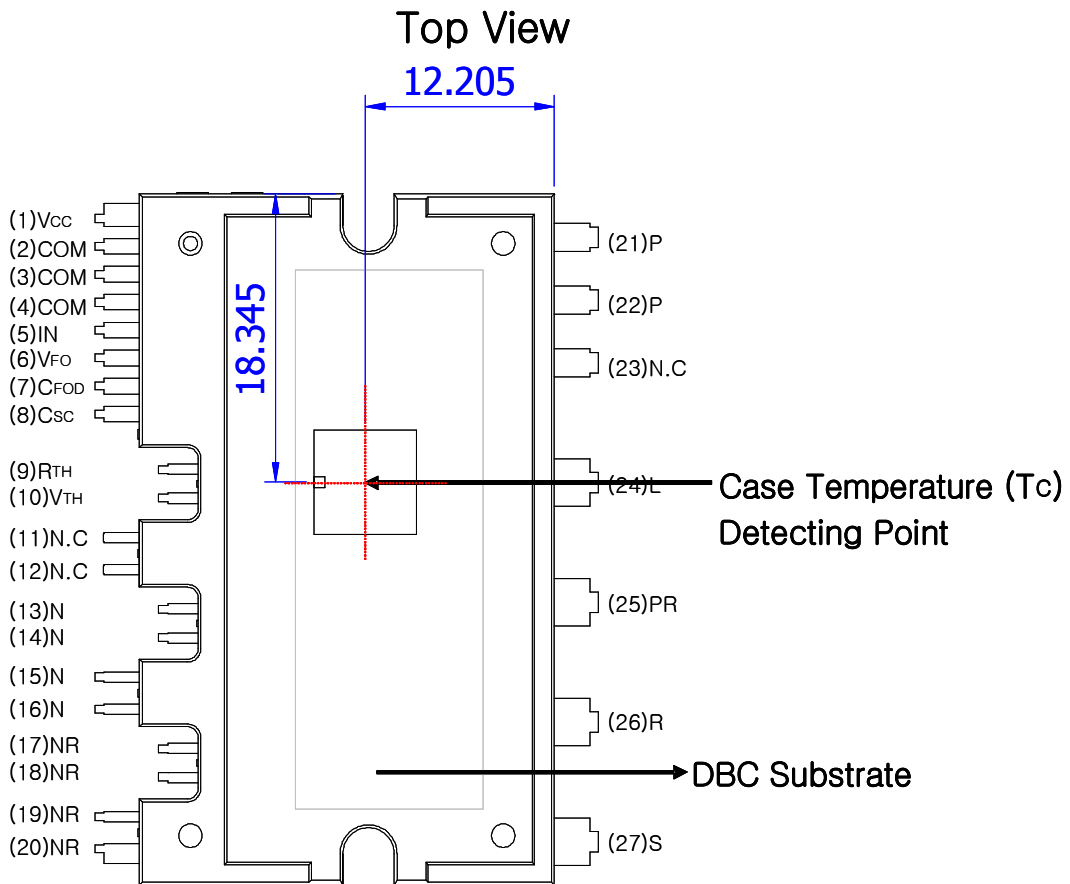
### Integrated Power Functions

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

### Integrated Drive, Protection and System Control Functions

- For IGBT: Gate drive circuit, Overcurrent circuit protection (OC), Control supply circuit under-voltage (UV) protection
- Fault signaling: Corresponding to a UV fault and OC fault
- Input interface: 3.3/5V CMOS/LSTTL compatible, Schmitt trigger input

### Pin Configuration



**Fig. 2.**

**Note :** For the measurement point of case temperature(T<sub>c</sub>), please refer to Fig. 2.

### Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V <sub>CC</sub>	Common Bias Voltage for IC and IGBT Driving
2,3,4	COM	Common Supply Ground
5	IN	Signal Input for 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
9	R <sub>(TH)</sub>	NTC Thermistor terminal
10	V <sub>(TH)</sub>	NTC Thermistor terminal
11,12	N.C	No Connection*
13~16	N	IGBT emitter
17~20	N <sub>R</sub>	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 <sub>R</sub>	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

