FAIRCHILD SEMICONDUCTOR®

April 2013

FPDB50PH60
PFC SPM® 3 Series for 2-Phase Bridgeless PFC

Features

- Low Thermal Resistance Thanks to AlN-DBC Substrate
- 600 V - 50 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

FPDB50PH60 Is A PFC SPM 3 Series for 2-Phase Bridgeless PFC (Power Factor Correction) that Fairchild Has 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*

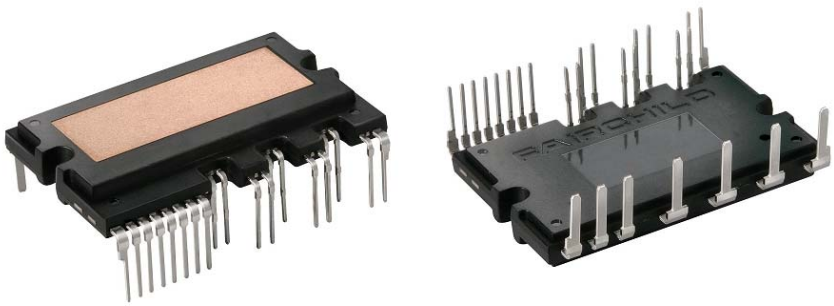


Fig. 1. Package Overview

Package Marking & Ordering Information

Device Marking	Device	Package	Packing Type	Reel Size	Tape Width	Quantity
FPDB50PH60	FPDB50PH60	SPMHA-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, Overcurrent circuit protection (OC), Control supply circuit under-voltage (UV) protection
- Fault signaling: Corresponding to OC and UV fault
- Input interface : Active-high interface, can work with 3.3 / 5 V Logic, Schmitt trigger input

Pin Configuration

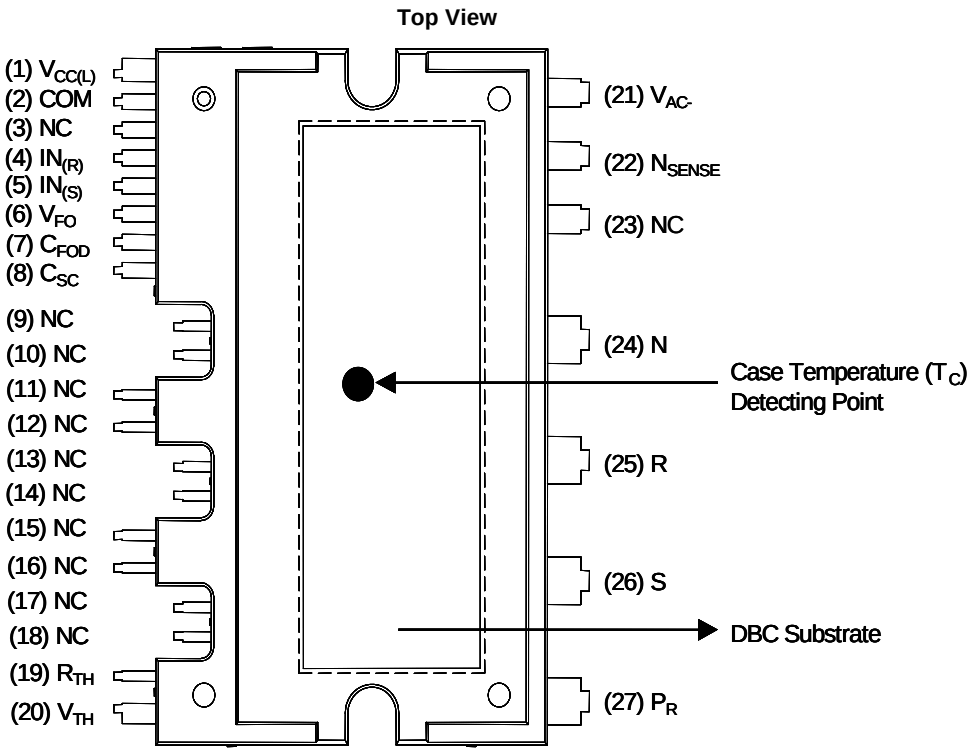
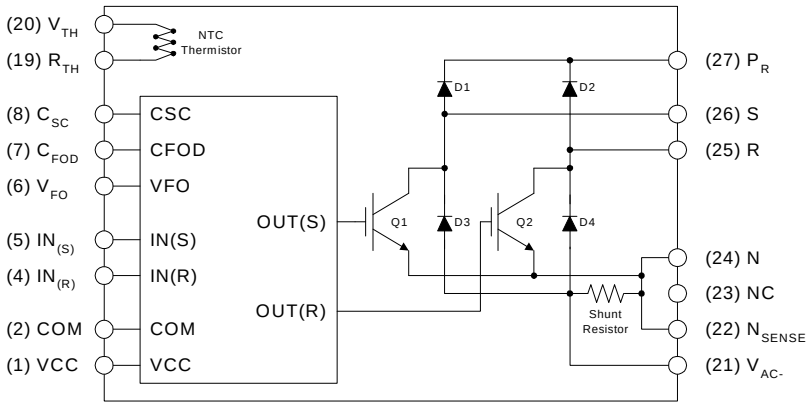


