



## FPDB60PH60B

### 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

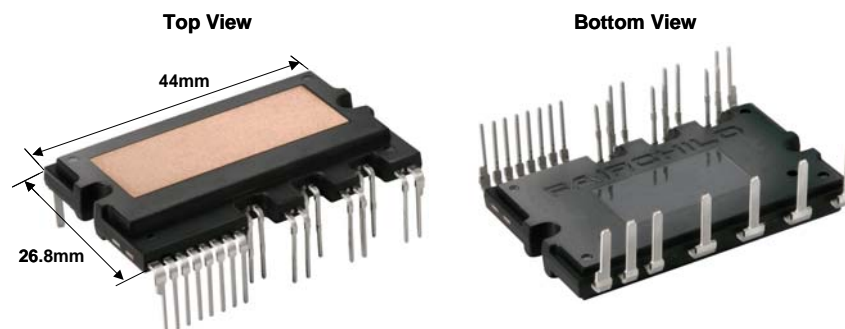


Fig. 1.

### 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

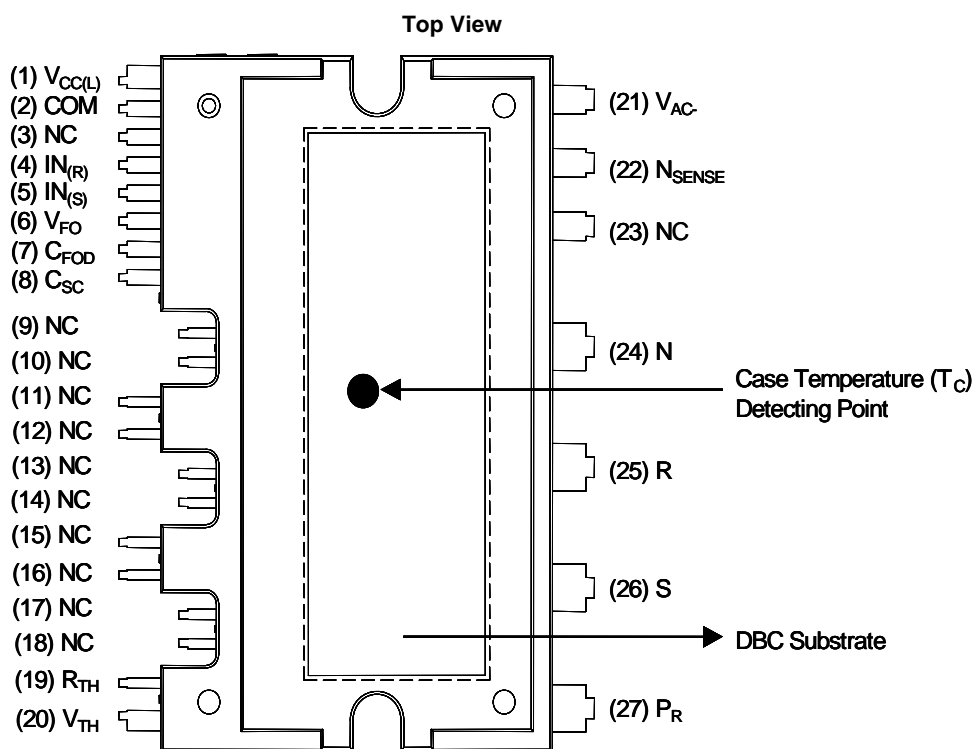
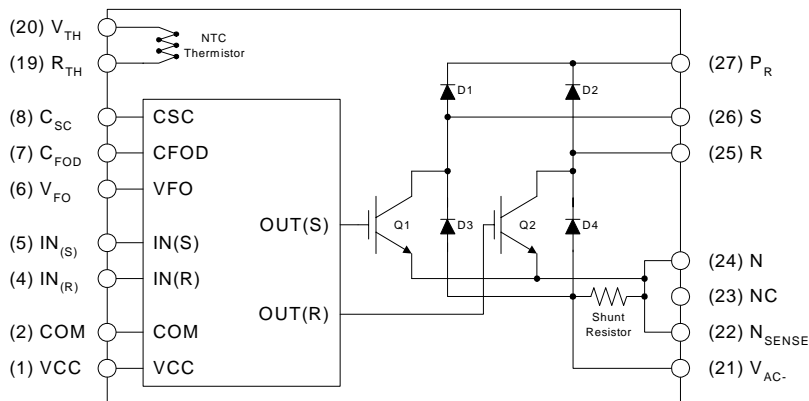


Fig. 2.

### Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V <sub>CC</sub>	Common Bias Voltage for IC and IGBTs Driving
2	COM	Common Supply Ground
4	IN <sub>(R)</sub>	Signal Input for Low-side R-phase IGBT
5	IN <sub>(S)</sub>	Signal Input for Low-side S-phase IGBT
6	V <sub>FO</sub>	Fault Output
7	C <sub>FOD</sub>	Capacitor for Fault Output Duration Time Selection
8	C <sub>SC</sub>	Capacitor (Low-pass Filter) for Over Current Detection
19	R <sub>(TH)</sub>	NTC Thermistor terminal
20	V <sub>(TH)</sub>	NTC Thermistor terminal
21	V <sub>AC-</sub>	Current Sensing Terminal
22	N <sub>SENSE</sub>	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 <sub>R</sub>	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** ( $T_J = 25^\circ\text{C}$ , 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	$\pm I_C$	$T_C = 25^\circ\text{C}$	60	A
Each IGBT collector current (Peak)	$\pm I_{CP}$	$T_C = 25^\circ\text{C}$ , Under 1ms pulse width	90	A
Collector Dissipation	$P_C$	$T_C = 25^\circ\text{C}$ 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	$P_{RSH}$	$T_C < 125^\circ\text{C}$	2	W
Operating Junction Temperature	$T_J$	(Note 1)	-40 ~ 150	$^\circ\text{C}$

**Note :**

1. The maximum junction temperature rating of the power chips integrated within the SPM is  $150^\circ\text{C}$  ( $@T_C \leq 100^\circ\text{C}$ ). However, to insure safe operation of the SPM, the average junction temperature should be limited to  $T_{J(ave)} \leq 125^\circ\text{C}$  ( $@T_C \leq 100^\circ\text{C}$ ).

**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	$^\circ\text{C}$
Storage Temperature	$T_{STG}$		-40 ~ 150	$^\circ\text{C}$
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	$^\circ\text{C/W}$
	$R_{\theta(j-c)HD}$	High-side diode	-	-	1.5	$^\circ\text{C/W}$
	$R_{\theta(j-c)LD}$	Low-side diode	-	-	0.85	$^\circ\text{C/W}$

**Note :**

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

**Electrical Characteristics** ( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)**Converter Part**

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
IGBT saturation voltage	$V_{CE(sat)}$	$V_{CC} = 15\text{V}$ , $V_{IN} = 5\text{V}$ ; $I_C = 50\text{A}$	-	2.0	2.5	V
High-side diode voltage	$V_{FH}$	$I_F = 50\text{A}$	-	2.4	2.9	V
Low-side diode voltage	$V_{FL}$	$I_F = 50\text{A}$	-	1.2	1.6	V
Switching Times	$t_{ON}$	$V_{PN} = 400\text{V}$ , $V_{CC} = 15\text{V}$ , $I_C = 60\text{A}$ $V_{IN} = 0\text{V} \leftrightarrow 5\text{V}$ , 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	$\text{m}\Omega$
Collector - emitter Leakage Current	$I_{CES}$	$V_{CE} = V_{CES}$	-	-	250	$\mu\text{A}$

