FAIRCHILD

SEMICONDUCTOR®

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 AIN-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.

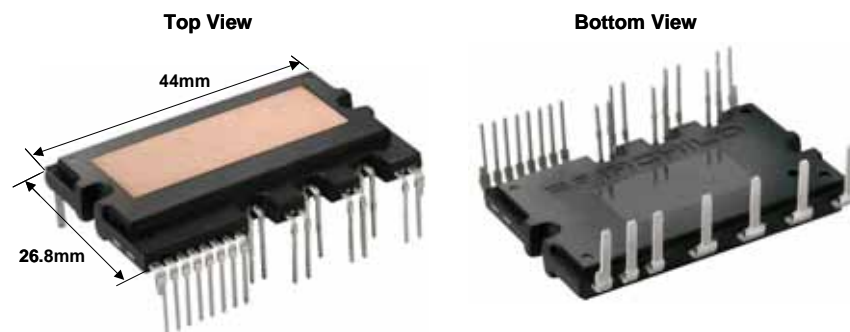### Applications

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

Top View

Bottom View

44mm

26.8mm

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
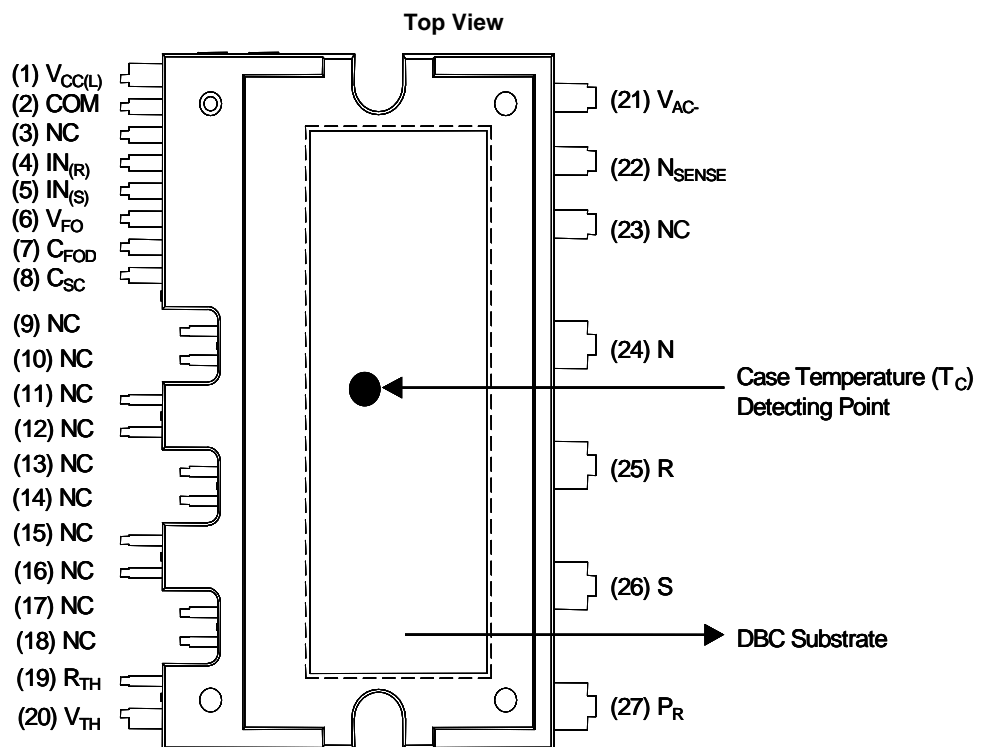
Pin Configuration

Top View

(1) $V_{CC(L)}$
(2) COM
(3) NC
(4) $IN_{(R)}$
(5) $IN_{(S)}$
(6) V_{FO}
(7) C_{FOD}
(8) C_{SC}
(9) NC
(10) NC
(11) NC
(12) NC
(13) NC
(14) NC
(15) NC
(16) NC
(17) NC
(18) NC
(19) R_{TH}
(20) V_{TH}