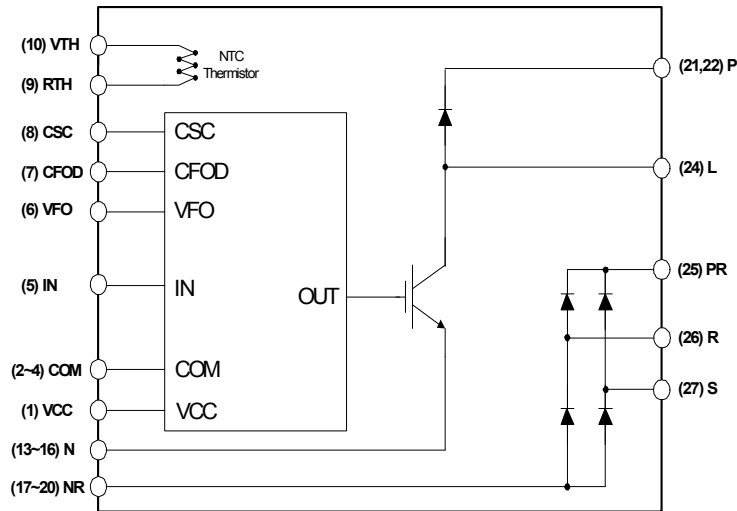


Fig. 3.

### Package Marking & Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FPAB20BH60B	FPAB20BH60B	SPM27-IC	-	-	10

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

Item	Symbol	Condition	Rating	Unit
Input Supply Voltage	$V_i$	Applied between R-S	264	$V_{RMS}$
Input 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	$I_C$	$T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$	20	A
Each IGBT Collector Current (peak)	$I_{CP}$	$T_C = 25^\circ\text{C}$ , $T_J < 150^\circ\text{C}$ Under 1ms pulse width	40	A
Collector Dissipation	$P_C$	$T_C = 25^\circ\text{C}$ per One IGBT	89	W
Repetitive Peak Reverse Voltage	$V_{RRM}$		600	V
Peak Forward Surge Current	$I_{FSM}$	Single half sine-wave	250	A
Operating Junction Temperature	$T_J$		-40 ~ 150	$^\circ\text{C}$

**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~ $V_{CC}+0.3$	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
Storage Temperature	$T_{STG}$		-40 ~ 125	$^\circ\text{C}$
Isolation Voltage	$V_{ISO}$	60Hz, 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	$R_{\theta(j-c)Q}$	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	-	-	2.1	$^\circ\text{C/W}$

## Electrical Characteristics (T<sub>J</sub> = 25°C, Unless Otherwise Specified)

### Converter Part

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
IGBT saturation voltage	V <sub>CE(sat)</sub>	V <sub>CC</sub> = 15V, V <sub>IN</sub> = 5V; I <sub>C</sub> = 20A	-	2.3	3.0	V
FRD forward voltage	V <sub>FF</sub>	I <sub>F</sub> = 20A	-	1.8	2.5	V
Rectifier forward voltage	V <sub>FR</sub>	I <sub>F</sub> = 20A	-	1.2	1.5	V
Switching Times	t <sub>ON</sub>	V <sub>PN</sub> = 400V, V <sub>CC</sub> = 15V, I <sub>C</sub> = 20A V <sub>IN</sub> = 0V ↔ 5V, Inductive Load (Note 1)	-	450	-	ns
	t <sub>C(ON)</sub>		-	200	-	ns
	t <sub>OFF</sub>		-	350	-	ns
	t <sub>C(OFF)</sub>		-	80	-	ns
	t <sub>rr</sub>		-	70	-	ns
	I <sub>rr</sub>		-	6	-	A
Collector - emitter Leakage Current	I <sub>CES</sub>	V <sub>CE</sub> = V <sub>CES</sub>	-	-	250	μA

#### Note

- t<sub>ON</sub> and t<sub>OFF</sub> include the propagation delay time of the internal drive IC. t<sub>C(ON)</sub> and t<sub>C(OFF)</sub> are the switching time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Fig. 4