**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	$I_{QCCL}$	$V_{CC} = 15\text{V}$ , $I_N = 0\text{V}$   $V_{CC} - \text{COM}$	-	-	26	mA
Fault Output Voltage	$V_{FOH}$	$V_{SC} = 0\text{V}$ , $V_{FO}$ Circuit: 4.7k $\Omega$ to 5V Pull-up	4.5	-	-	V
	$V_{FOL}$	$V_{SC} = 1\text{V}$ , $V_{FO}$ Circuit: 4.7k $\Omega$ to 5V Pull-up	-	-	0.8	V
Over Current Trip Level	$V_{SC(ref)}$	$V_{CC} = 15\text{V}$	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	$t_{FOD}$	$C_{FOD} = 33\text{nF}$ (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	$R_{TH}$	@ $T_C = 25^\circ\text{C}$ (Note Fig. 9)	-	50	-	k $\Omega$
		@ $T_C = 80^\circ\text{C}$ (Note Fig. 9)	-	5.76	-	k $\Omega$

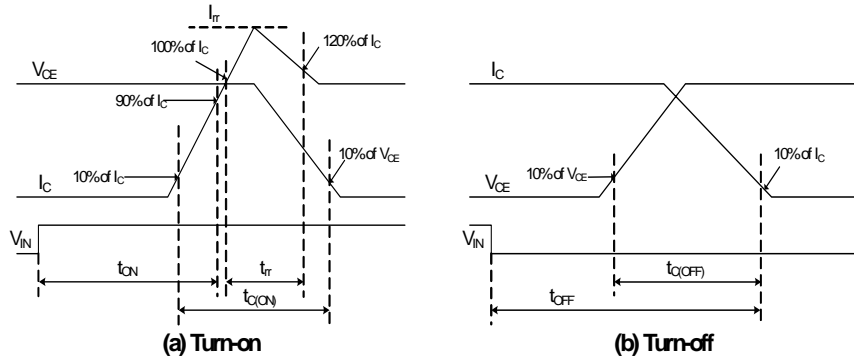
**Note**

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

**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 $V_{CC} - \text{COM}$	13.5	15	16.5	V
Control Supply Variation	$dV_{CC}/dt$	Applied between IN - COM	-1	-	1	V/ $\mu\text{s}$
PWM Input Signal	$f_{PWM}$	$T_C \leq 100^\circ\text{C}$ , $T_J \leq 125^\circ\text{C}$ , Per IGBT	-	20	-	kHz

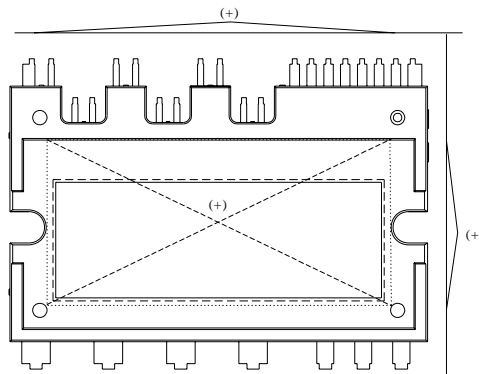
**Electrical Characteristics**



**Fig. 4. Switching Time Definition**

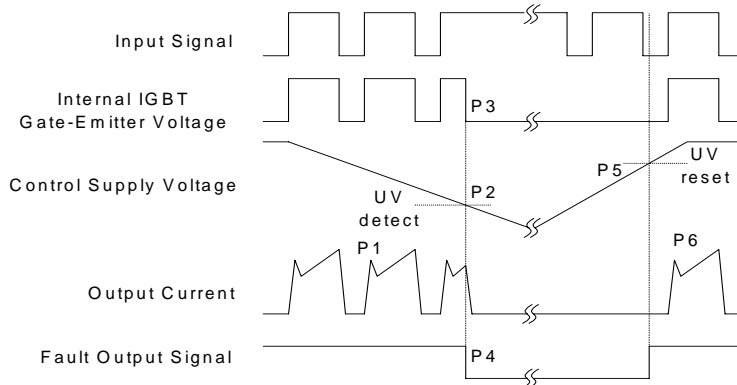
**Mechanical Characteristics and Ratings**