Fig. 2.

Pin Descriptions

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

Note

1. The maximum junction temperature rating of the power chips integrated within the PFC SPM® product is 150 °C(@$T_C \leq$ 100°C). However, to insure safe operation of the PFC SPM product, the average junction temperature should be limited to $T_{J(ave)} \leq$ 125°C (@$T_C \leq$ 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	°C
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 (Referenced to PKG center)	$R_{\theta(j-c)Q}$	IGBT	-	-	0.7	°C/W
	$R_{\theta(j-c)HD}$	High-side diode	-	-	1.5	°C/W
	$R_{\theta(j-c)LD}$	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} = 15 V, V_{IN} = 5 V; I_C = 50 A	-	2.8	3.2	V
High-side diode voltage	V_{FH}	I_C = 50 A	-	2.1	2.7	V
Low-side diode voltage	V_{FL}	I_C = 50 A	-	1.3	1.7	V
Switching Times	t_{ON}	V_{PN} = 400 V, V_{CC} = 15 V, I_C =30 A V_{IN} = 0 V ↔ 5 V, 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} = 15 V, IN = 0 V | V_{CC} - COM	-	-	26	mA
Fault Output Voltage	V_{FOH}	V_{SC} = 0 V, V_{FO} Circuit: 4.7 kΩ to 5 V Pull-up	4.5	-	-	V
	V_{FOL}	V_{SC} = 1 V, V_{FO} Circuit: 4.7 kΩ to 5 V Pull-up	-	-	0.8	V
Over Current Trip Level	$V_{OC(ref)}$	V_{CC} = 15 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 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°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 : $C_{FOD} = 18.3 \times 10^{-6} \times t_{FOD}$[F]