## Electrical Characteristics

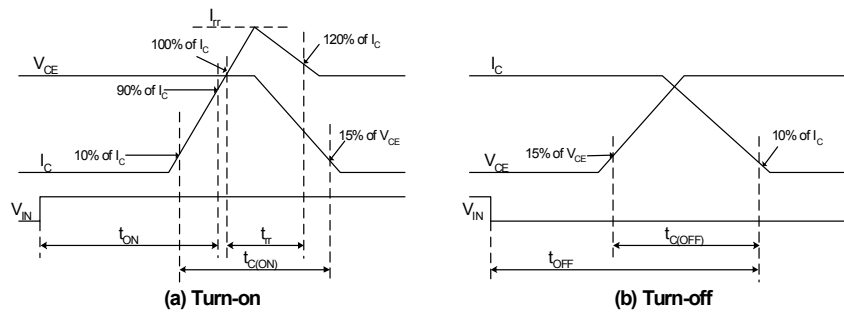


Fig. 4. Switching Time Definition

### Control Part

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Quiescent V <sub>CC</sub> Supply Current	I <sub>QCCL</sub>	V <sub>CC</sub> = 15V, I <sub>N</sub> = 0V V <sub>CC</sub> - COM	-	-	26	mA
Fault Output Voltage	V <sub>FOH</sub>	V <sub>SC</sub> = 0V, V <sub>FO</sub> Circuit: 4.7kΩ to 5V Pull-up	4.5	-	-	V
	V <sub>FOL</sub>	V <sub>SC</sub> = 1V, V <sub>FO</sub> Circuit: 4.7kΩ to 5V Pull-up	-	-	0.8	V
Over Current Trip Level	V <sub>SC(ref)</sub>	V <sub>CC</sub> = 15V	0.45	0.5	0.55	V
Supply Circuit Under-Voltage Protection	UV <sub>CCD</sub>	Detection Level	10.7	11.9	13.0	V
	UV <sub>CCR</sub>	Reset Level	11.2	12.4	13.2	V
Fault-out Pulse Width	t <sub>FOD</sub>	C <sub>FOD</sub> = 33nF (Note 2)	1.4	1.8	2.0	ms
ON Threshold Voltage	V <sub>IN(ON)</sub>	Applied between IN - COM	2.8	-	-	V
OFF Threshold Voltage	V <sub>IN(OFF)</sub>		-	-	0.8	V
Resistance of Thermistor	R <sub>TH</sub>	@ T <sub>TH</sub> = 25°C (Note3, Fig. 9)	-	47.0	-	kΩ
		@ T <sub>TH</sub> = 100°C (Note3, Fig. 9)	-	2.9	-	kΩ

#### Note

- The fault-out pulse width t<sub>FOD</sub> depends on the capacitance value of C<sub>FOD</sub> according to the following approximate equation : C<sub>FOD</sub> = 18.3 × 10<sup>-6</sup> × t<sub>FOD</sub>[F]
- T<sub>TH</sub> is the temperature of thermistor itself. To know case temperature (T<sub>C</sub>), please make the experiment considering your application.

### Recommended Operating Condition

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Input Supply Voltage	$V_i$	Applied between R-S	187	220	253	V
Output Voltage	$V_{PN}$	Applied between P-N		380	400	V
Control Supply Voltage	$V_{CC}$	Applied between $V_{CC(L)}$ - COM	13.5	15	16.5	V
Control supply variation	$dV_{CC}/dt$		-1	-	1	V/ $\mu$ s
PWM Input Frequency	$f_{PWM}$	$T_J \leq 150^\circ\text{C}$ per IGBT		20		kHz
Allowable Input Current (Peak)	$I_i$	$T_C < 95^\circ\text{C}$ , $V_i=220\text{V}$ , $V_{PN}=380\text{V}$ $V_{PWM}=20\text{KHz}$			20	A

### Mechanical Characteristics and Ratings

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

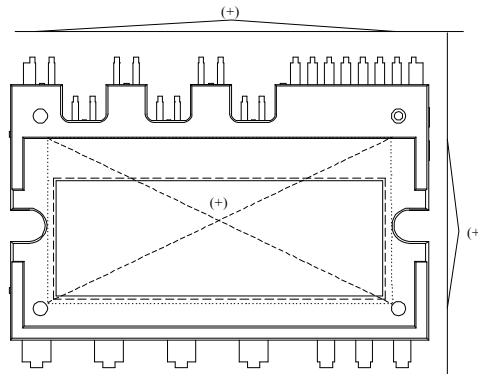
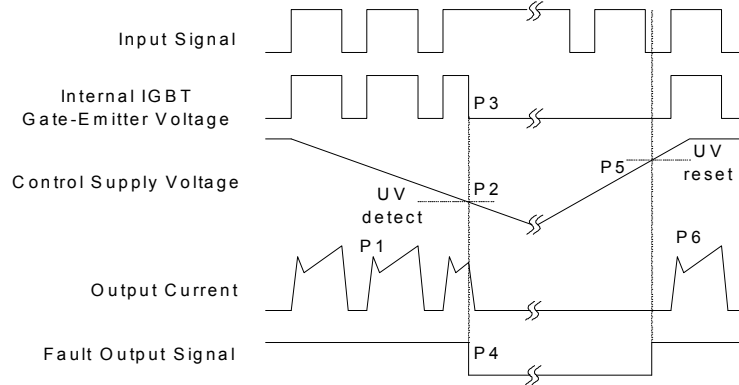


