FAIRCHILD
SEMICONDUCTOR®

December, 2005

FPDB50PH60

Smart Power Module for Front-End Rectifier

General Description

FPDB50PH60 is an advanced smart power module 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 IGBTs. System reliability is futher enhanced by the integrated under-voltage lock-out and over-current protection function.

Features

- Low thermal resistance due to AlN-DBC substrate
- 600V-50A 2-phase IGBT PWM semi-converter including a drive IC for IGBT gate driving and protection
- Typical switching frequency of 20kHz
- Isolation rating of 2500Vrms/min.

Applications

- AC 180V ~ 264V single-phase front-end rectifier

Top View **Bottom View**

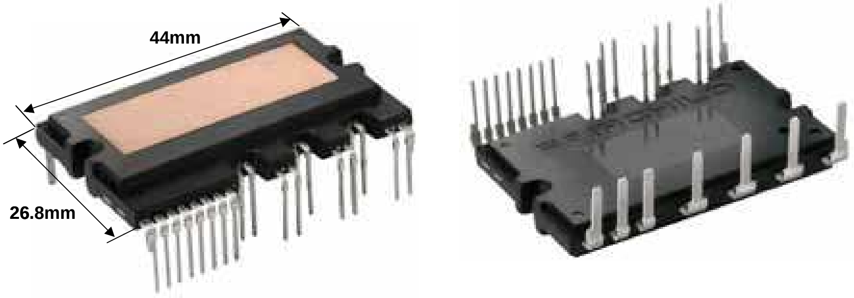


Fig. 1.

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

Pin Configuration

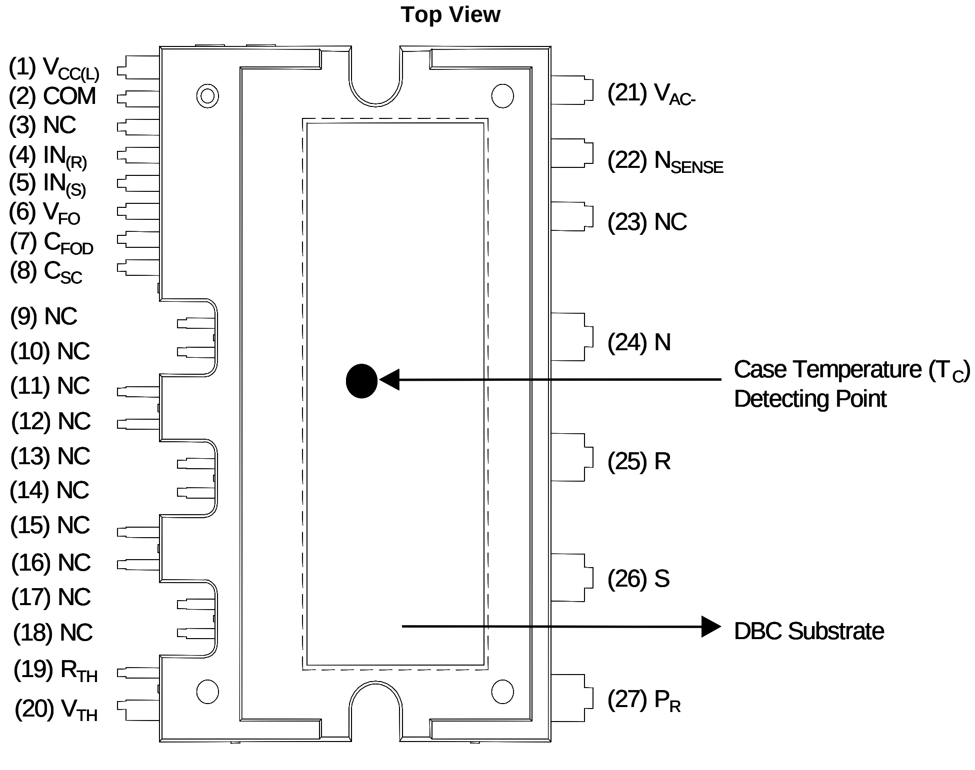
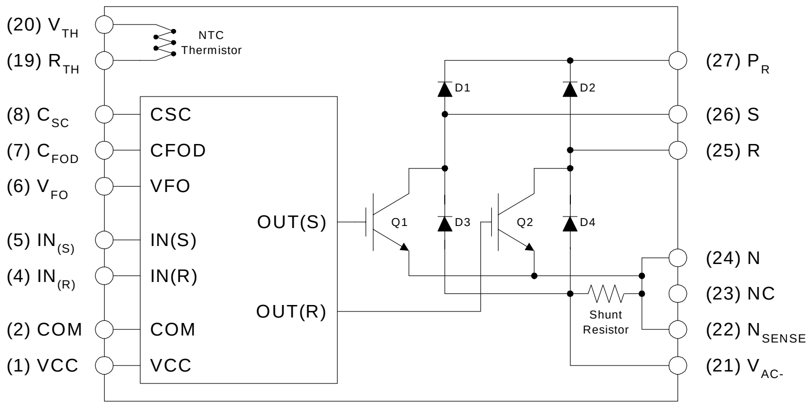