(21) V_{AC-}
(22) N_{SENSE}
(23) NC
(24) N
(25) R
(26) S
(27) P_R

Case Temperature (T_C) Detecting Point

DBC Substrate

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
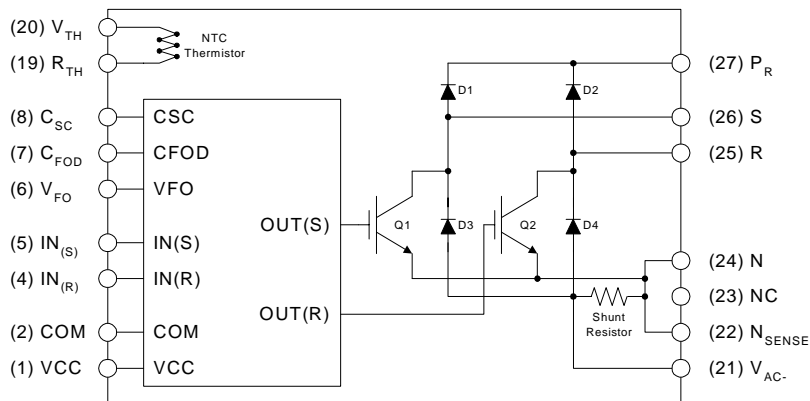
Note :
1) Converter is composed of two IGBTs including four diodes and one IC which has gate driving and protection functions.

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=220V, V_{PN}= 390V, V_{PWM}=20kHz	30	A
Input Current (125% Load)	$I_{i(125\%)}$	T_C < 95°C, V_i=220V, V_{PN}= 390V, V_{PWM}=20kHz, 1min 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 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	-	-	0.7	°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$_{CC}$ =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°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 : $C_{FOD} = 18.3 \times 10^{-6} \times t_{FOD}[F]$
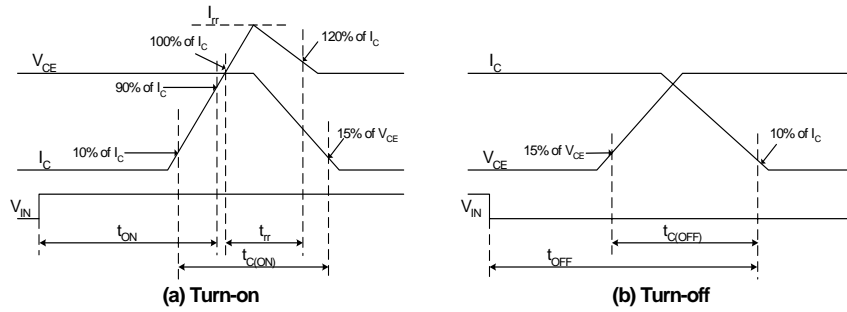
Electrical Characteristics

(a) Turn-on   (b) Turn-off

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
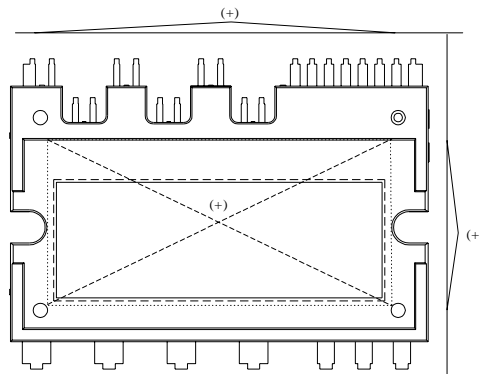
Fig. 5. Flatness Measurement Position

Time Charts of SPMs Protective Function

Input Signal

Internal IGBT
Gate-Emitter Voltage

Control Supply Voltage

Output Current

Fault Output Signal

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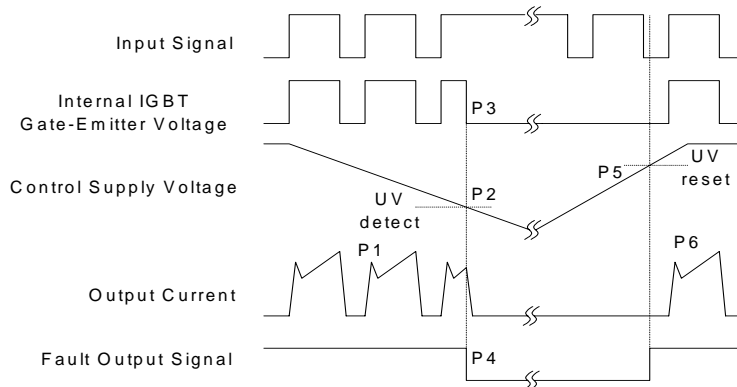
P1 : Normal operation - IGBT ON and conducting current
P2 : Under voltage detection
P3 : IGBT gate interrupt
P4 : Fault signal generation
P5 : Under voltage reset
P6 : Normal operation - IGBT ON and conducting current

