FAIRCHILD SEMICONDUCTOR®

May 2007

# FPAB30BH60

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

### General Description

FPAB30BH60 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 IGBTs. System reliability is futher enhanced by the integrated under-voltage lock-out and over-current protection function.

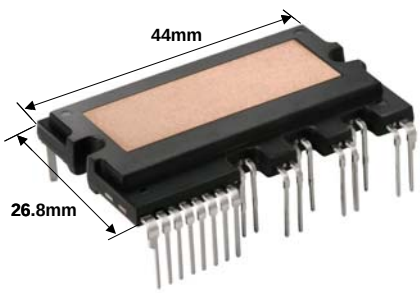
### Features

- Low thermal resistance due to $Al_2O_3$-DBC substrate
- 600V-30A 1-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 85V ~ 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) protection
- Fault signaling: Corresponding to a UV fault
- Input interface: 5V CMOS/LSTTL compatible, Schmitt trigger input

## Pin Configuration

**Top View**

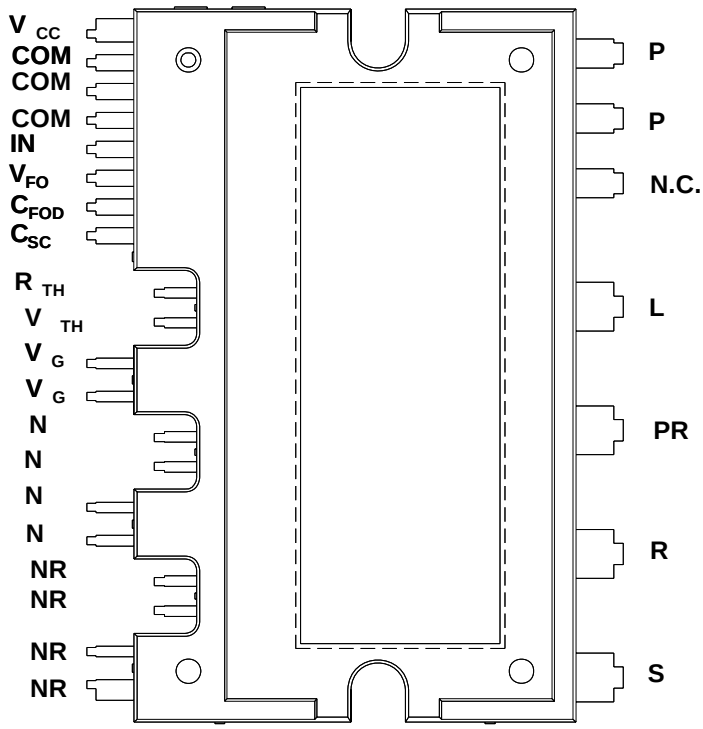



**Fig. 2.**

## Pin Descriptions

| Pin Number | Pin Name | Pin Description |
|---|---|---|
| 1 | $V_{CC}$ | Common Bias Voltage for IC and IGBTs Driving |
| 2,3,4 | COM | Common Supply Ground |
| 5 | $IN_{(R)}$ | Signal Input for Low-side R-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 |
| 9 | $R_{(TH)}$ | NTC Thermistor terminal |
| 10 | $V_{(TH)}$ | NTC Thermistor terminal |
| 11,12 | Vg | IGBT gate dummy |
| 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 |

## Internal Equivalent Circuit and Input/Output Pins

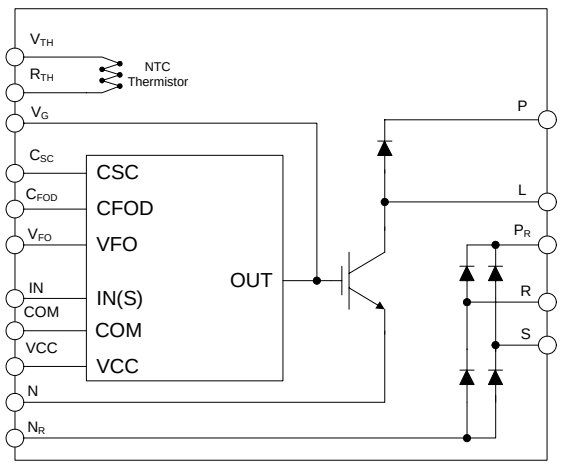



**Fig. 3.**

## Package Marking & Ordering Information

| Device Marking | Device | Package | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|
| FPAB30BH60 | FPAB30BH60 | SPM27-IA | - | - | 10 |

