Chapter 1

Product Outline

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1. Introduction

The objective of this document is introducing Fuji IGBT Intelligent-Power-Module “Small-IPM”.
At first, the product outline of this module is described.
Secondary, the terminal symbol and terminology used in this note and the specification sheet are explained. Next, the design guideline on signal input terminals and power terminals are shown using its structure and behavior. Furthermore, recommended wiring and layout, and the mount guideline are given.

Feature and functions

1.1 Product concept

- 7th gen. IGBT technology offers high-efficiency and energy-saving operation.
- Guarantee $T_{j(ope)}$=150℃
- Higher accuracy of short circuit detection contribute to expanding over load operating area.
- Compatible pin assignment, foot print size and mounting dimensions as the 1st gen. Small IPM series.
- Product range: 15A – 35A / 600V.
- The total dissipation loss has been improved by improvement of the trade-off between the Collector-Emitter saturation voltage $V_{CE(sat)}$ and switching loss.

1.2 Built-in drive circuit

- Drives the IGBT under optimal conditions.
- The control IC of upper side arms have a built-in high voltage level shift circuit (HVIC).
- This IPM is possible for driven directly by a microprocessor. Of course, the upper side arm can also be driven directly. The voltage level of input signal is 3.3V or 5V.
- Since the wiring length between the internal drive circuit and IGBT is short and the impedance of the drive circuit is low, no reverse bias DC source is required.
- This IPM device requires four control power sources. One is a power supply for the lower side IGBTs and control ICs. The other three power supplies are power supplies for the upper side IGBTs with proper circuit isolation.
  The IPM doesn’t need insulated power supplies for the upper side drive because the IPM has built-in bootstrap diodes (BSD).

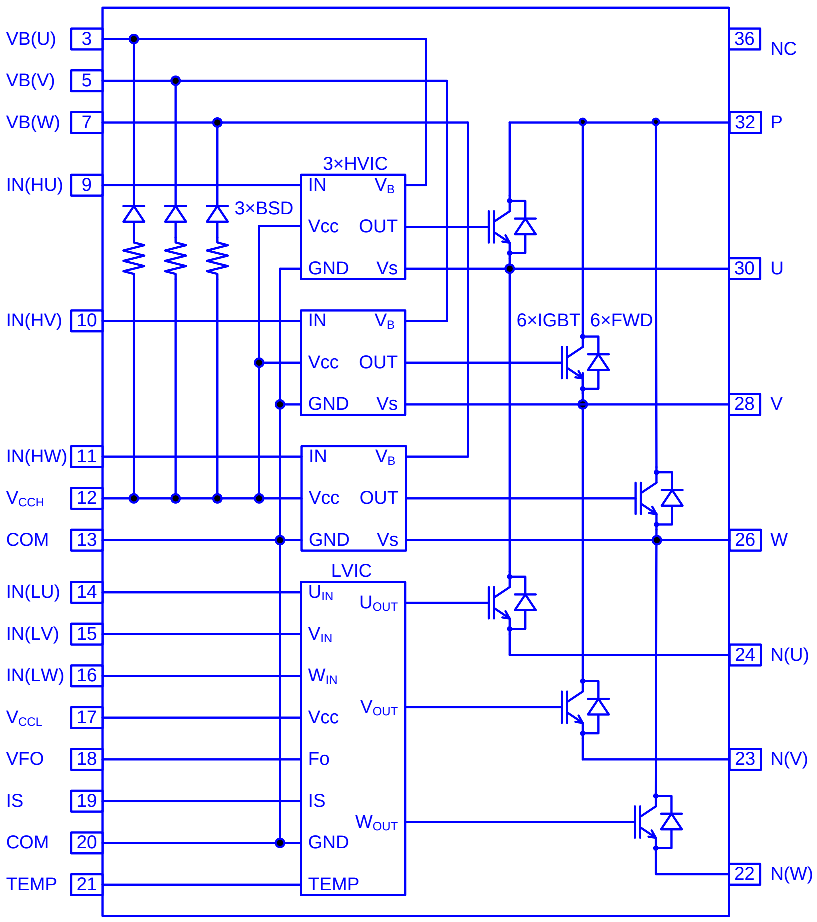


Fig. 1-1 Block Diagram of Internal Circuit

1.3 Built-in protection circuits

- The following built-in protection circuits are incorporated in the IPM device:
  - (OC): Over current protection
  - (UV): Under voltage protection for power supplies of control IC
  - (LT) or (OH): Temperature sensor output function or Overheating protection
  - (FO): Fault alarm signal output

- The OC protection circuits protect the IGBT against over current, load short-circuit or arm short-circuit. The protection circuit monitors the emitter current using external shunt resistor in each lower side IGBT and thus it can protect the IGBT against arm short-circuit.
- The UV protection circuit is integrated into all of the IGBT drive circuits and control power supply. This protection function is effective for a voltage drop of all of the high side drive circuits and the control power supply.
- The OH protection circuit protects the IPM from overheating. The OH protection circuit is built into the control IC of the lower side arm (LVIC).
- The temperature sensor output function enables to output measured temperature as an analog voltage (built in LVIC)
- The FO function outputs a fault signal, making it possible to shut down the system reliably by outputting the fault signal to a microprocessor unit which controls the IPM when the circuit detects abnormal conditions.

