



FPDB40PH60B

Smart Power Module for Front-End Rectifier

General Description

FPDB40PH60B 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 Al_2O_3 -DBC substrate
- 600V-40A 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

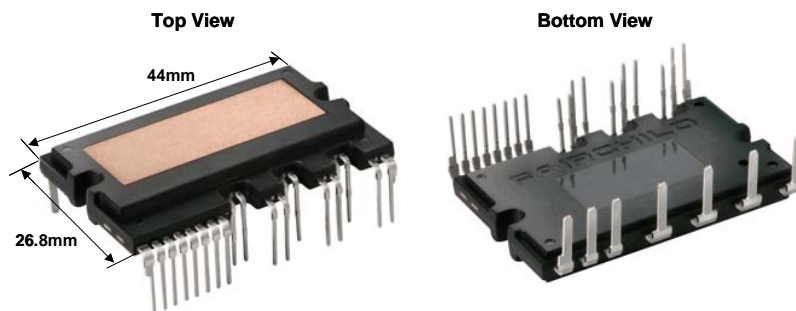


Fig. 1.

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

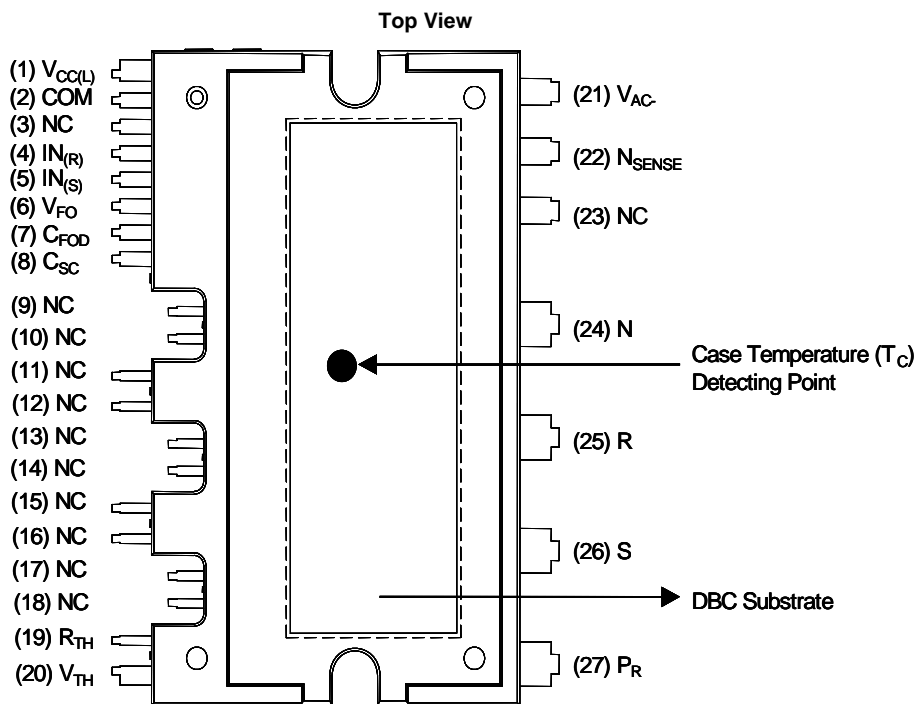
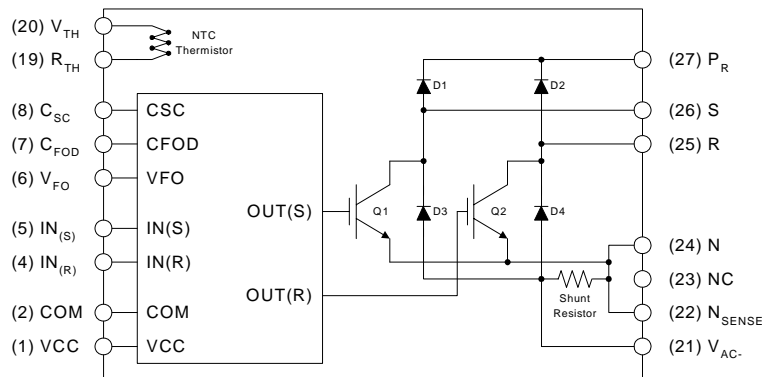


Fig. 2.