Fig. 2.

Pin Descriptions

Pin Number	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 R-phase IGBT
5	$IN_{(S)}$	Signal Input for S-phase 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
19	$R_{(TH)}$	NTC Thermistor terminal
20	$V_{(TH)}$	NTC Thermistor terminal
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.

Fig. 3.

Absolute Maximum Ratings (T_J = 25℃, 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
Input Current (100% Load)	I_i	T_C < 95℃, V_i=220V, V_{PN}= 390V, V_{PWM}=20kHz	30	A
Input Current (125% Load)	$I_{i(125\%)}$	T_C < 95℃, V_i=220V, V_{PN}= 390V, V_{PWM}=20kHz, 1min Non-repetitive	37.5	A
Collector Dissipation	P_C	T_C = 25℃ per One IGBT	143	W
Power Rating of Shunt Resistor	P_{RSH}	T_C < 125℃	2	W
Operating Junction Temperature	T_J	(Note 1)	-20 ~ 125	℃

Note
1. The maximum junction temperature rating of the power chips integrated within the SPM is 150 °C(@$T_C \le$ 100°C). However, to insure safe operation of the SPM, the average junction temperature should be limited to $T_{J(ave)} \le$ 125°C (@$T_C \le$ 100°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	-0.3~5.5	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	℃
Storage Temperature	T_{STG}		-40 ~ 125	℃
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 (Referenced to PKG center)	$R_{\theta(j-c)Q}$	IGBT	-	-	0.7	℃/W
	$R_{\theta(j-c)HD}$	High-side diode	-	-	1.5	℃/W
	$R_{\theta(j-c)LD}$	Low-side diode	-	-	0.85	℃/W

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

Electrical Characteristics (T_J = 25℃, 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 =50A	-	2.8	3.2	V
High-side diode voltage	V_{FH}	I_C = 50A	-	2.1	2.7	V
Low-side diode voltage	V_{FL}	I_C = 50A	-	1.3	1.7	V
Switching Times	t_{ON}	V_{PN} = 400V, V_{CC} = 15V, I_C =30A V_{IN} = 0V ↔ 5V, Inductive Load (Note 3)	-	550	-	ns
	$t_{C(ON)}$		-	200	-	ns
	t_{OFF}		-	430	-	ns
	$t_{C(OFF)}$		-	180	-	ns
	t_{rr}		-	60	-	ns
	I_{rr}		-	6	-	A
Current sensing resistor	R_{SENSE}		1.8	2.0	2.2	mΩ
Collector - emitter Leakage Current	I_{CES}	$V_{CE} = V_{CES}$	-	-	250	μA

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} = 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	$V_{OC(ref)}$	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 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℃ (Note Fig. 9)		-	50	-	kΩ
		@ T_C = 80℃ (Note Fig. 9)		-	5.76	-	kΩ

