



February, 2009



FPDB60PH60B

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Smart Power Module for Front-End Rectifier

General Description

FPDB60PH60B 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 further enhanced by the integrated under-voltage lock-out and over-current protection function.

Features

- Low thermal resistance due to AlN-DBC substrate
- 600V-60A 2-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

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

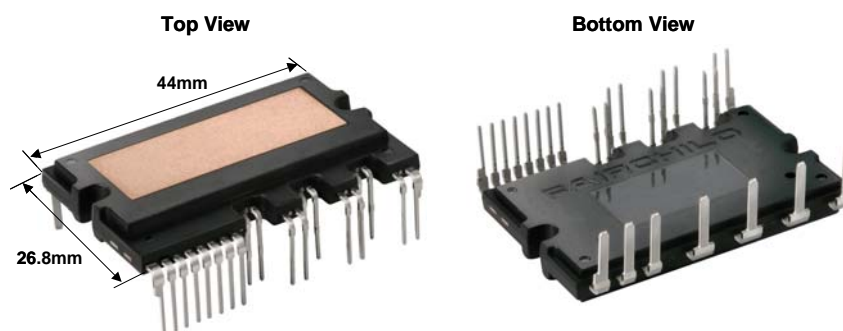


Fig. 1.

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) protection
- Fault signaling: Corresponding to a UV fault
- Input interface: 5V CMOS/LSTTL compatible, Schmitt trigger input

Pin Configuration

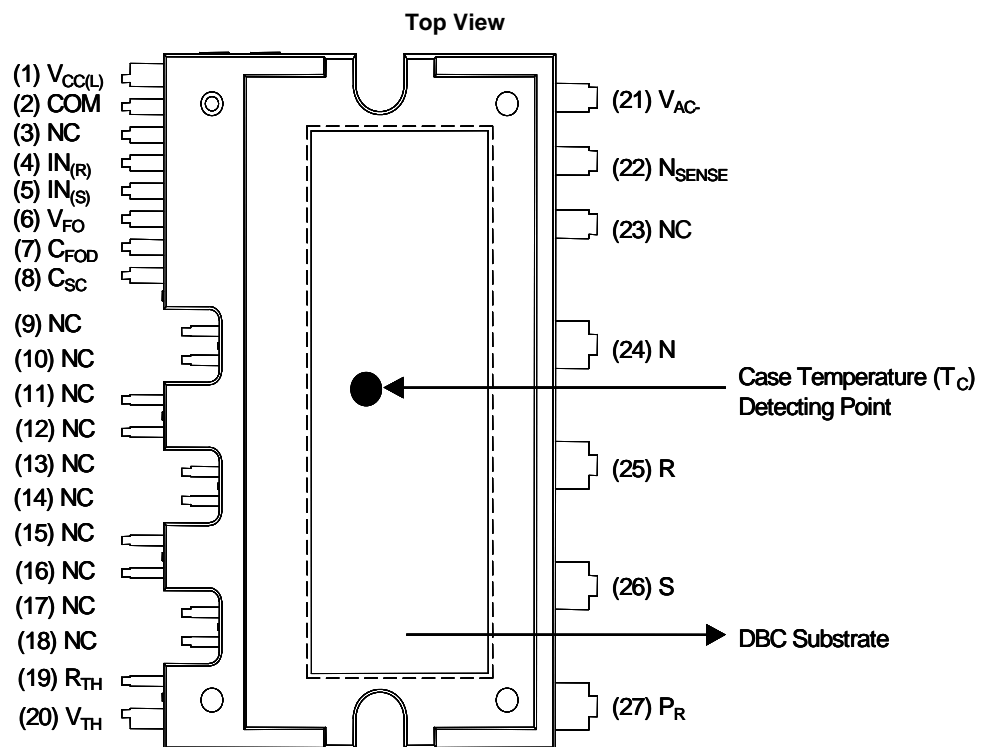
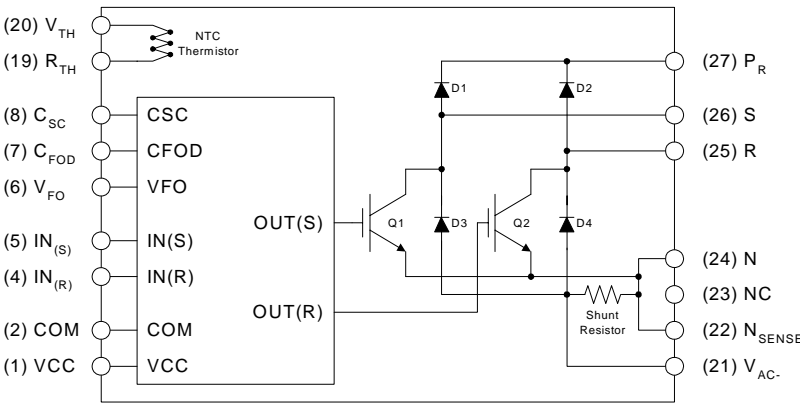