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 ($T_J = 25^\circ\text{C}$, 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	$\pm I_C$	$T_C = 25^\circ\text{C}$	40	A
Each IGBT collector current (Peak)	$\pm I_{CP}$	$T_C = 25^\circ\text{C}$, Under 1ms pulse width	70	A
Collector Dissipation	P_C	$T_C = 25^\circ\text{C}$ per One IGBT	113	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°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	-	-	1.1	$^\circ\text{C/W}$
	$R_{\theta(j-c)HD}$	High-side diode	-	-	1.9	$^\circ\text{C/W}$
	$R_{\theta(j-c)LD}$	Low-side diode	-	-	1.4	$^\circ\text{C/W}$

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	$V_{CE(sat)}$	$V_{CC} = 15\text{V}$, $V_{IN} = 5\text{V}$; $I_C = 40\text{A}$	-	1.8	2.3	V
High-side diode voltage	V_{FH}	$I_F = 40\text{A}$	-	2.2	2.7	V
Low-side diode voltage	V_{FL}	$I_F = 40\text{A}$	-	1.15	1.55	V
Switching Times	t_{ON}	$V_{PN} = 400\text{V}$, $V_{CC} = 15\text{V}$, $I_C = 40\text{A}$ $V_{IN} = 0\text{V} \leftrightarrow 5\text{V}$, Inductive Load (Note 3)	-	500	-	ns
	$t_{C(ON)}$		-	180	-	ns
	t_{OFF}		-	500	-	ns
	$t_{C(OFF)}$		-	90	-	ns
	t_{rr}		-	43	-	ns
	I_{rr}		-	6	-	A
Current sensing resistor	R_{SENSE}		1.8	2.0	2.2	m Ω
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}	$V_{CC} = 15\text{V}$, $I_N = 0\text{V}$ $V_{CC} - \text{COM}$	-	-	26	mA
Fault Output Voltage	V_{FOH}	$V_{SC} = 0\text{V}$, V_{FO} Circuit: 4.7k Ω to 5V Pull-up	4.5	-	-	V
	V_{FOL}	$V_{SC} = 1\text{V}$, V_{FO} Circuit: 4.7k Ω 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 Ω
		@ $T_C = 80^\circ\text{C}$ (Note Fig. 9)	-	5.76	-	k Ω

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/ μs
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

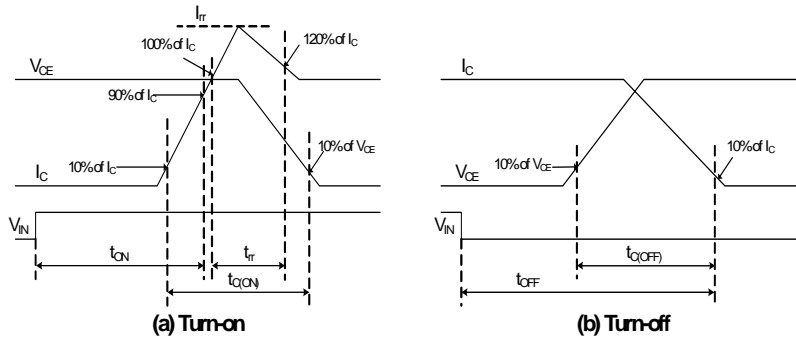


Fig. 4. Switching Time Definition

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

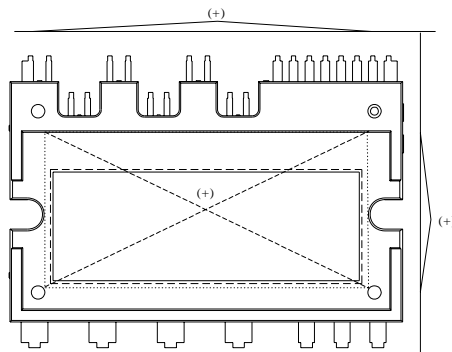
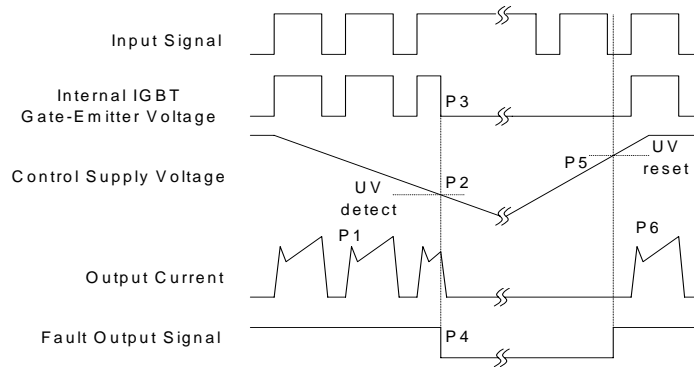