1.4 Compact package

- The package of this product includes with an aluminum base, which further improves the heat radiation.
- The control input terminals have a shrink pitch of 1.778mm (70mil).
- The power terminals have a standard pitch of 2.54mm (100mil).

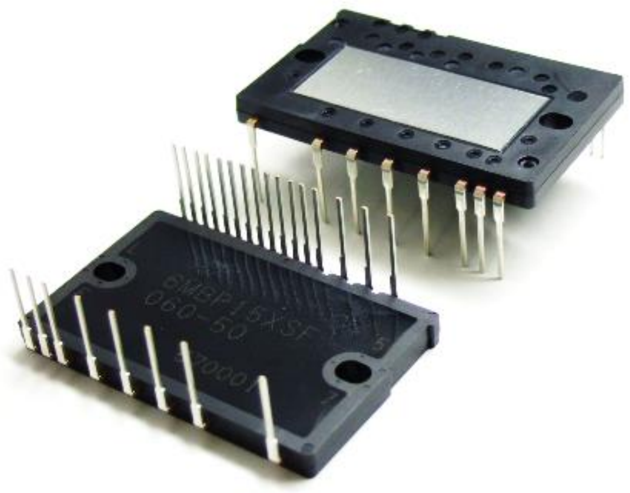


Fig.1-2 Package overview

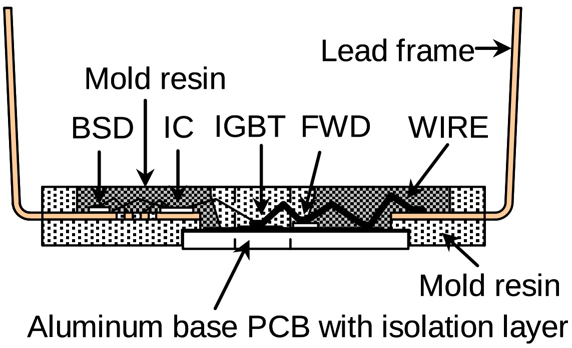


Fig.1-3 Package cross section diagram

2. Product line-up and applicable products for this manual

Table. 1-1 Line-up

Type name	Rating of IGBT Voltage [V]	Rating of IGBT Current [A]	Isolation Voltage [Vrms]	Variation	Target application
6MBP15XSD060-50	600	15	1500Vrms Sinusoidal 60Hz, 1min. (Between shorted all terminals and case)	LT*1	･Room air conditioner compressor drive ･Heat pump applications ･Fan motor drive ･General motor drive ･Servo drive
6MBP15XSF060-50				LT*1 OH*1	
6MBP20XSD060-50		20		LT*1	
6MBP20XSF060-50				LT*1 OH*1	
6MBP30XSD060-50		30		LT*1	
6MBP30XSF060-50				LT*1 OH*1	
6MBP35XSD060-50		35		LT*1	
6MBP35XSF060-50				LT*1 OH*1	