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



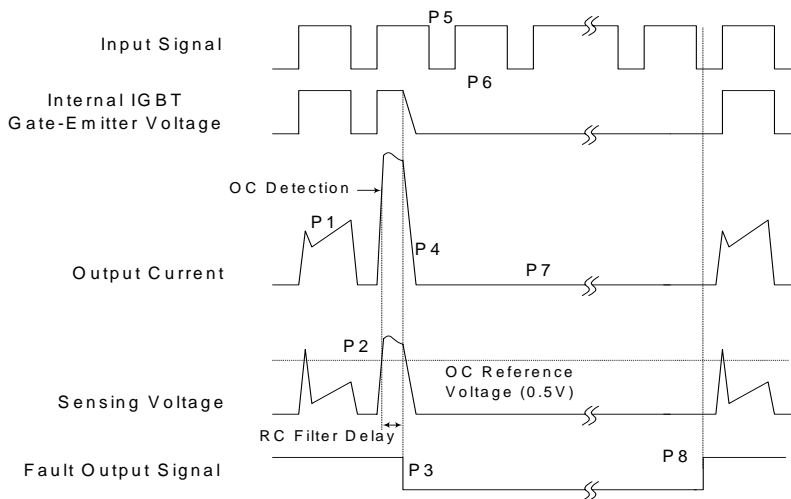
**Fig. 5. Flatness Measurement Position**

**Time Charts of SPMs Protective Function**



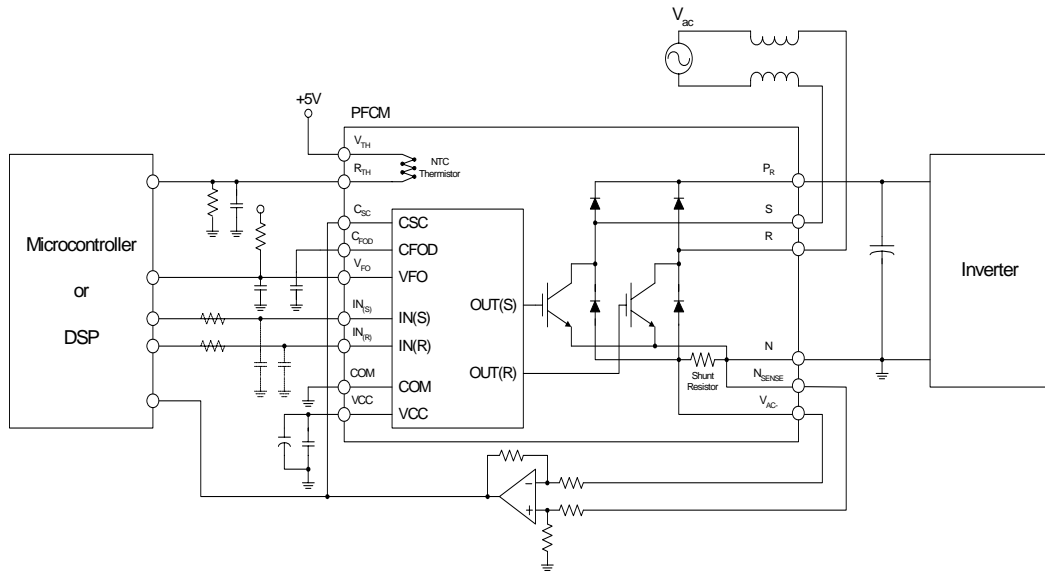
- P1 : Normal operation - IGBT ON and conducting current
- P2 : Under voltage detection
- P3 : IGBT gate interrupt
- P4 : Fault signal generation
- P5 : Under voltage reset
- P6 : Normal operation - IGBT ON and conducting current