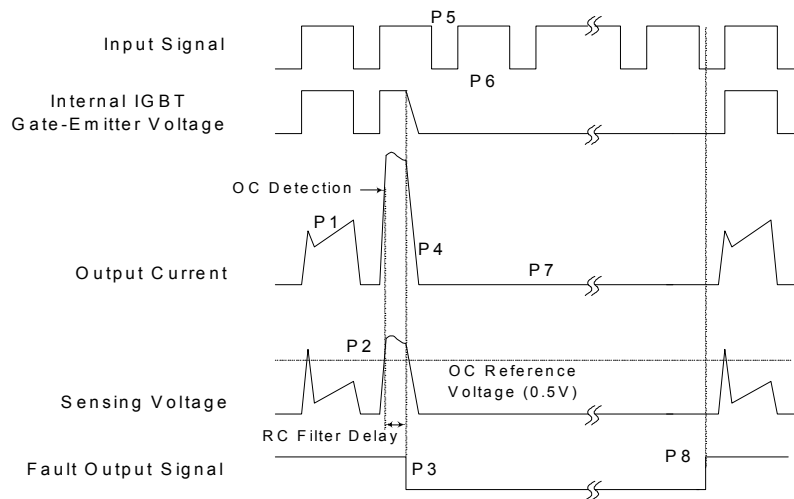
Fig. 5. Flatness Measurement Position

### 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**

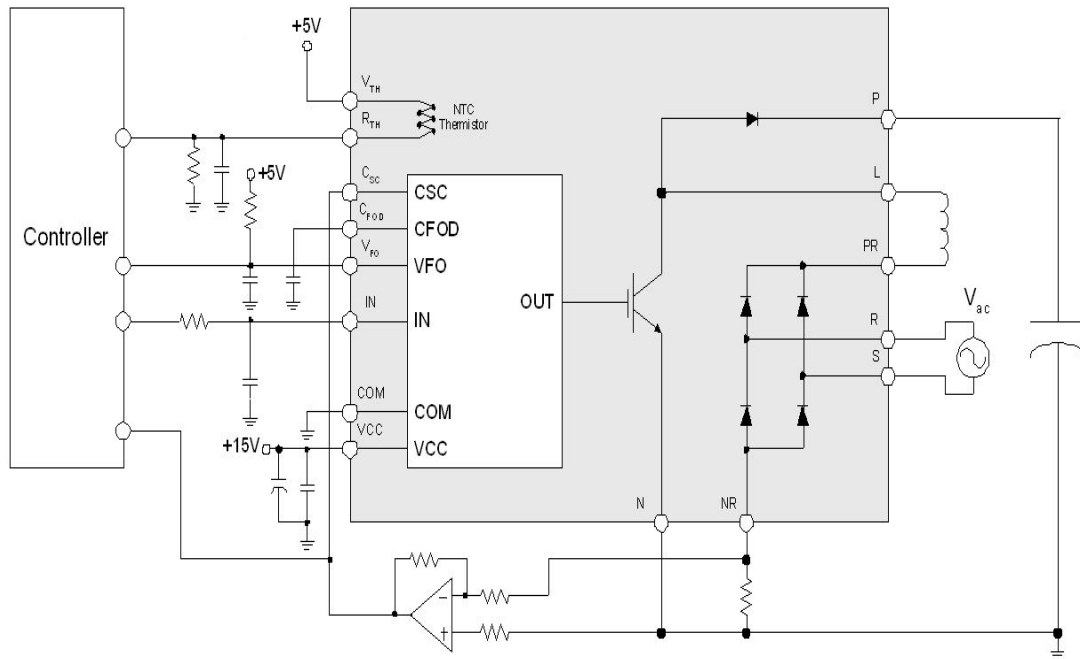


Fig. 8. Application Example

### R-T Curve

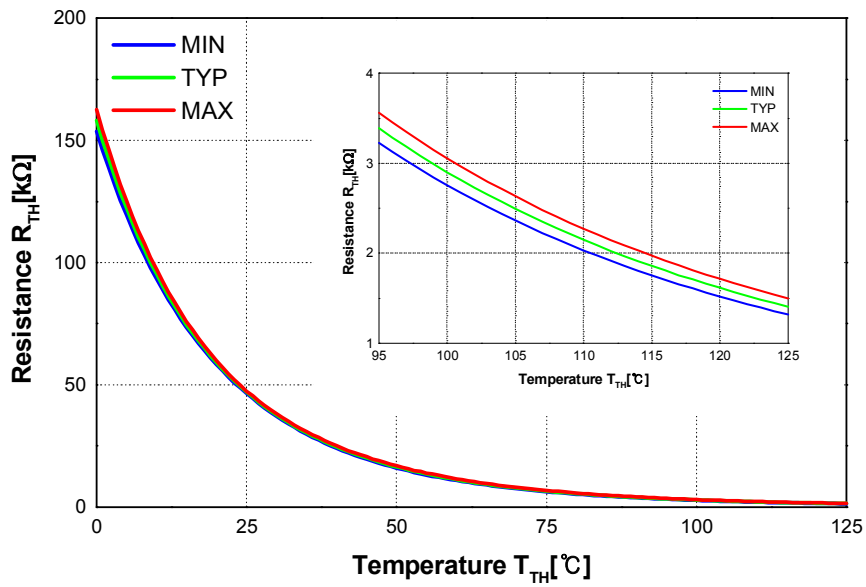