## 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, $V_i$=220V, $V_{PN}$= 390V, $V_{PWM}$=20kHz | 25 | A |
| Input Current (125% Load) | $I_{i(125\%)}$ | $T_C$ < 95°C, $V_i$=220V, $V_{PN}$= 390V, $V_{PWM}$=20kHz, 1min Non-repetitive | 30 | A |
| Collector Dissipation | $P_C$ | $T_C$ = 25°C per One IGBT | 169 | W |
| Operating Junction Temperature | $T_J$ | (Note 1) | -20 ~ 150 | °C |

**Note**

1. The maximum junction temperature rating of the power chips integrated within the SPM® is 150 °C(@$T_C \leq$ 100°C). However, to insure safe operation of the SPM®, 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 | - | - | 0.74 | °C/W |
| | $R_{\theta(j-c)F}$ | FRD | - | - | 1.44 | °C/W |
| | $R_{\theta(j-c)R}$ | Rectifier | - | - | 2.07 | °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; $I_C$ =30A | - | 2.0 | 2.8 | V |
| FRD forward voltage | $V_{FF}$ | $I_F$ = 30A | - | 1.8 | 2.5 | V |
| Rectifier forward voltage | $V_{FR}$ | $I_F$ = 30A | - | 1.2 | 1.5 | V |
| Switching Times | $t_{ON}$ | $V_{PN}$ = 400V, $V_{CC}$ = 15V, $I_C$ =30A | - | 650 | - | ns |
| | $t_{C(ON)}$ | $V_{IN}$ = 0V ↔ 5V, Inductive Load | - | 400 | - | ns |
| | $t_{OFF}$ | (Note 3) | - | 620 | - | ns |
| | $t_{C(OFF)}$ | | - | 200 | - | ns |
| | $t_{rr}$ | | - | 60 | - | ns |
| | $I_{rr}$ | | - | 3.5 | - | A |
| 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 | $V_{SC(ref)}$ | $V_{CC}$ = 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 |
| | | @ $T_C$ = 100°C (Note Fig. 9) | - | 2.99 | - | 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]