Electrical Characteristics

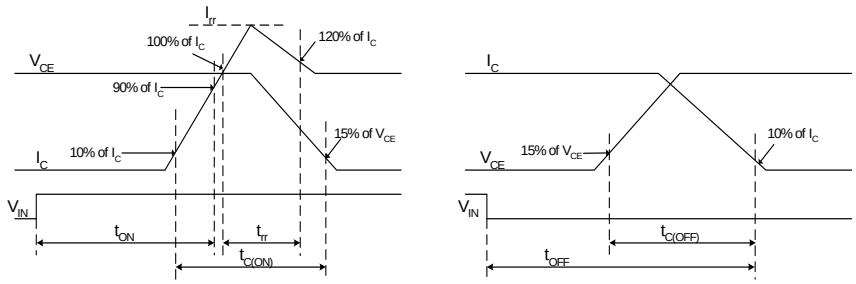


Fig. 4. Switching Time Definition

Mechanical Characteristics and Ratings

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

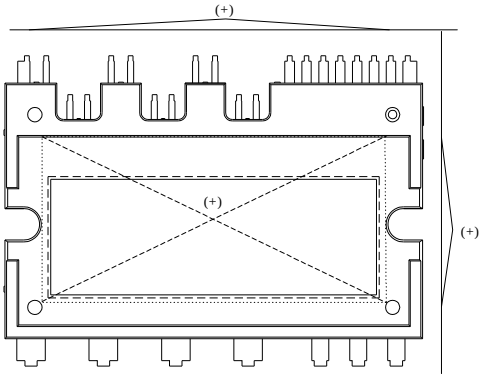
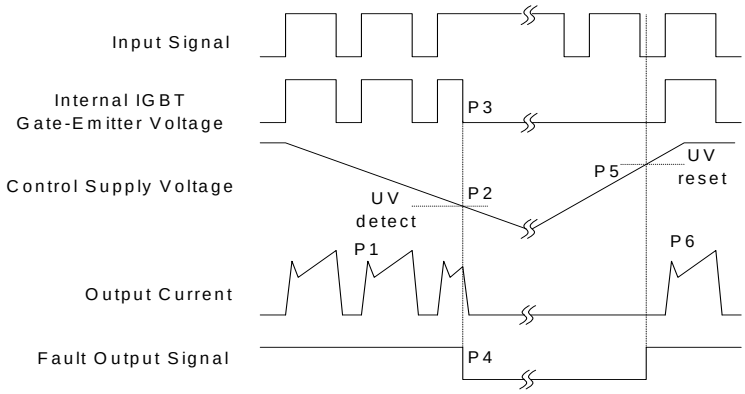