Fig. 2.

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 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 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°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	± I _C	T _C = 25°C	60	A
Each IGBT collector current (Peak)	± I _{CP}	T _C = 25°C, Under 1ms pulse width	90	A
Collector Dissipation	P _C	T _C = 25°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°C	2	W
Operating Junction Temperature	T _J	(Note 1)	-40 ~ 150	°C

Note :

1. The maximum junction temperature rating of the power chips integrated within the SPM is 150°C (@T_C ≤ 100°C). However, to insure safe operation of the SPM, the average junction temperature should be limited to T_{J(ave)} ≤ 125°C (@T_C ≤ 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	-0.3~17	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	°C
Storage Temperature	T _{STG}		-40 ~ 150	°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 (Referenced to PKG center)	R _{θ(j-c)Q}	IGBT	-	-	0.7	°C/W
	R _{θ(j-c)HD}	High-side diode	-	-	1.5	°C/W
	R _{θ(j-c)LD}	Low-side diode	-	-	0.85	°C/W

Note :

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

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 = 50A	-	2.0	2.5	V
High-side diode voltage	V _{FH}	I _F = 50A	-	2.4	2.9	V
Low-side diode voltage	V _{FL}	I _F = 50A	-	1.2	1.6	V
Switching Times	t _{ON}	V _{PN} = 400V, V _{CC} = 15V, I _C = 60A V _{IN} = 0V ↔ 5V, 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	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, I _N = 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 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°C (Note Fig. 9)	-	50	-	kΩ
		@ T _C = 80°C (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 x 10⁻⁶ x t_{FOD}[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} - COM	13.5	15	16.5	V
Control Supply Variation	dV _{CC} /dt	Applied between IN - COM	-1	-	1	V/μs
PWM Input Signal	f _{PWM}	T _C ≤ 100°C, T _J ≤ 125°C, Per IGBT	-	20	-	kHz