## Electrical Characteristics

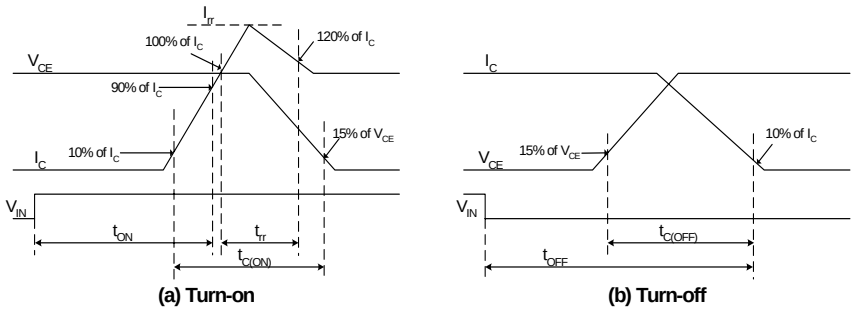



**Fig. 4. Switching Time Definition**

## 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 |

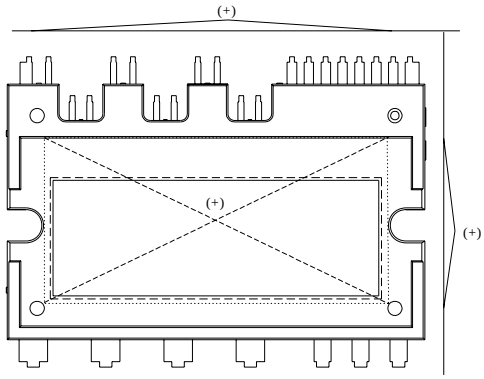
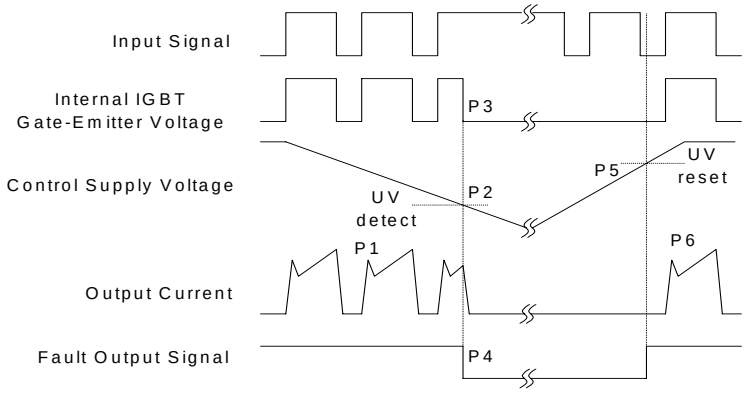