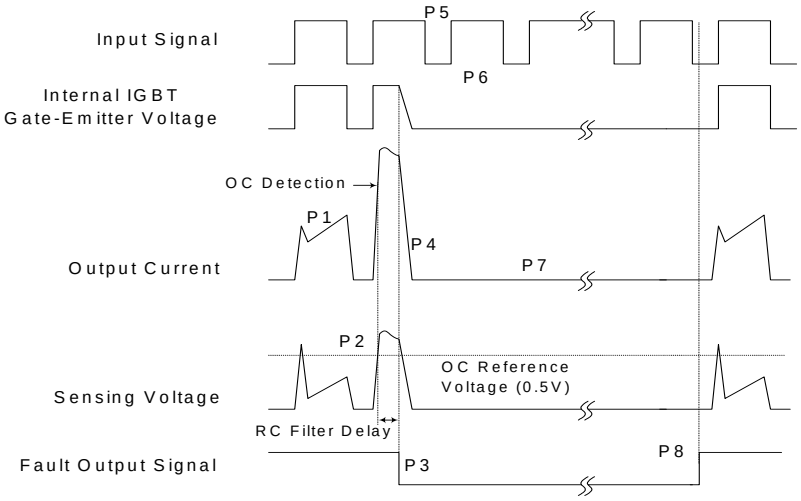
Fig. 5. Flatness Measurement Position

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

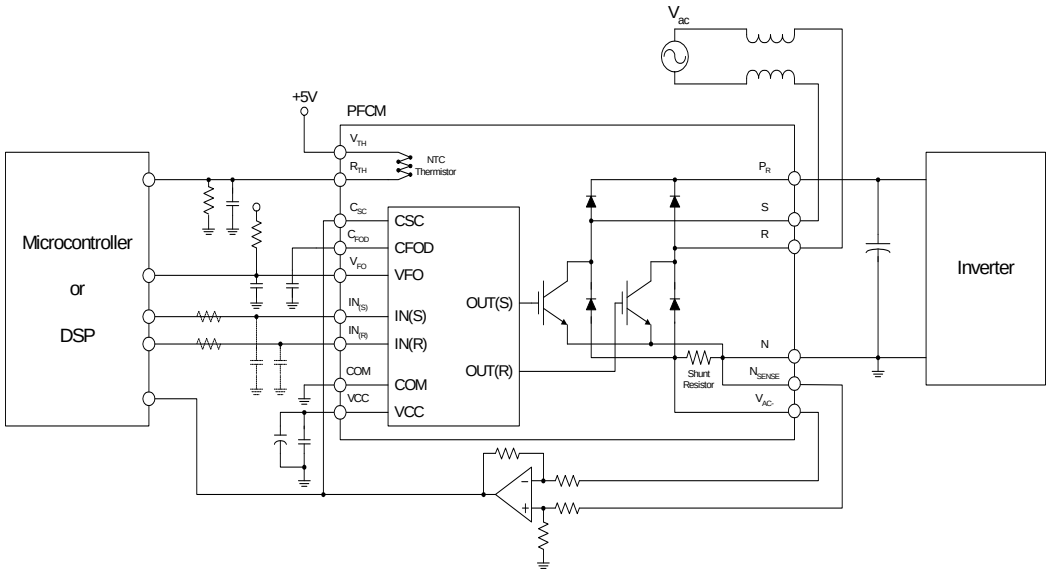


Fig. 8. Application Example

R-T Graph

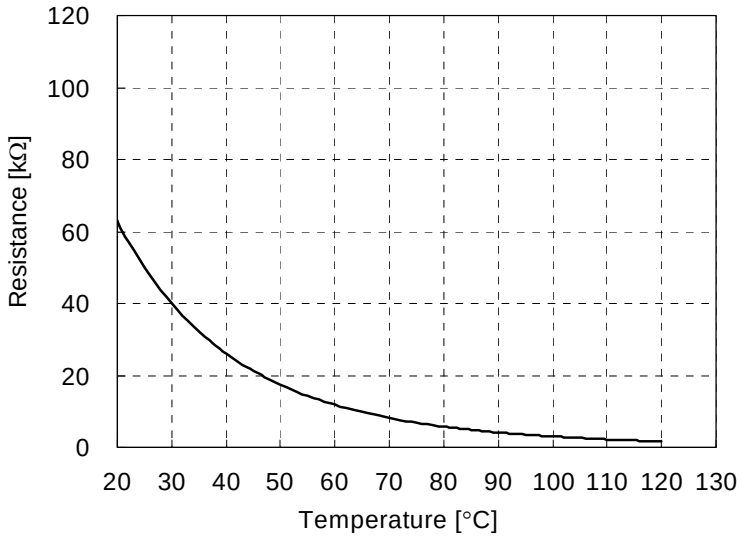
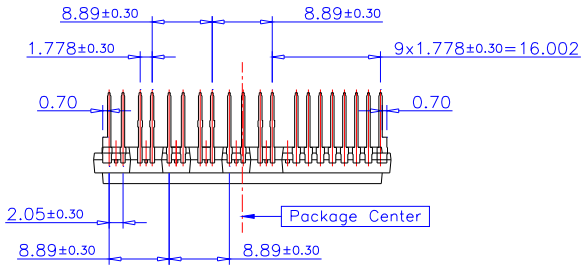
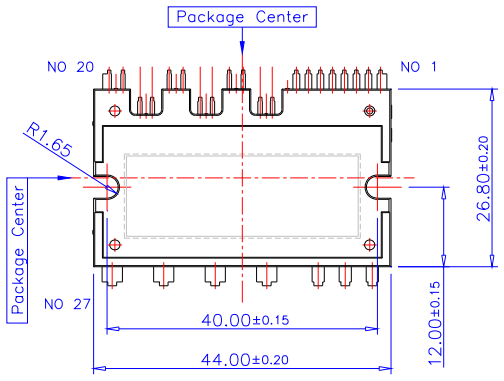
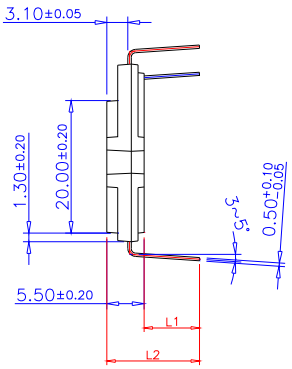