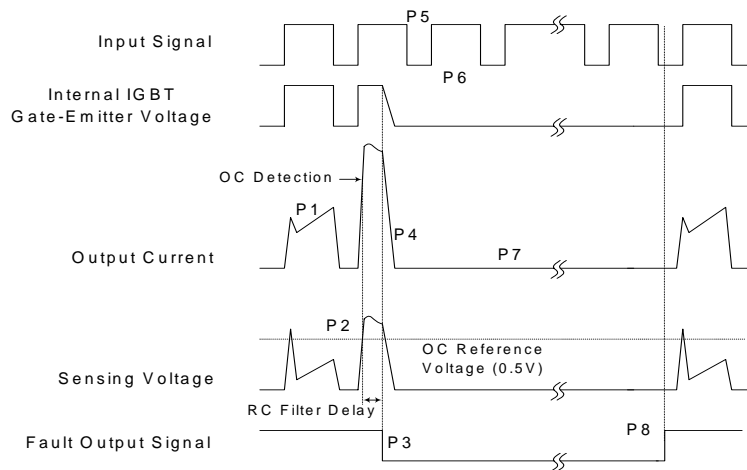
Fig. 5. Flatness Measurement Position

Time Charts of SPMs Protective Function



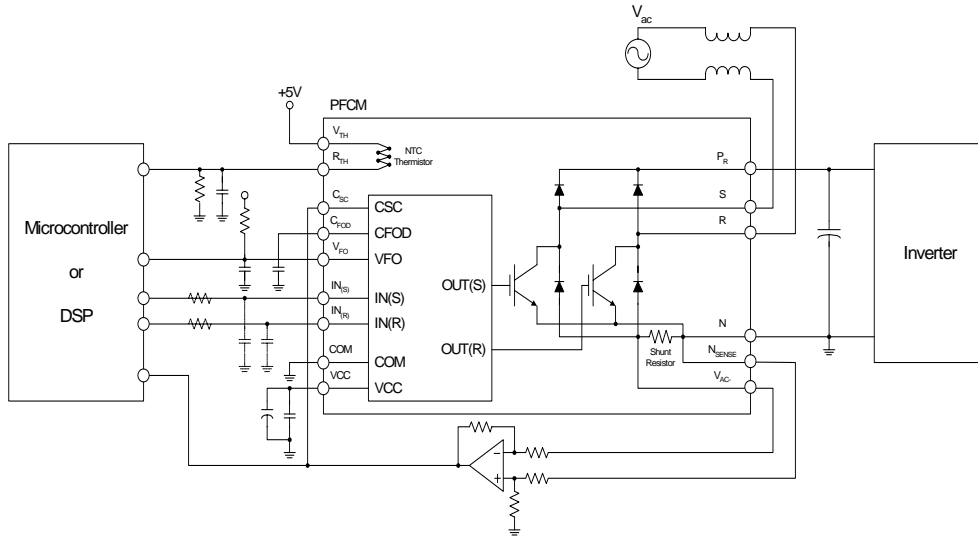
- P1 : Normal operation - IGBT ON and conducting current
- P2 : Under voltage detection
- P3 : IGBT gate interrupt
- P4 : Fault signal generation
- P5 : Under voltage reset
- P6 : Normal operation - IGBT ON and conducting current

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 μ s.