Fig. 6. Under-Voltage Protection

Input Signal

Internal IGBT
Gate-Emitter Voltage

Output Current

Sensing Voltage

Fault Output Signal

P5
P6
OC Detection
P1
P4
P7
P2
OC Reference Voltage (0.5V)
RC Filter Delay
P3
P8
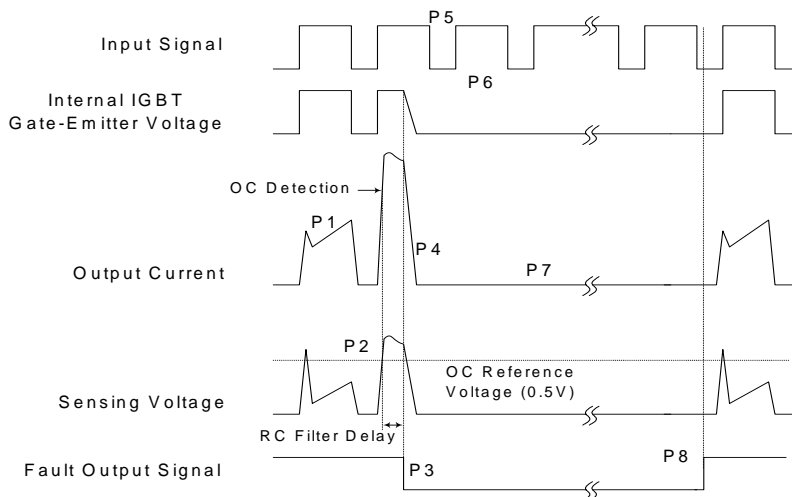
P1 : Normal operation - IGBT ON and conducting current
P2 : Over current detection
P3 : IGBT gate interrupt / Fault signal generation
P4 : IGBT is slowly turned off
P5 : IGBT OFF signal
P6 : IGBT ON signal - but IGBT cannot be turned on during the fault Output activation
P7 : IGBT OFF state
P8 : Fault Output reset and normal operation start
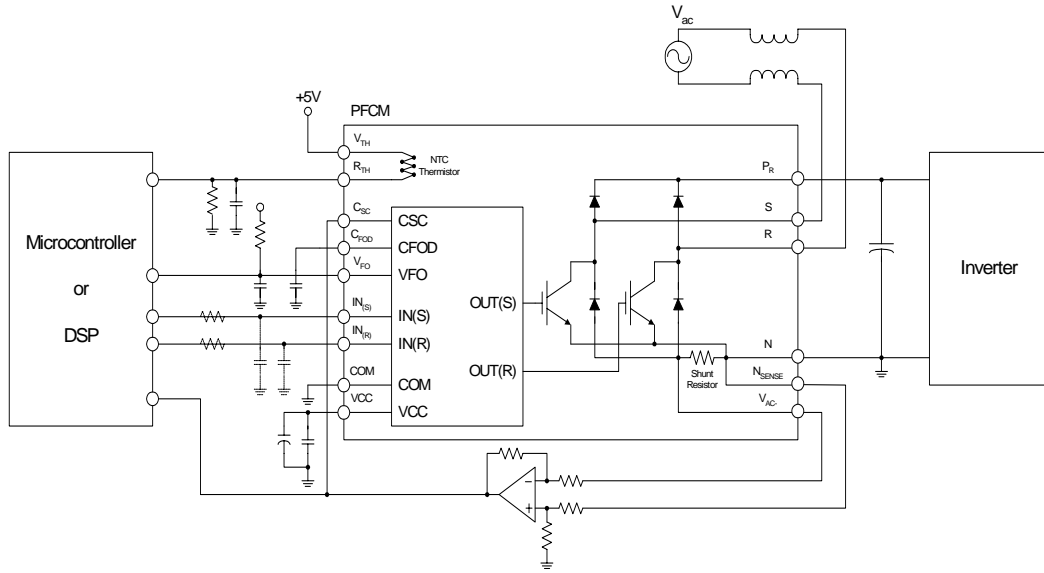
Fig. 7. Over Current Protection
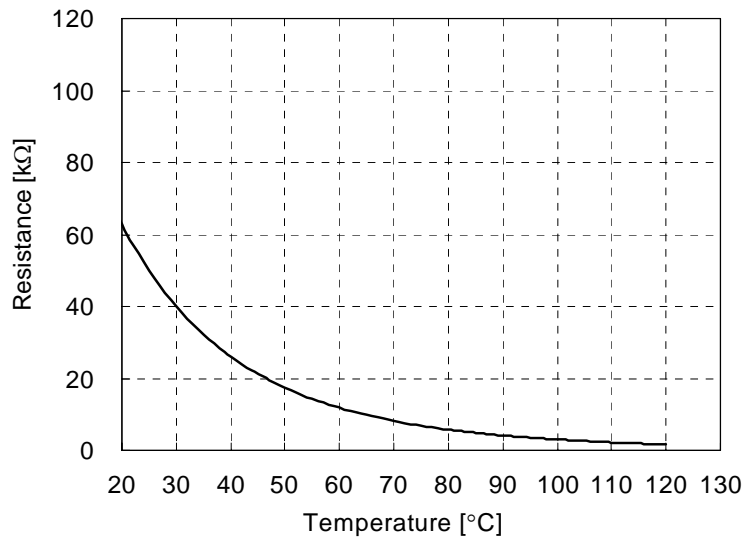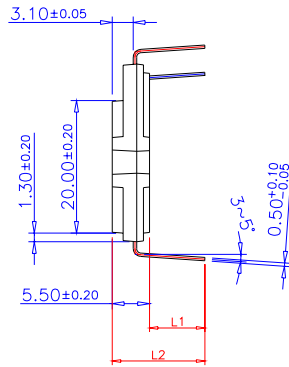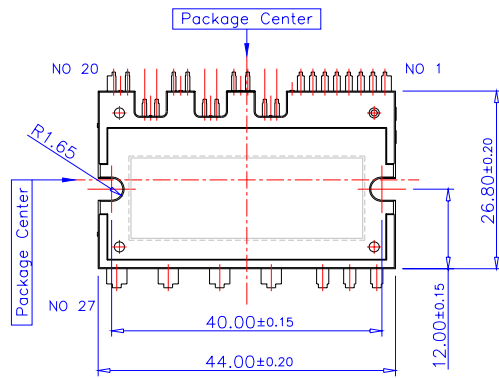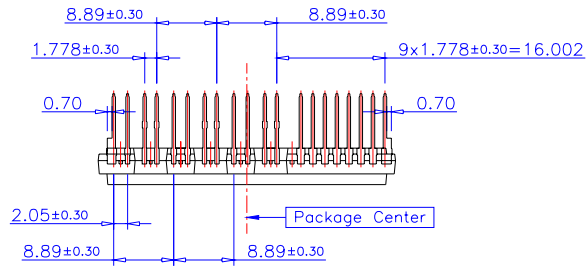
Fig. 8. Application Example