Note

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

Electrical Characteristics

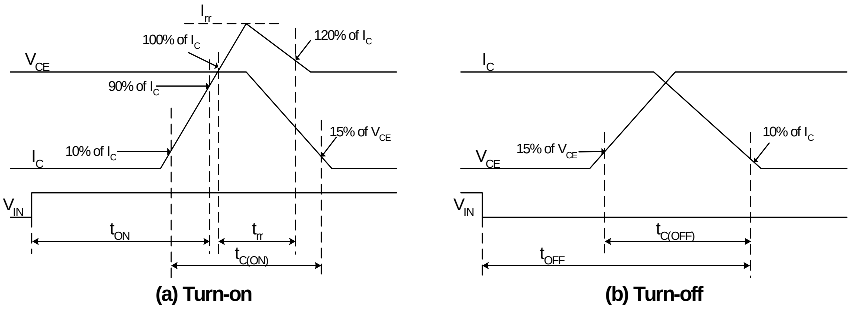


Fig. 4. Switching Time Definition

Mechanical Characteristics and Ratings

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

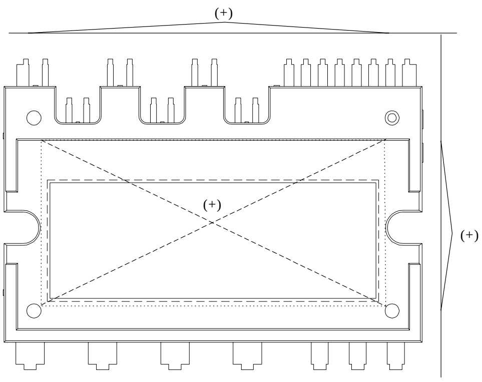
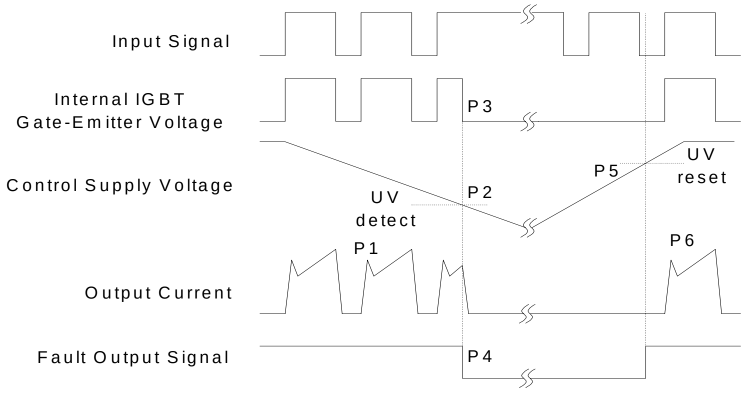