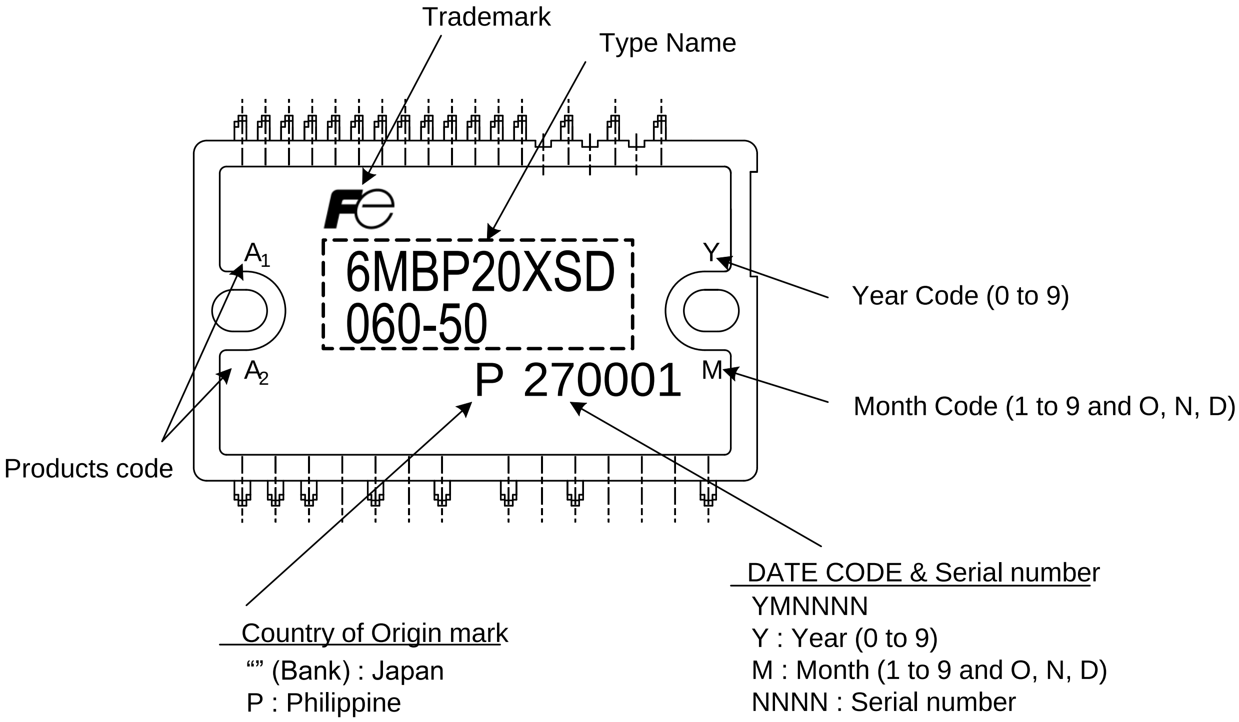
*1 (LT): Temperature sensor output function (LT)
(OH): Overheating protection function (OH)

3. Definition of Type Name and Marking Spec.

• Type name

6 MBP 20 X S D 060 –50

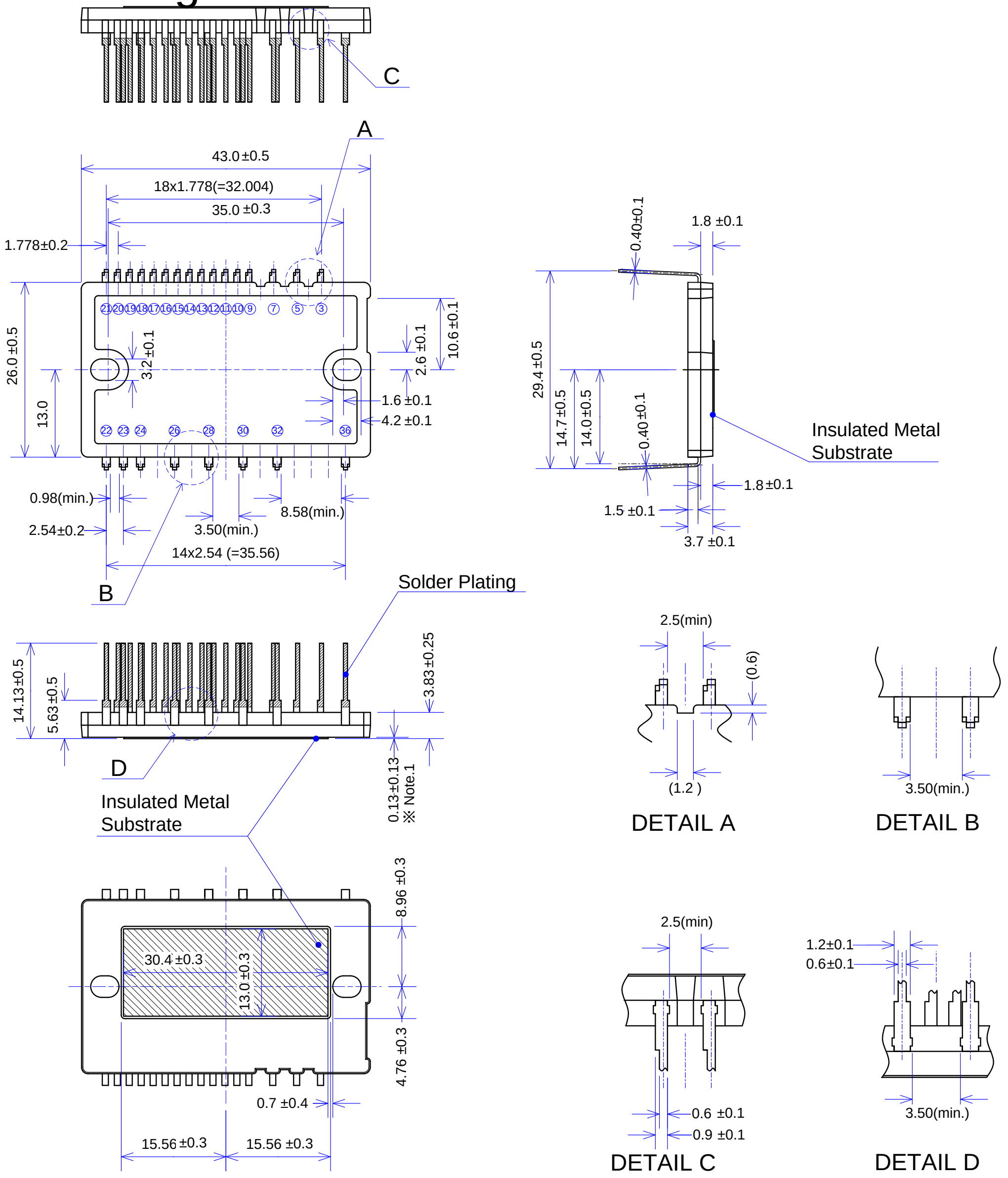
- –50: Additional model number (Option)
  50 : RoHS
- 060: Voltage rating
  060 : 600V
- D: Additional number of series
  D : Temperature sensor output
  F : Temperature sensor output and Over heating protection
- S: Series name
  S: Package type
- X: Series name
  X: Chip generation
- 20: IGBT current rating
  15: 15A, 20: 20A, 30: 30A, 35: 35A
- MBP: Indicates IGBT-IPM
- 6: Number of switch elements
  6 : 6-chip circuit of three phase bridge