R-T Graph

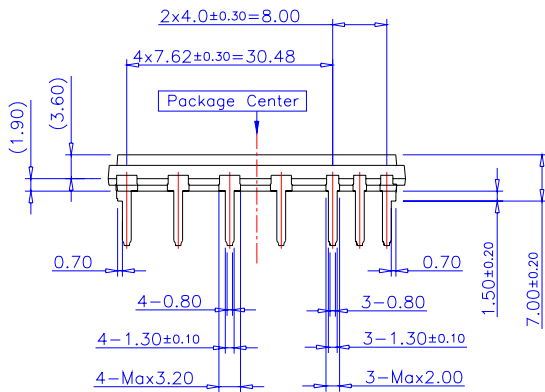**Fig. 9. R-T Curve of the Built-in Thermistor**
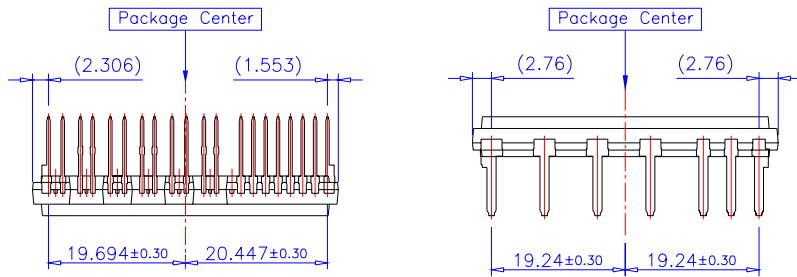
Detailed Package Outline Drawings