Electrical Characteristics

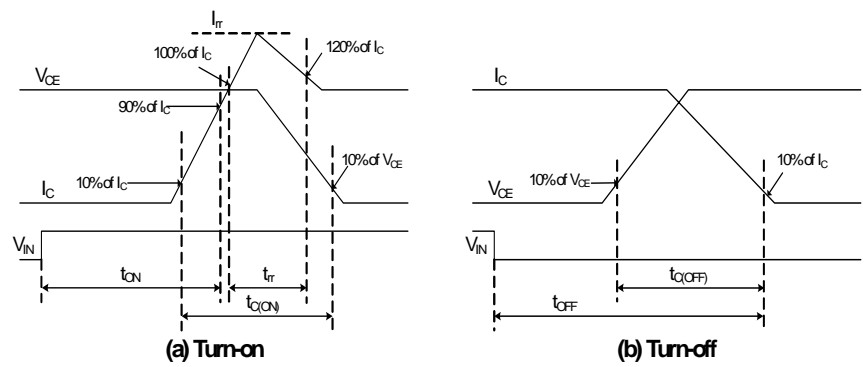


Fig. 4. Switching Time Definition

Mechanical Characteristics and Ratings

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

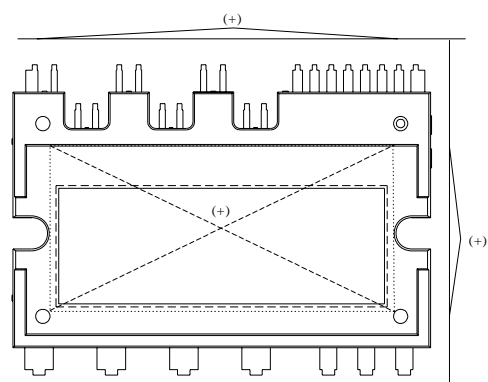
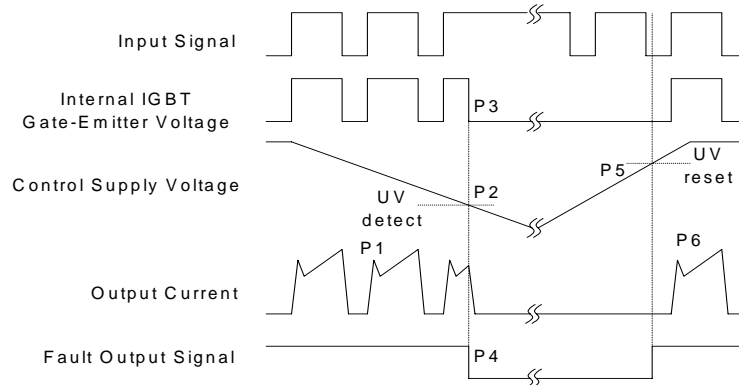


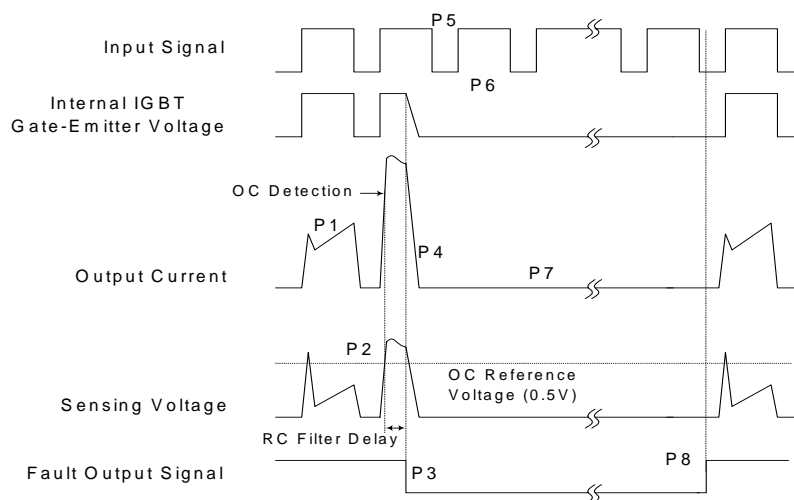
Fig. 5. Flatness Measurement Position

Time Charts of SPMs Protective Function



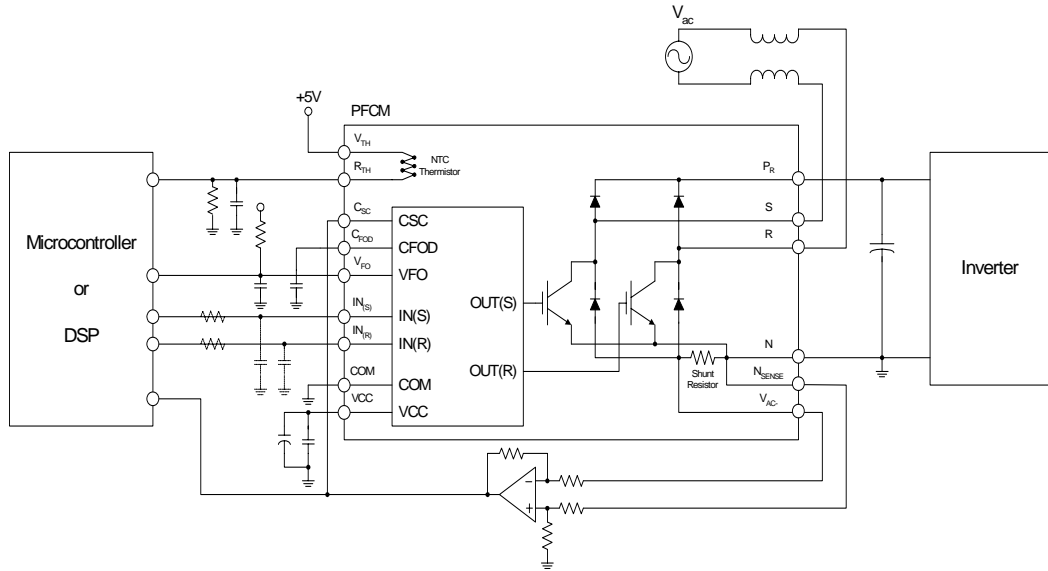
- P1 : Normal operation - IGBT ON and conducting current
- P2 : Under voltage detection
- P3 : IGBT gate interrupt
- P4 : Fault signal generation
- P5 : Under voltage reset
- P6 : Normal operation - IGBT ON and conducting current