Fig. 8. Application Example

R-T Graph

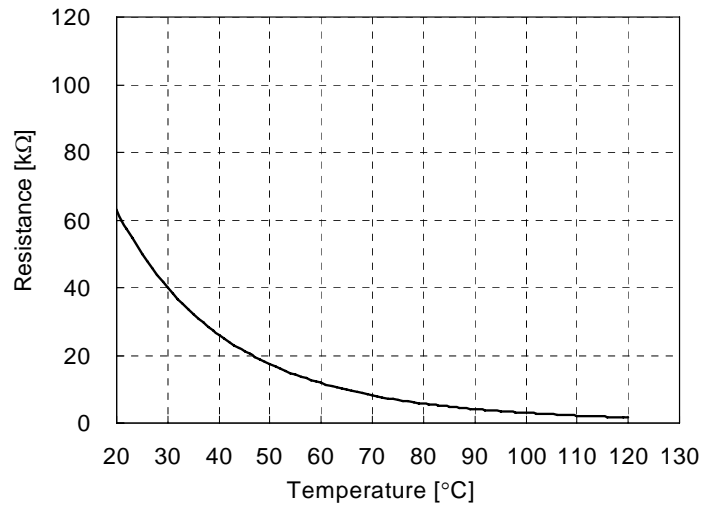
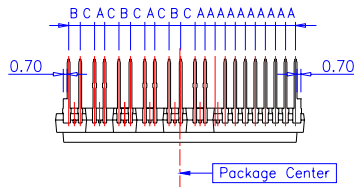
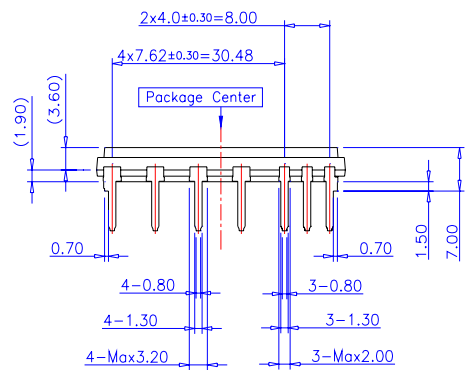
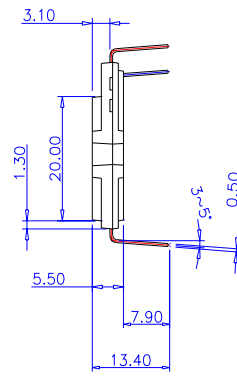
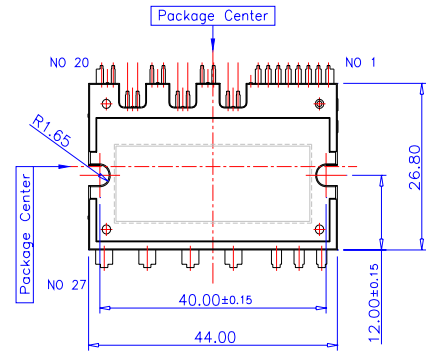


Fig. 9. R-T Curve of the Built-in Thermistor

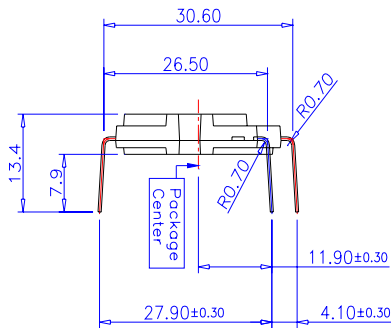
Detailed Package Outline Drawings



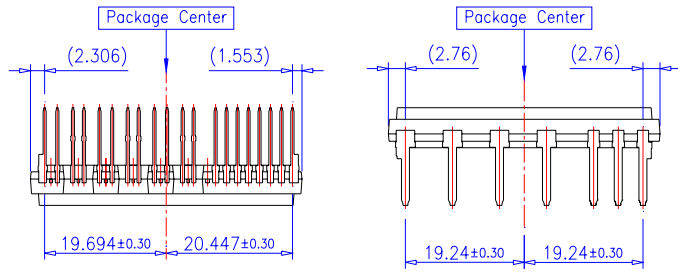
Lead Pitch : ± 0.30
 A : 1.778
 B : 2.050
 C : 2.531



Detailed Package Outline Drawings



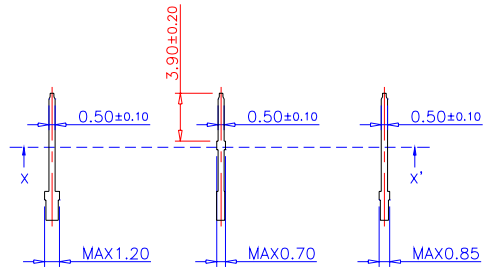
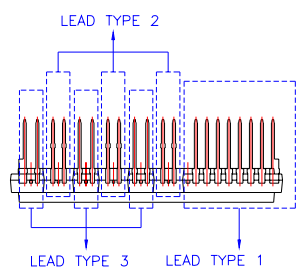
Lead Forming Dimension



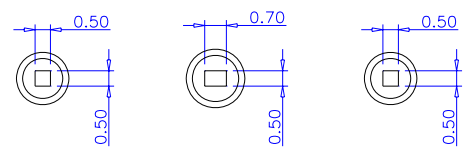
PKG Center to Lead Distance

Detailed Package Outline Drawings

DETAIL LEAD



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



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

LEAD SECTION X-X'

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