8.89±0.30   8.89±0.30

1.778±0.30   9x1.778±0.30=16.002

0.70   0.70

2.05±0.30   Package Center

8.89±0.30   8.89±0.30

Package Center

NO 20   NO 1

3.10±0.05

R1.65

Package Center

26.80±0.20

1.30±0.20   20.00±0.20   0.50±0.10/0.05

3~5°

NO 27   5.50±0.20

40.00±0.15   12.00±0.15   L1

44.00±0.20   L2

Lead Length Option

2x4.0±0.30=8.00

4x7.62±0.30=30.48

(1.90) (3.60)   Package Center

0.70   0.70

4-0.80   3-0.80   1.50±0.20   7.00±0.20

4-1.30±0.10   3-1.30±0.10

4-Max3.20   3-Max2.00

	L1	L2
	Lead Length	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 LENGTH TYPE 1

30.60
26.50
R0.70
R0.70
13.7±0.2
8.2±0.2
Package Center
11.92±0.30
27.95±0.30
4.10±0.30

LEAD LENGTH TYPE 2

30.60
26.50
R0.70
R0.70
11.1±0.2
5.6±0.2
Package Center
11.74±0.30
27.6±0.3
4.10±0.30

Lead Forming Dimension

Package Center

(2.306)   (1.553)

19.694±0.30   20.447±0.30

Package Center

(2.76)   (2.76)

19.24±0.30   19.24±0.30

PKG Center to Lead Distance

Detailed Package Outline Drawings

DETAIL LEAD

LEAD TYPE 2

LEAD TYPE 3   LEAD TYPE 1
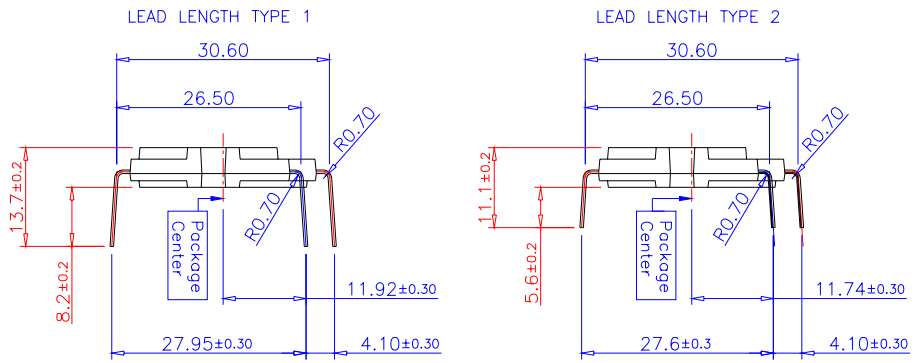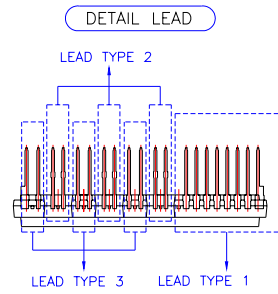
	L1 Lead Length	Y Length
Type 1	8.20±0.20	4.20±0.20
Type 2	5.60±0.20	1.60±0.20

0.50±0.15   0.50±0.15   0.50±0.15

X   X'

MAX1.20   MAX0.70   MAX0.85

LEAD TYPE 1   LEAD TYPE 2   LEAD TYPE 3

SCALE 2 : 1

0.50   0.70   0.50

0.50   0.50   0.50

LEAD TYPE 1   LEAD TYPE 2   LEAD TYPE 3
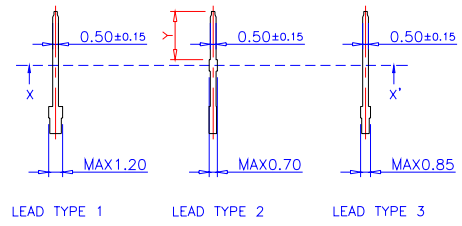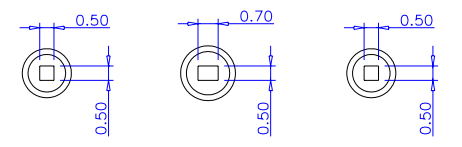
SCALE 5 : 1

LEAD SECTION X−X'

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FACT Quiet Series™		OPTOPLANAR™	SMART START™	Wire™

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SuperSOT™-3

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