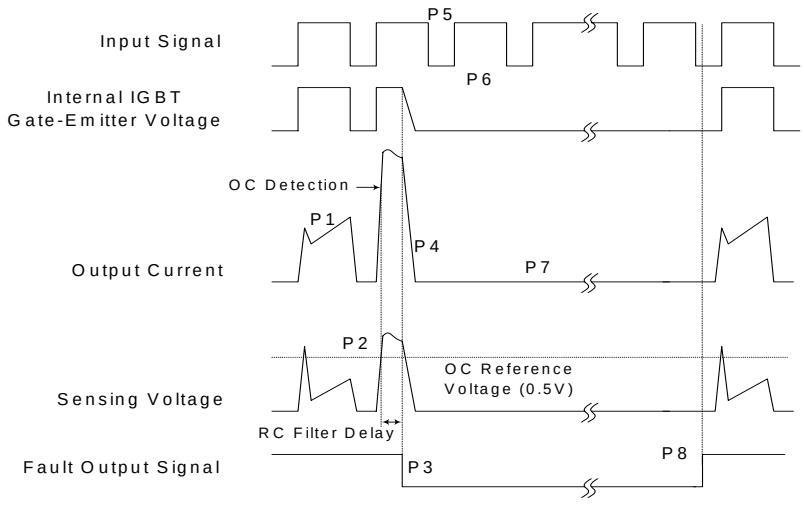

**Fig. 5. Flatness Measurement Position**

## 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**

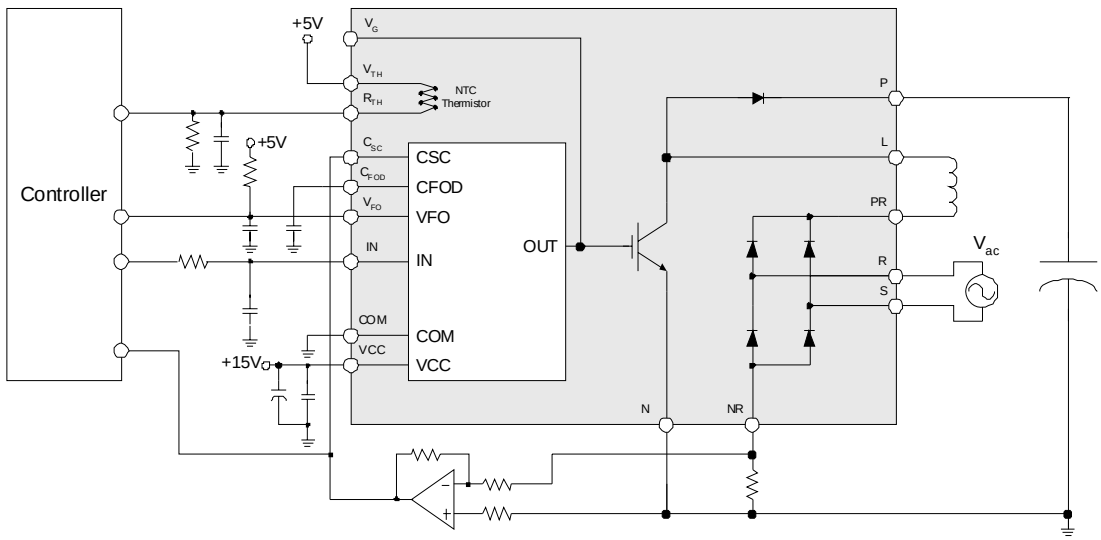



**Fig. 8. Application Example**

R-T Graph

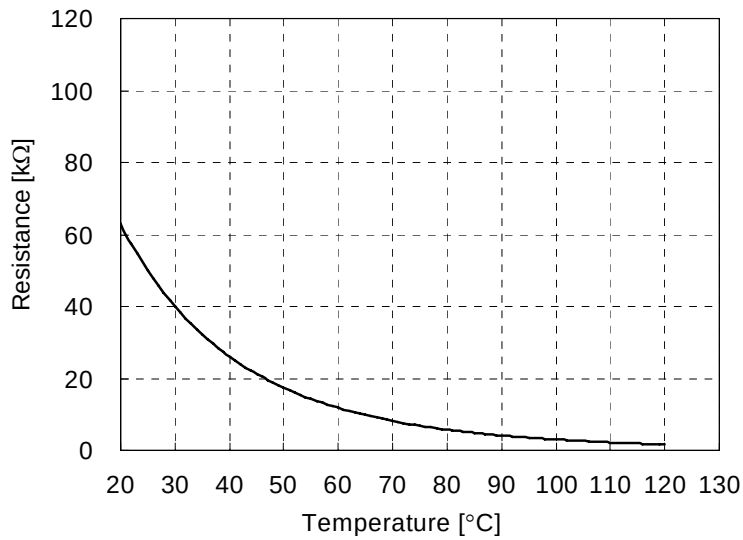
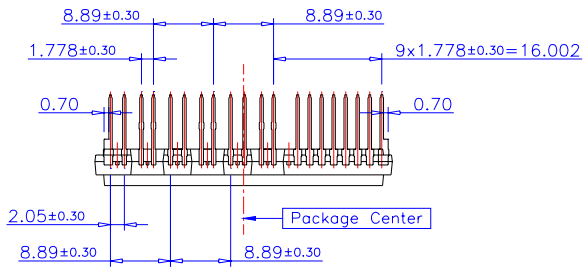
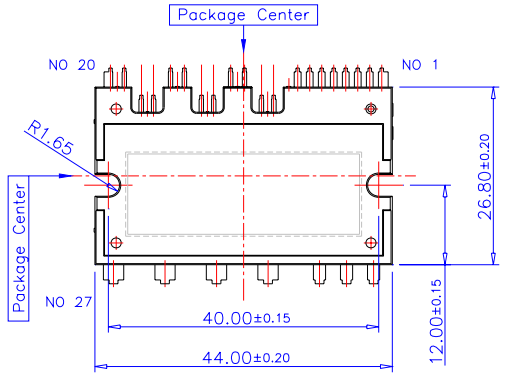
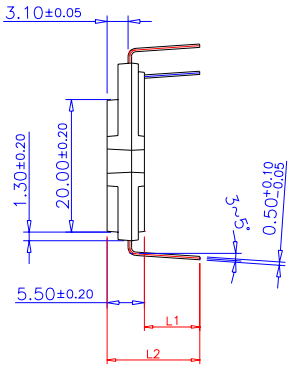