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



Note :

- 1) For the over-current protection, please set the delay time in the range 3~4 μ s.

Fig. 8. Application Example

R-T Graph

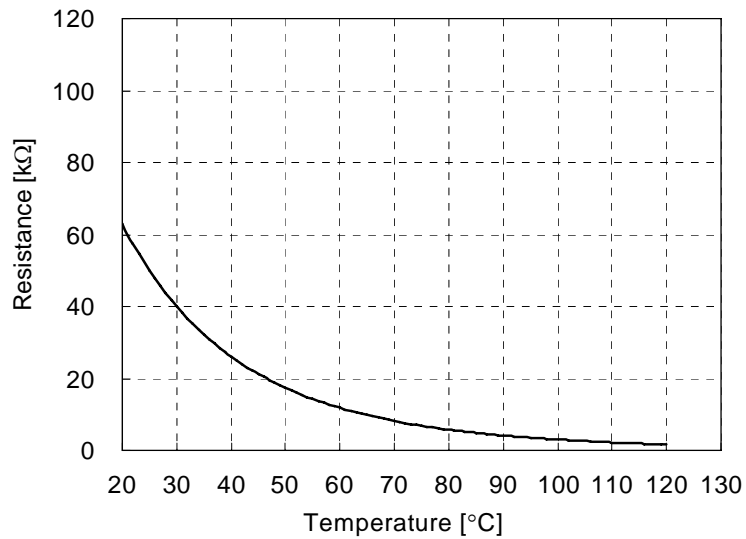
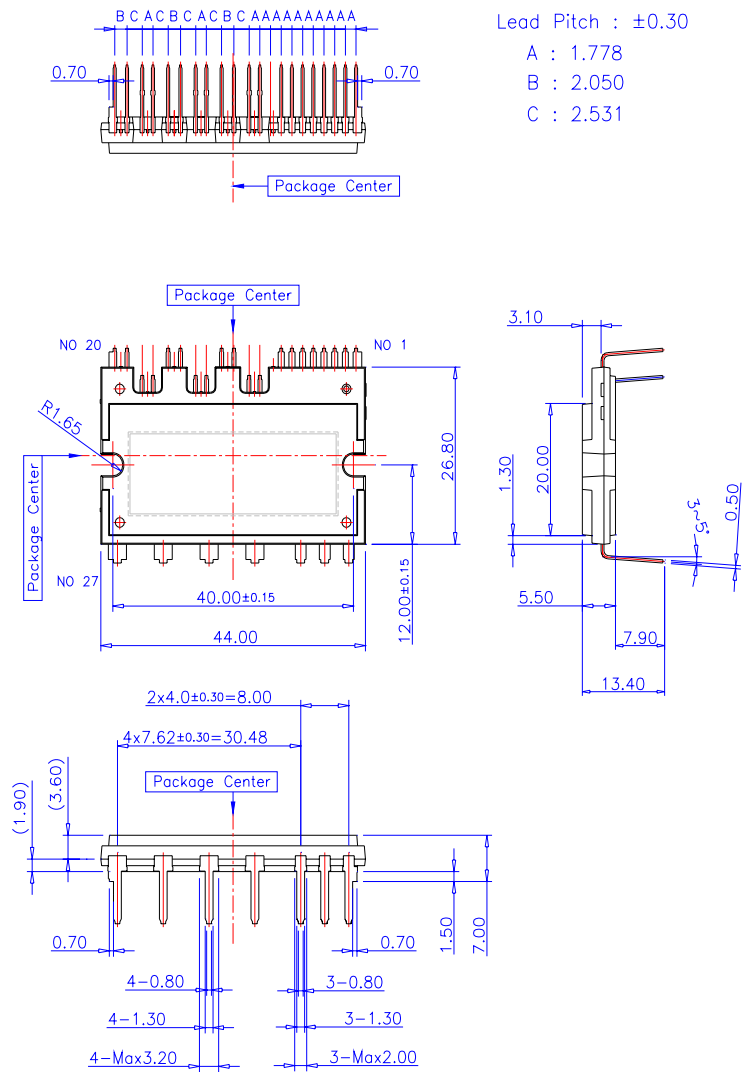
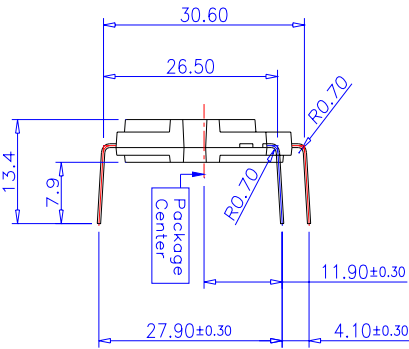