Fig. 9. R-T Curve of the Built-in Thermistor

Detailed Package Outline Drawings

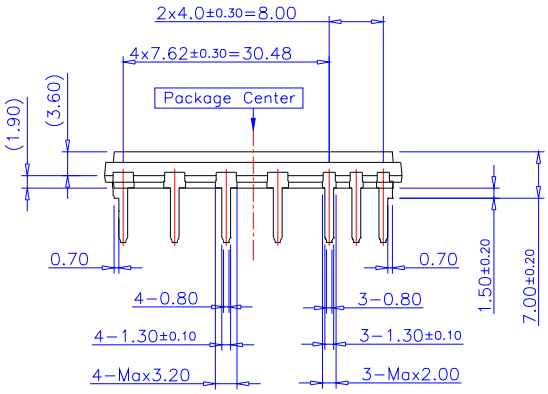






Lead Length Option

	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



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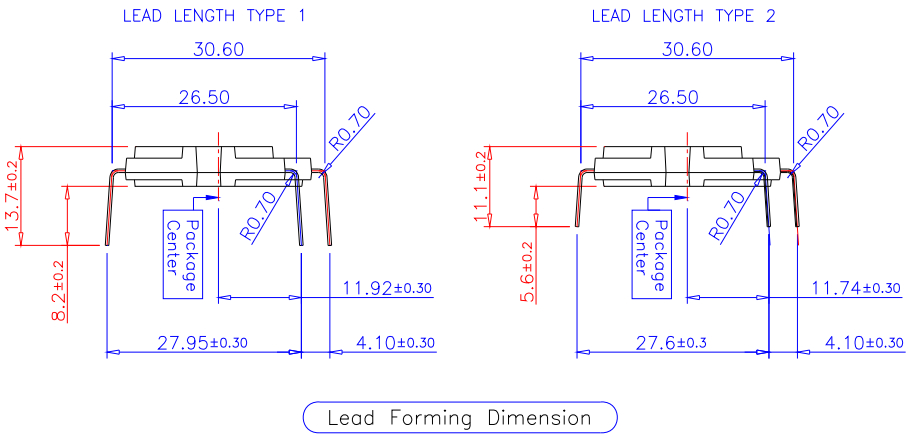
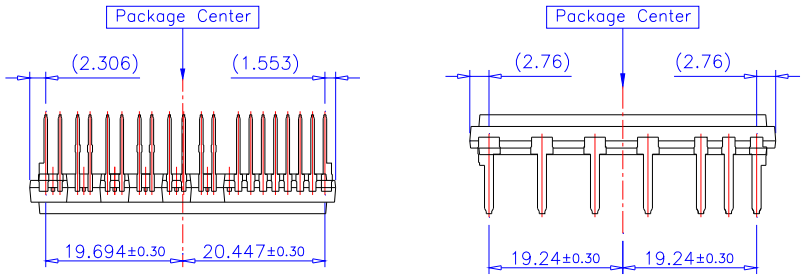
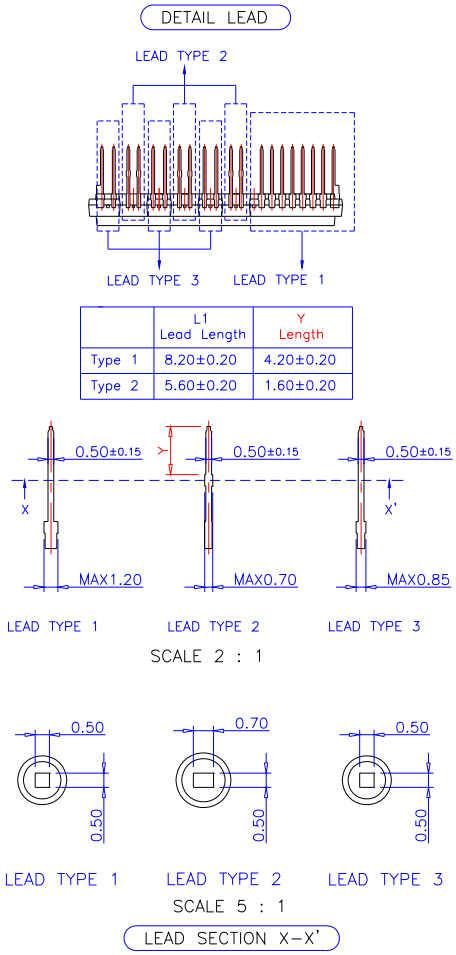


Lead Forming Dimension



PKG Center to Lead Distance

Detailed Package Outline Drawings



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