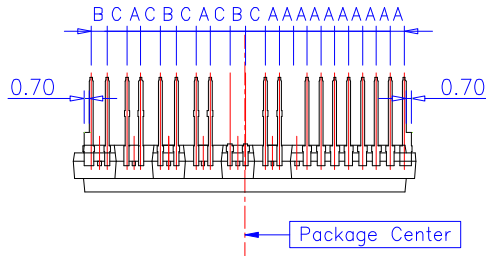


Fig. 9. R-T Curve of the Built-in Thermistor



Detailed Package Outline Drawings

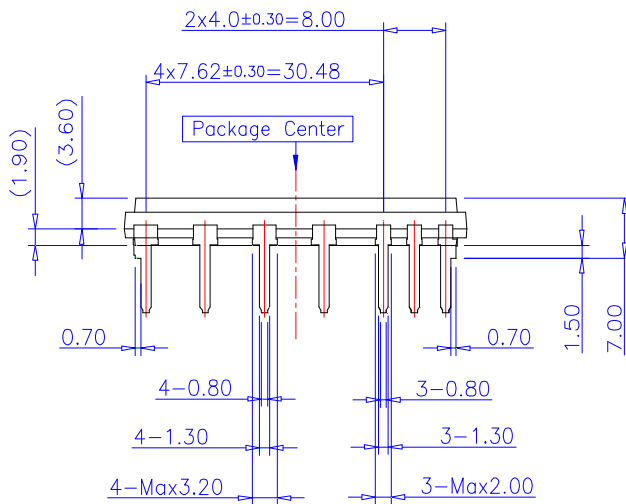
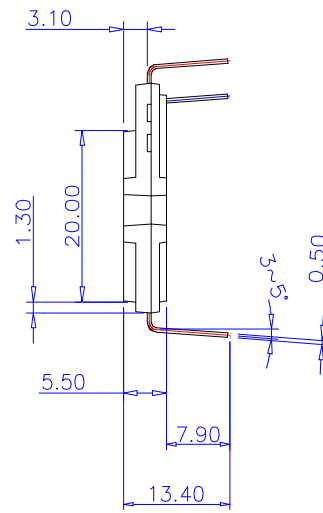
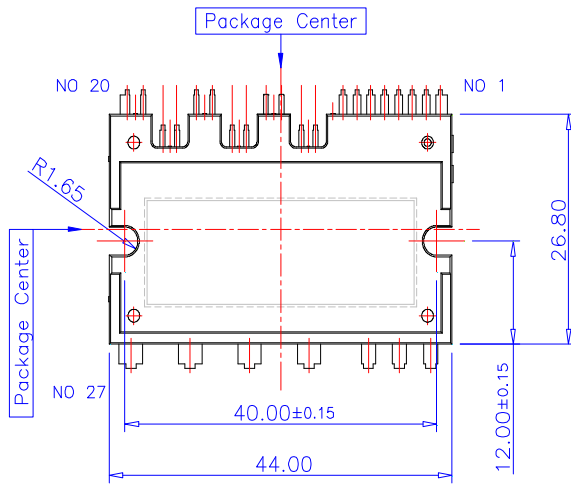


