FAIRCHILD SEMICONDUCTOR®

March 2010

SPM™

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 futher 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

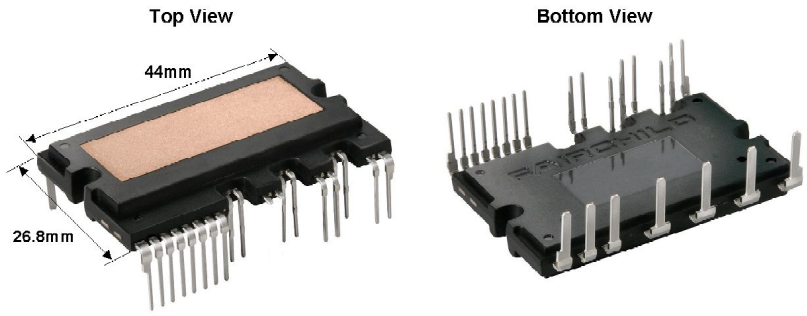


Fig. 1.

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

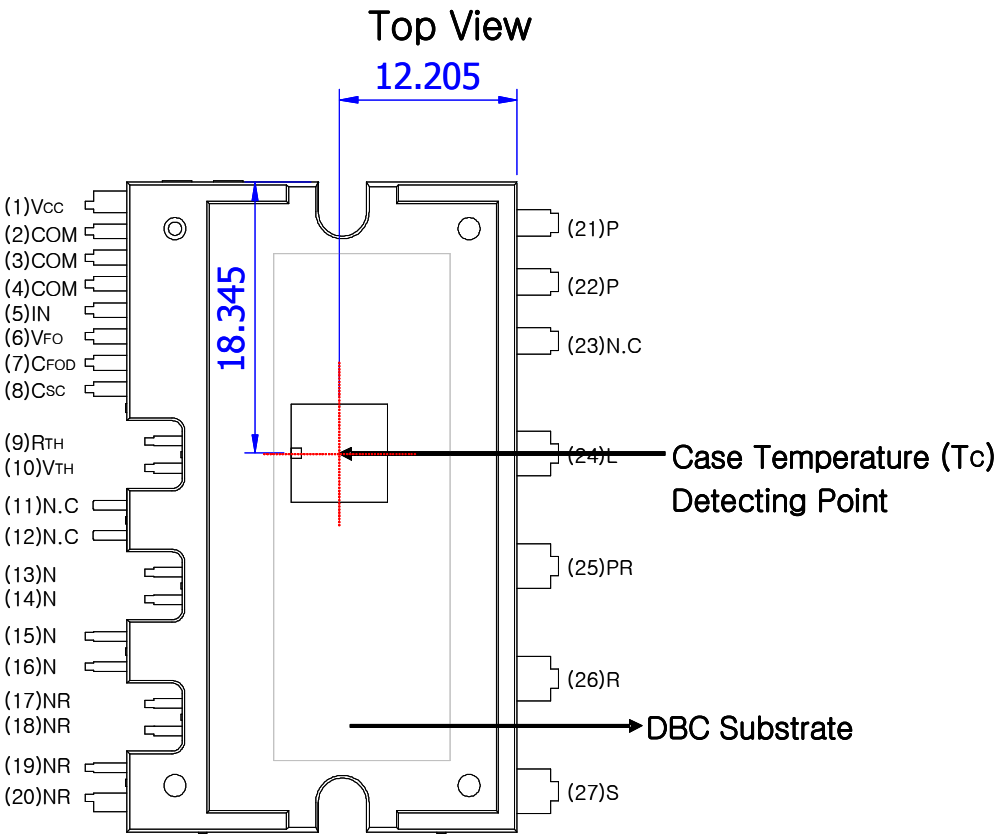


Fig. 2.

Note : For the measurement point of case temperature(T_C), please refer to Fig. 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 Time Selection
8	C_{SC}	Capacitor (Low-pass Filter) for Over Current Detection
9	$R_{(TH)}$	NTC Thermistor terminal
10	$V_{(TH)}$	NTC Thermistor terminal
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