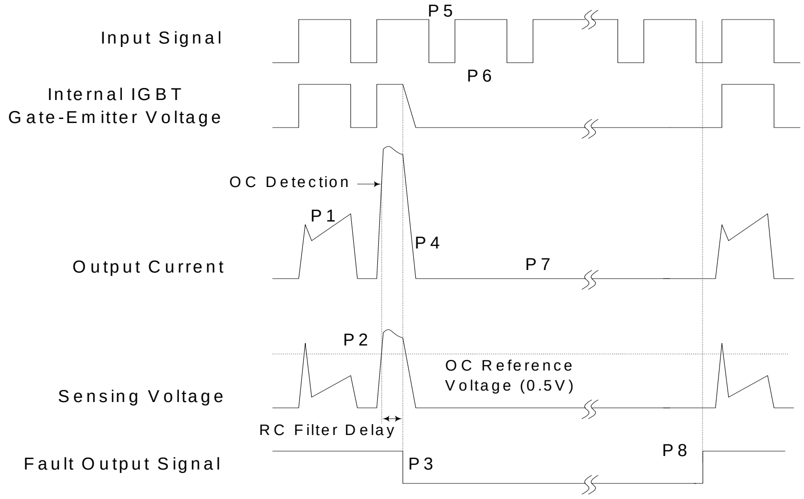
Fig. 5. Flatness Measurement Position

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

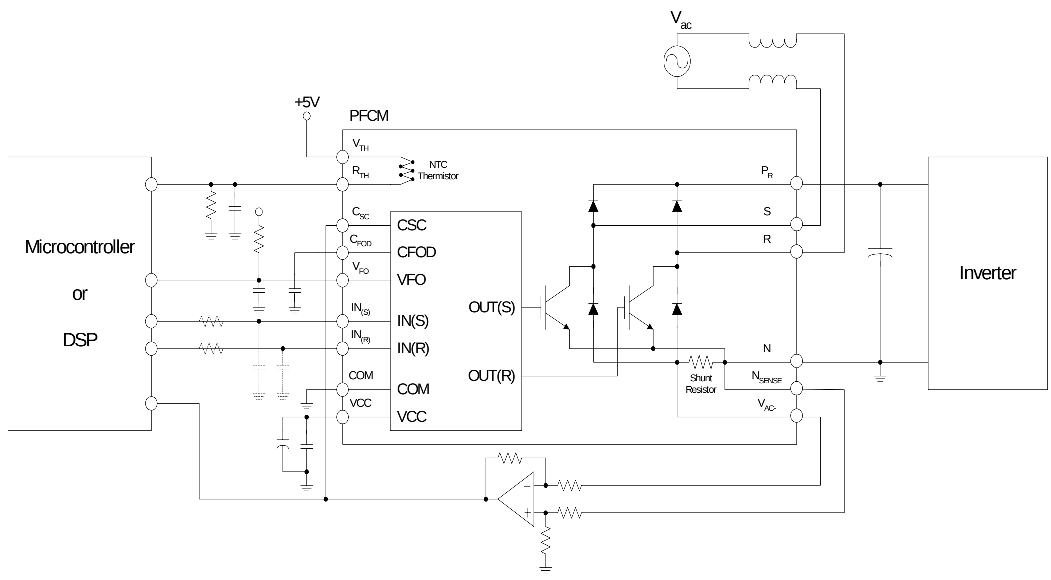


Fig. 8. Application Example

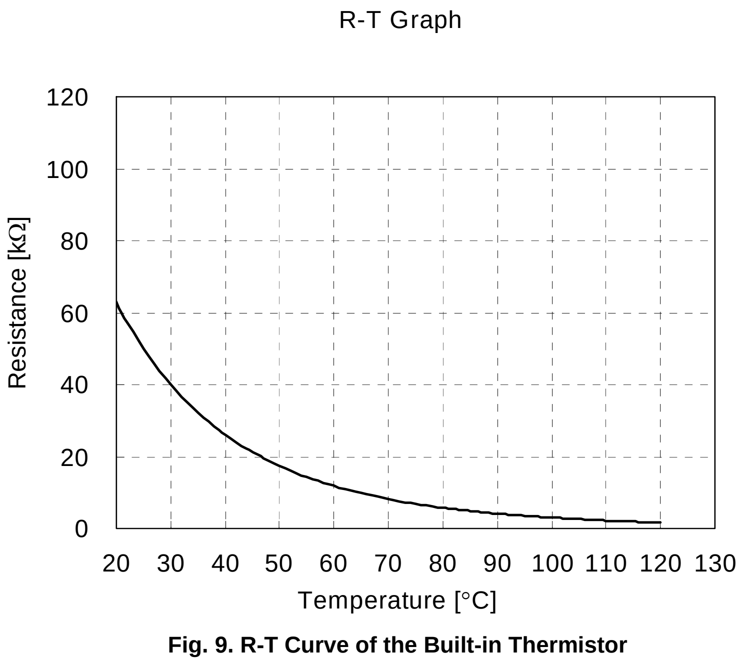
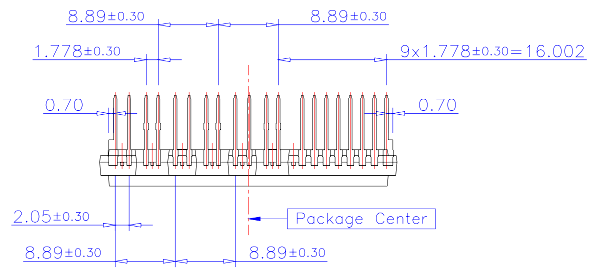
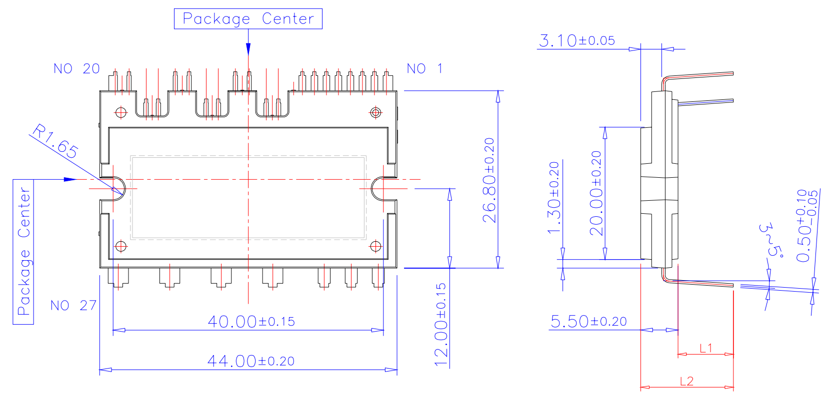
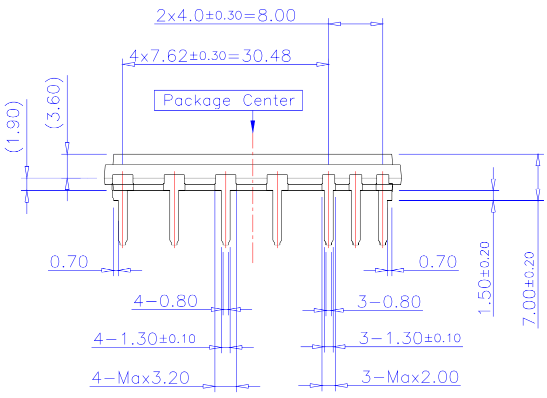