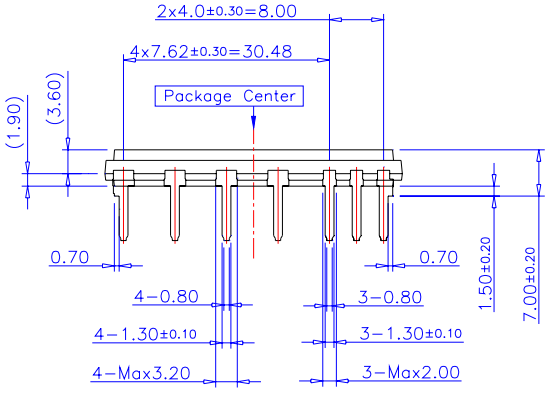

**Fig. 9. R-T Curve of the Built-in Thermistor**

## Detailed Package Outline Drawings



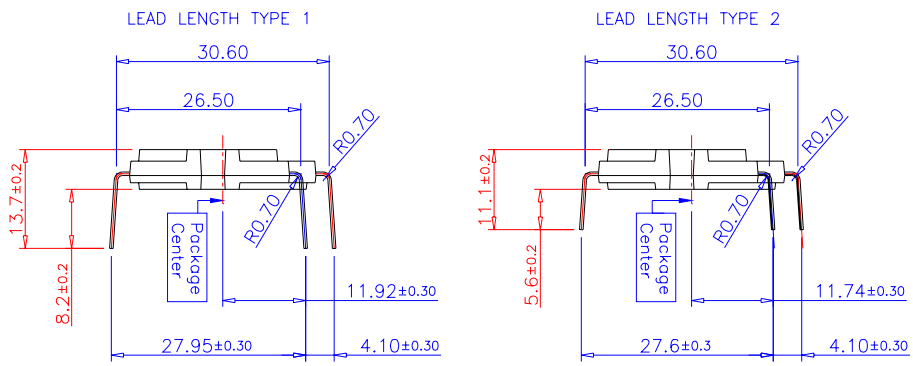



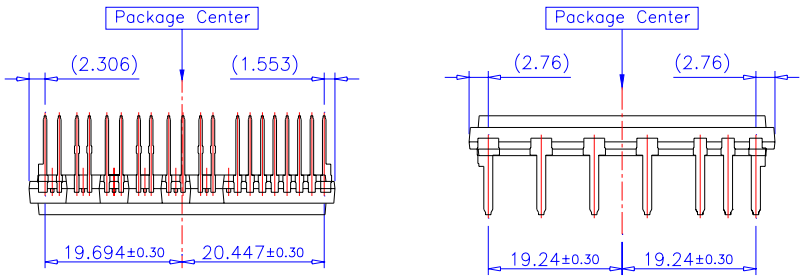

Lead Length Option

| | L1<br>Lead Length | L2<br>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

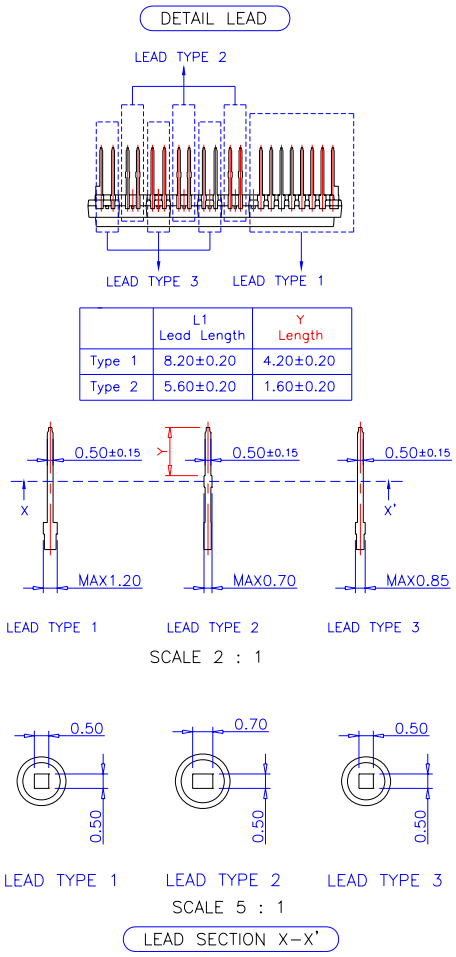



Lead Forming Dimension




PKG Center to Lead Distance

## Detailed Package Outline Drawings



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