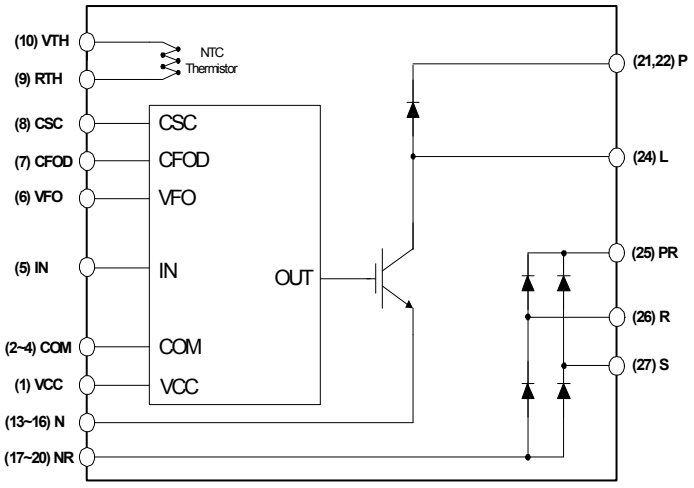


Fig. 3.

Package Marking & Ordering Information

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

Absolute Maximum Ratings (T_J = 25°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°C, T_J < 150°C	20	A
Each IGBT Collector Current (peak)	I_{CP}	T_C = 25°C, T_J < 150°C Under 1ms pulse width	40	A
Collector Dissipation	P_C	T_C = 25°C per One IGBT	89	W
Repititive 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	°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	°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	°C/W
	$R_{\theta(j-c)F}$	FRD	-	-	1.4	°C/W
	$R_{\theta(j-c)R}$	Rectifier	-	-	2.1	°C/W

Electrical Characteristics (T_J = 25°C, Unless Otherwise Specified)

Converter Part

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

Note

1. 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

Electrical Characteristics

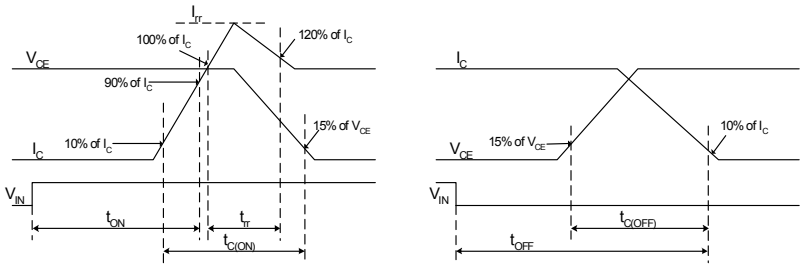


Fig. 4. Switching Time Definition

Control Part

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Quiescent V_{CC} Supply Current	I_{QCCL}	V_{CC} = 15V, IN = 0V | V_{CC} - COM	-	-	26	mA
Fault Output Voltage	V_{FOH}	V_{SC} = 0V, V_{FO} Circuit: 4.7kΩ to 5V Pull-up	4.5	-	-	V
	V_{FOL}	V_{SC} = 1V, V_{FO} Circuit: 4.7kΩ to 5V Pull-up	-	-	0.8	V
Over Current Trip Level	$V_{SC(ref)}$	V_{CC} = 15V	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} = 33nF (Note 2)	1.4	1.8	2.0	ms
ON Threshold Voltage	$V_{IN(ON)}$	Applied between IN - COM	2.8	-	-	V
OFF Threshold Voltage	$V_{IN(OFF)}$		-	-	0.8	V
Resistance of Thermistor	R_{TH}	@ T_{TH} = 25°C (Note3, Fig. 9)	-	47.0	-	kΩ
		@ T_{TH} = 100°C (Note3, Fig. 9)	-	2.9	-	kΩ

Note

2. 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 x 10^{-6} x t_{FOD}[F]
3. T_{TH} is the temperature of thermister itselt. To know case temperature (T_C), 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/μs
PWM Input Frequency	f_{PWM}	$T_J \leq 150°C$ per IGBT		20		kHz
Allowable Input Current (Peak)	I_i	$T_C < 95°C$, V_i=220V, V_{PN}=380V V_{PWM}=20KHz			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	μm
Weight			-	15.00	-	g