Fig. 9. R-T Curve of the Built-in Thermistor

Detailed Package Outline Drawings



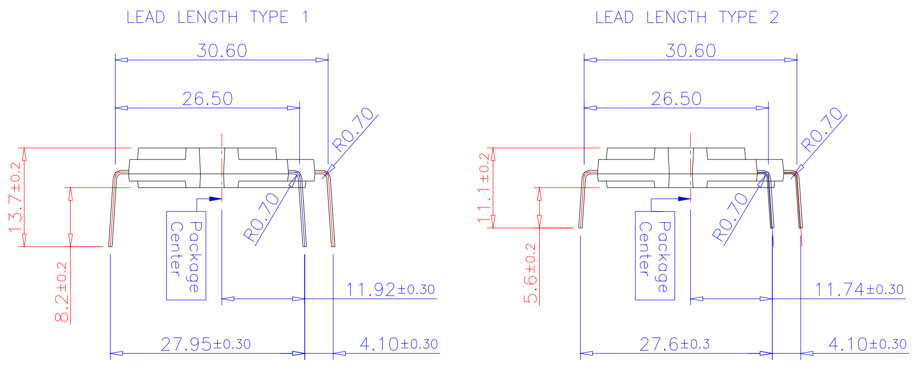




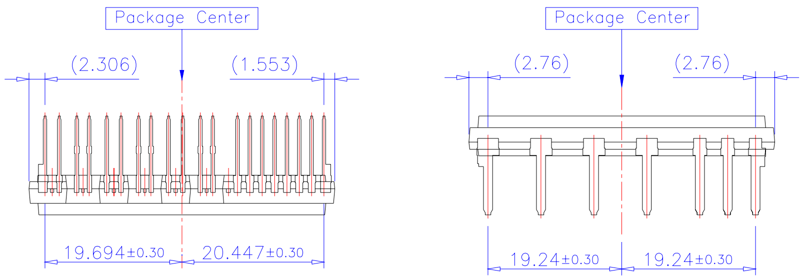
Lead Length Option

	L1 Lead Length	L2 PKG Heigth
Type 1	8.20±0.20	13.7±0.20
Type 2	5.60±0.20	11.1±0.20

Detailed Package Outline Drawings

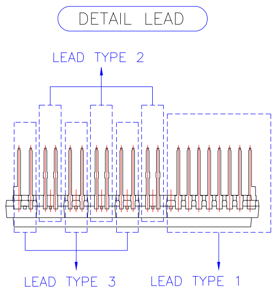


Lead Forming Dimension

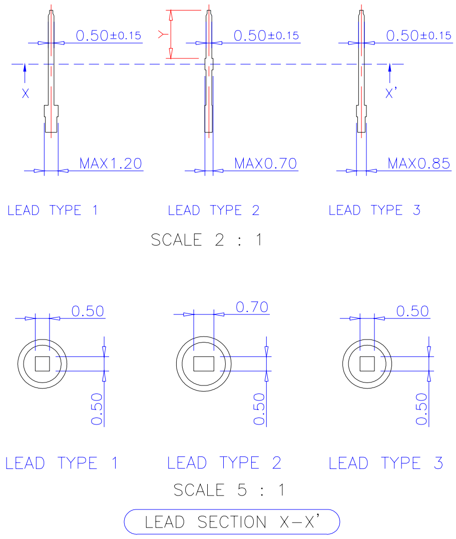


PKG Center to Lead Distance

Detailed Package Outline Drawings



	L1 Lead Length	Y Length
Type 1	8.20±0.20	4.20±0.20
Type 2	5.60±0.20	1.60±0.20



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