Lead Pitch : ±0.30

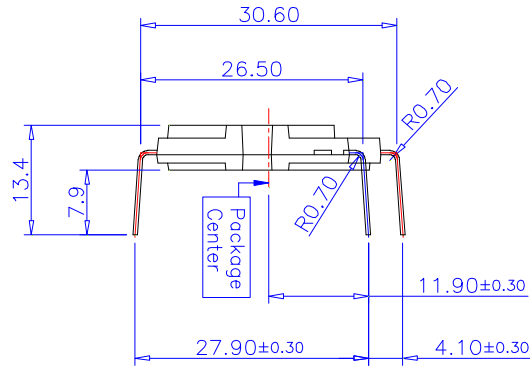
A : 1.778

B : 2.050

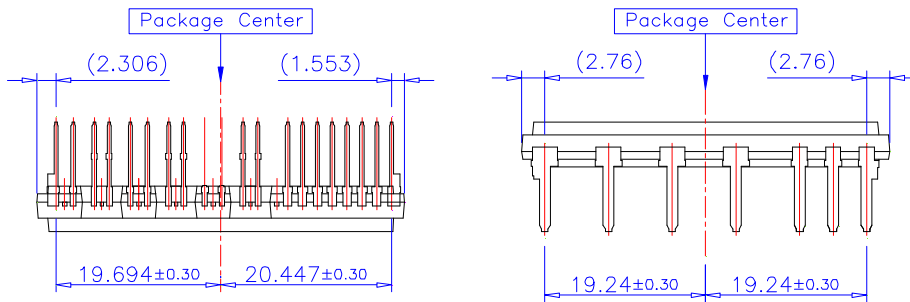
C : 2.531



Detailed Package Outline Drawings



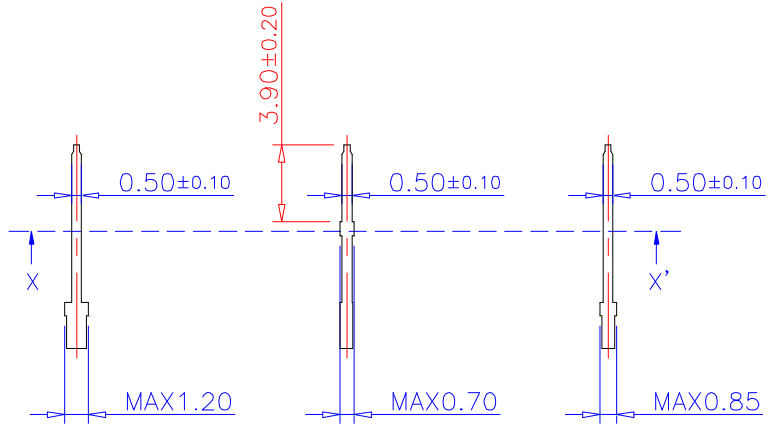
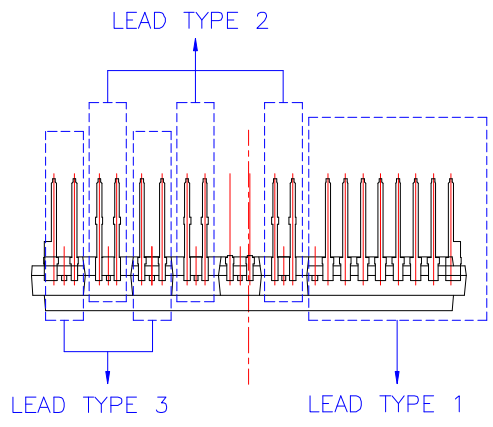
Lead Forming Dimension



PKG Center to Lead Distance

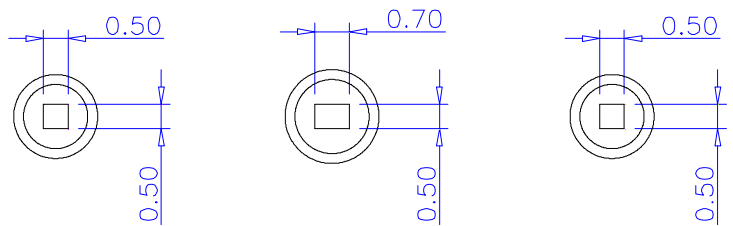
Detailed Package Outline Drawings

DETAIL LEAD




LEAD TYPE 1      LEAD TYPE 2      LEAD TYPE 3

SCALE 2 : 1



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