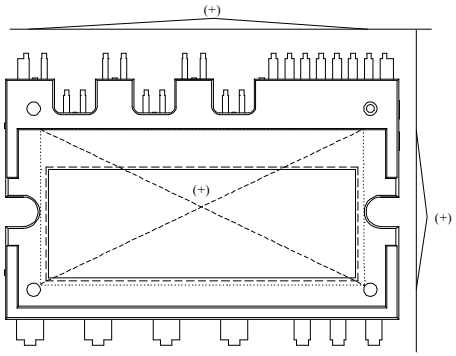
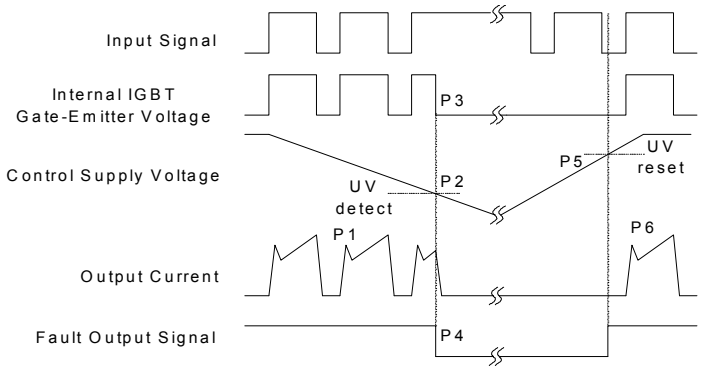