**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 $\mu$ s.

Fig. 8. Application Example

R-T Graph

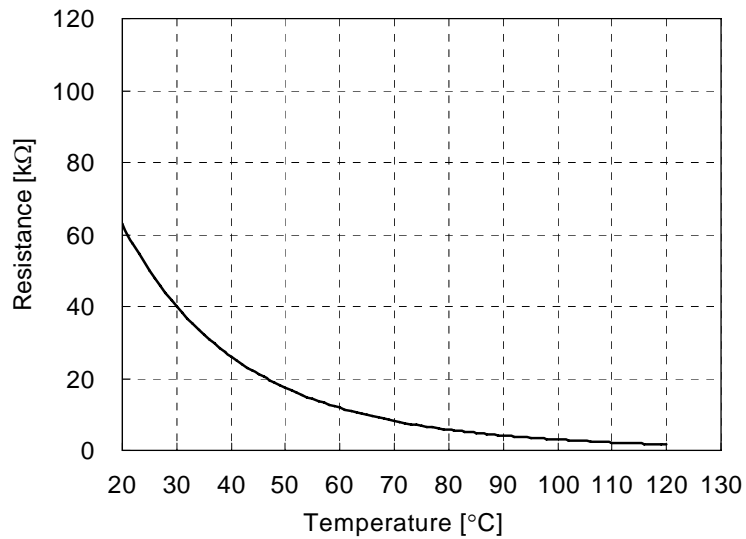
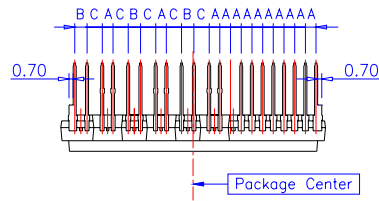


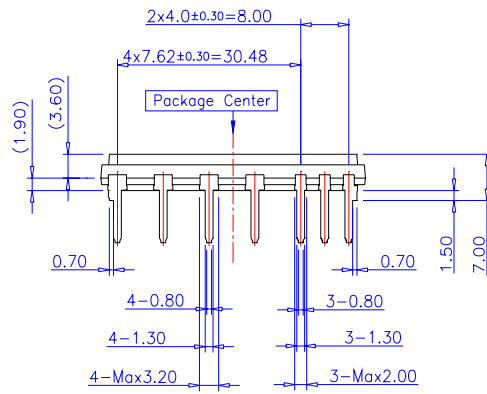
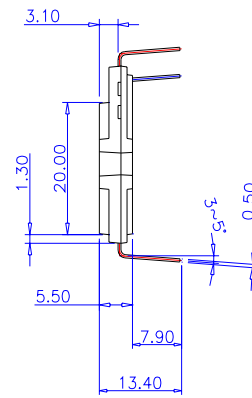
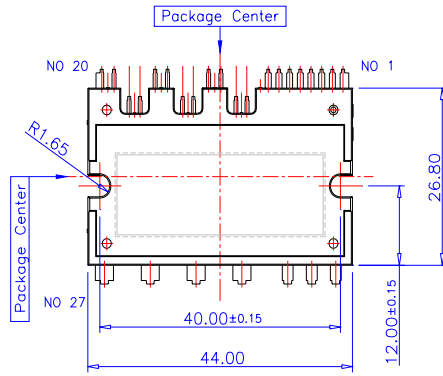
Fig. 9. R-T Curve of the Built-in Thermistor



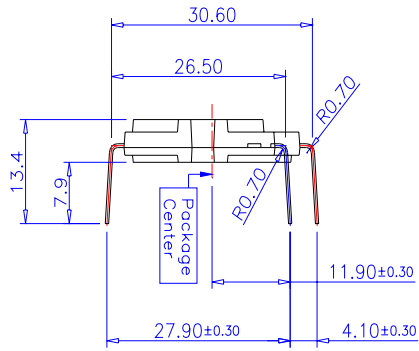
Detailed Package Outline Drawings



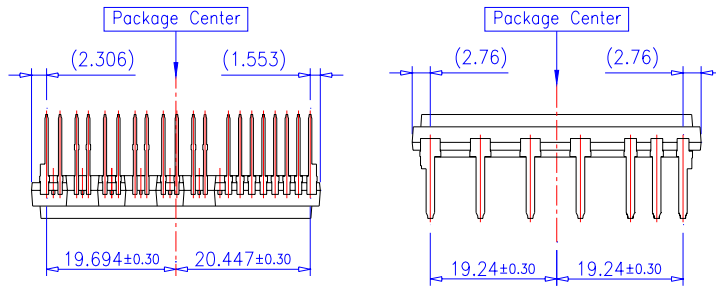
Lead Pitch :  $\pm 0.30$   
 A : 1.778  
 B : 2.050  
 C : 2.531