Fig. 9. R-T Curve of the Built-in Thermistor

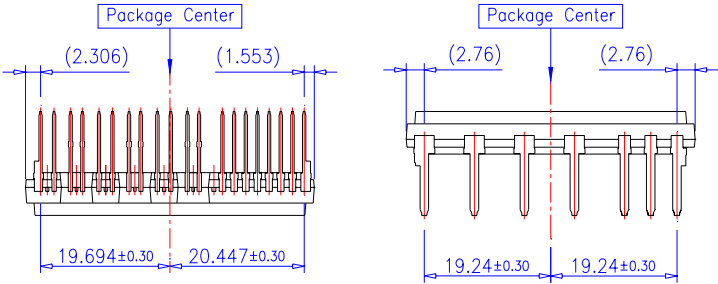
Detailed Package Outline Drawings



Detailed Package Outline Drawings

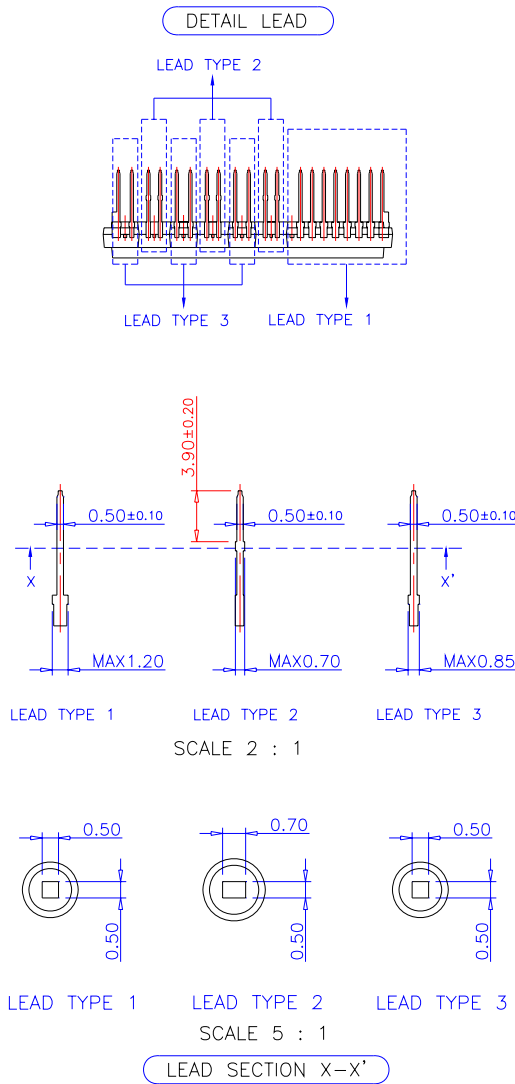


Lead Forming Dimension



PKG Center to Lead Distance

Detailed Package Outline Drawings



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