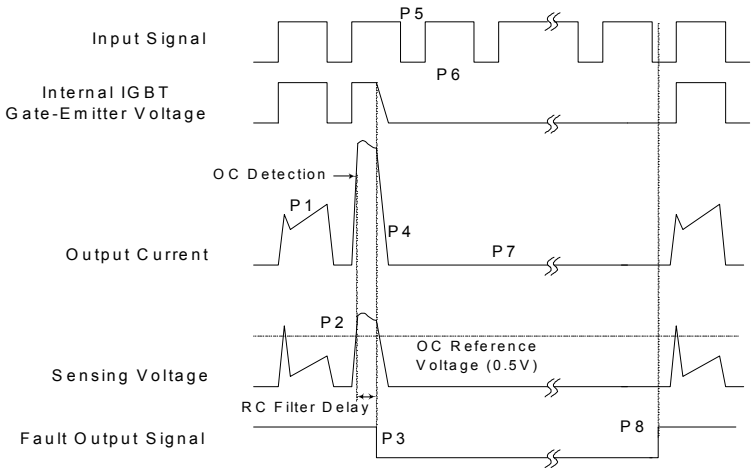
Fig. 5. Flatness Measurement Position

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

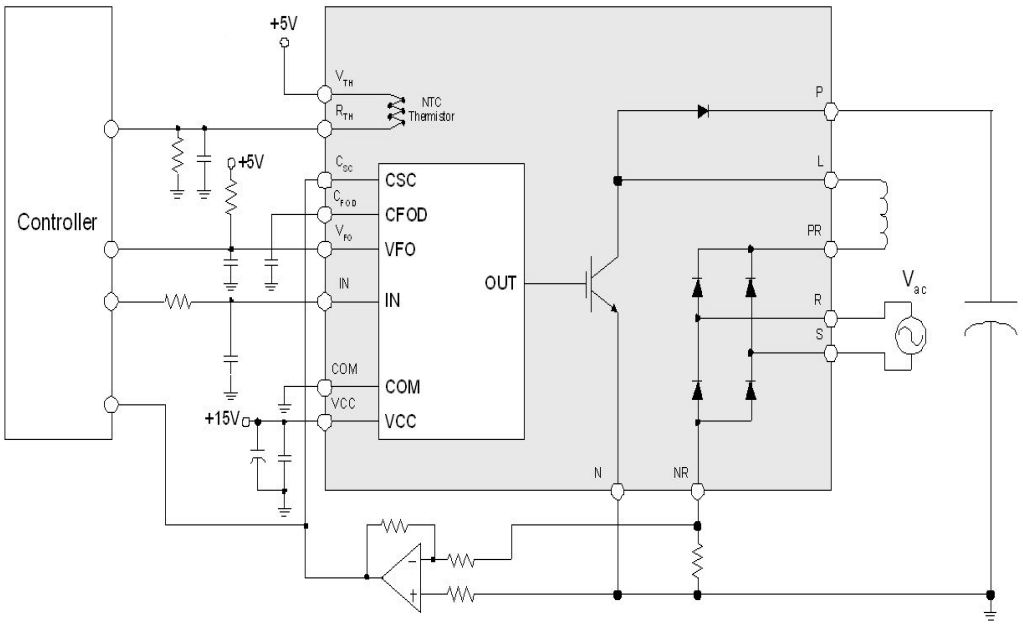


Fig. 8. Application Example

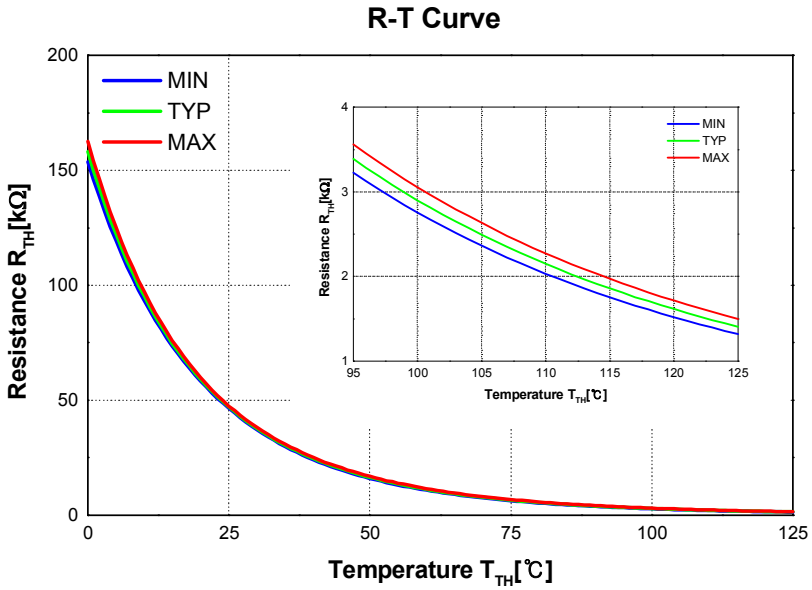
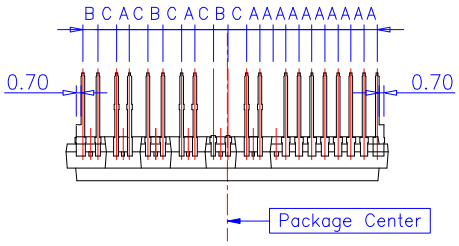
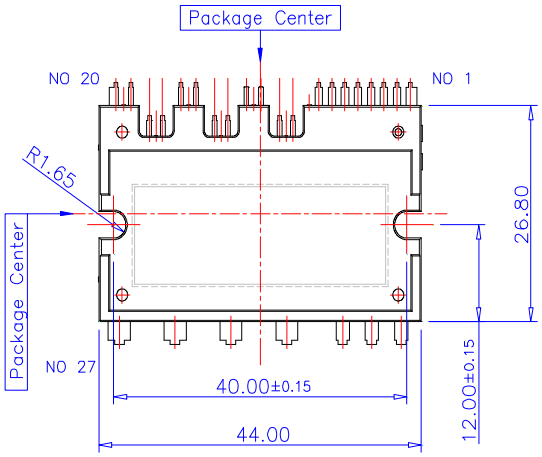


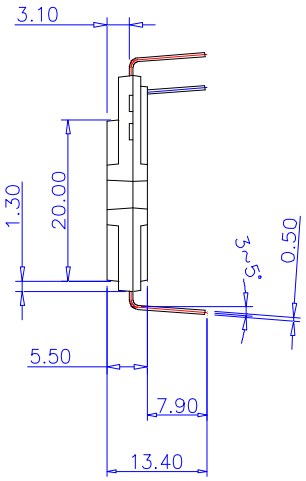
Fig. 9. R-T Curve of the Built-in Thermistor

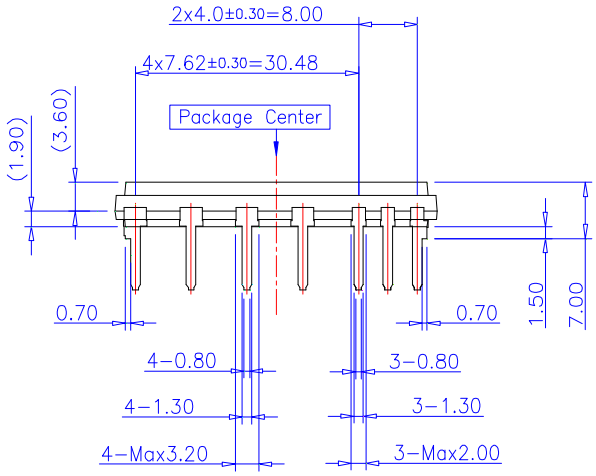
Detailed Package Outline Drawings



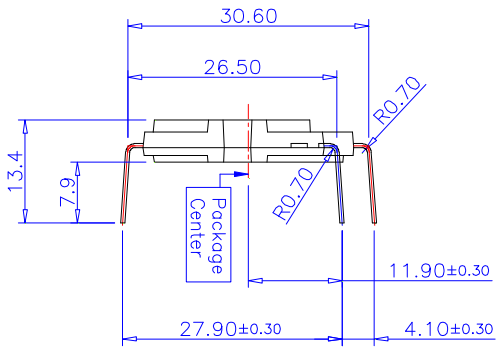
Lead Pitch : ±0.30
A : 1.778
B : 2.050
C : 2.531