### Detailed Package Outline Drawings

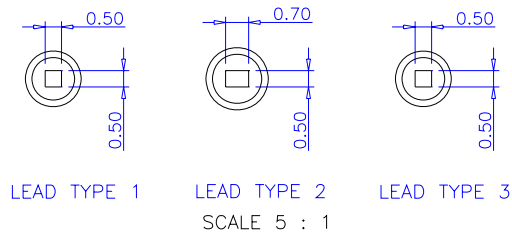
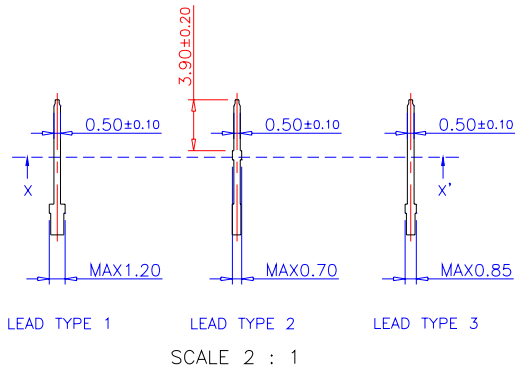
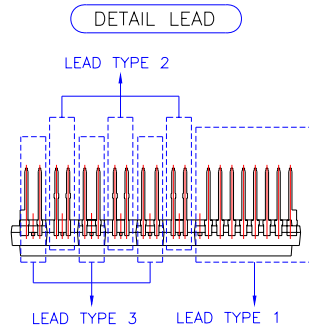


Lead Forming Dimension



PKG Center to Lead Distance

### Detailed Package Outline Drawings



LEAD SECTION X-X'

## TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACE <sup>x</sup> <sup>TM</sup>	FAST <sup>®</sup>	PACMAN <sup>TM</sup>	SuperSOT <sup>TM</sup> -3
Bottomless <sup>TM</sup>	FAST <sup>r</sup> <sup>TM</sup>	POP <sup>TM</sup>	SuperSOT <sup>TM</sup> -6
CoolFET <sup>TM</sup>	GlobalOptoisolator <sup>TM</sup>	PowerTrench <sup>®</sup>	SuperSOT <sup>TM</sup> -8
CROSSVOLT <sup>TM</sup>	GTO <sup>TM</sup>	QFET <sup>TM</sup>	SyncFET <sup>TM</sup>
DenseTrench <sup>TM</sup>	HiSeC <sup>TM</sup>	QS <sup>TM</sup>	TinyLogic <sup>TM</sup>
DOME <sup>TM</sup>	ISOPLANAR <sup>TM</sup>	QT Optoelectronics <sup>TM</sup>	UHC <sup>TM</sup>
EcoSPARK <sup>TM</sup>	LittleFET <sup>TM</sup>	Quiet Series <sup>TM</sup>	UltraFET <sup>®</sup>
E <sup>2</sup> CMOS <sup>TM</sup>	MicroFET <sup>TM</sup>	SLIENT SWITCHER <sup>®</sup>	VCX <sup>TM</sup>
EnSigna <sup>TM</sup>	MICROWIRE <sup>TM</sup>	SMART START <sup>TM</sup>	
FACT <sup>TM</sup>	OPTOLOGIC <sup>TM</sup>	Star* Power <sup>TM</sup>	
FACT Quiet Series <sup>TM</sup>	OPTOPLANAR <sup>TM</sup>	Stealth <sup>TM</sup>	

## DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

## LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.