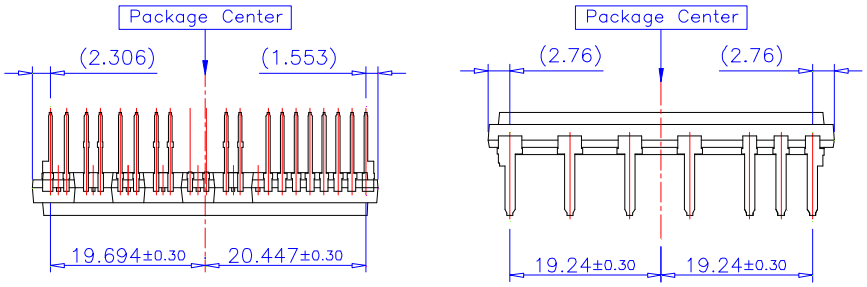




Detailed Package Outline Drawings

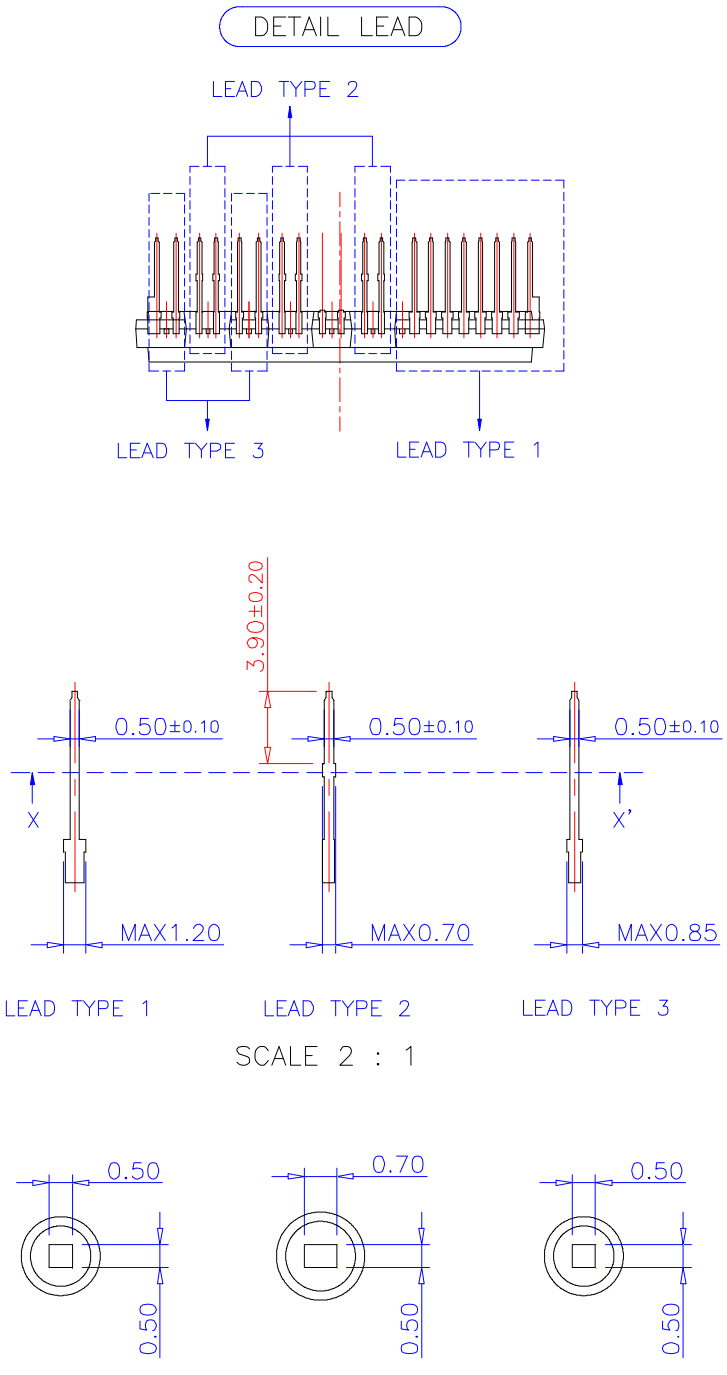


Lead Forming Dimension



PKG Center to Lead Distance

Detailed Package Outline Drawings



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