TYPE NAME	PRODUCT CODE	
	A1	A2
6MBP15XSD060-50	L	D
6MBP15XSF060-50	L	F
6MBP20XSD060-50	M	D
6MBP20XSF060-50	M	F
6MBP30XSD060-50	O	D
6MBP30XSF060-50	O	F
6MBP35XSD060-50	P	D
6MBP35XSF060-50	P	F

Fig.1-4 Marking Specification

4. Package outline dimensions



Unit: mm

Note.1
The IMS (Insulated Metal Substrate) deliberately protruded from back surface of case.
It is improved of thermal conductivity between IMS and heat-sink.

Pin No.	Pin Name
3	VB(U)
5	VB(V)
7	VB(W)
9	IN(HU)
10	IN(HV)
11	IN(HW)
12	V_{CCH}
13	COM
14	IN(LU)
15	IN(LV)
16	IN(LW)
17	V_{CCL}
18	VFO
19	IS
20	COM
21	Temp

Pin No.	Pin Name
22	N(W)
23	N(V)
24	N(U)
26	W
28	V
30	U
32	P
36	NC

Fig.1-5. Case outline drawings

5. Absolute Maximum Ratings

An example of the absolute maximum ratings of 6MBP20XSD060-50 is shown in Table 1-2.

Table 1-2 Absolute Maximum Ratings at Tj=25°C,Vcc=15V (unless otherwise specified)

Item	Symbol	Rating	Unit	Description
DC bus Voltage	V_{DC}	450	V	DC voltage that can be applied between P-N(U),N(V),N(W) terminals
Bus Voltage (Surge)	$V_{DC(Surge)}$	500	V	Peak value of the surge voltage that can be applied between P-N(U),N(V),N(W) terminals during switching operation
Collector-Emitter Voltage	V_{CES}	600	V	Maximum collector-emitter voltage of the built-in IGBT chip and repeated peak reverse voltage of the FWD chip
Collector Current	$I_{C@25}$	20	A	Maximum collector current for the IGBT chip T_c=25°C, T_j=150°C
Peak Collector Current	$I_{CP@25}$	40	A	Maximum pulse collector current for the IGBT chip T_c=25°C, T_j=150°C
Diode Forward Current	$I_{F@25}$	20	A	Maximum forward current for the FWD chip T_c=25°C, T_j=150°C
Peak Diode Forward Current	$I_{FP@25}$	40	A	Maximum pulse forward current for the FWD chip T_c=25°C, T_j=150°C
Collector Power Dissipation	P_{D_IGBT}	41.0	W	Maximum power dissipation for one IGBT element at T_c=25°C, T_j=150°C
FWD Power Dissipation	P_{D_FWD}	27.8	W	Maximum power dissipation for one FWD element at T_c=25°C, T_j=150°C
Maximum Junction Temperature of Inverter Block	$T_{j(max)}$	+150	°C	Maximum junction temperature of the IGBT chips and the FWD chips
Operating Junction Temperature of Inverter Block	T_{jOP}	-40 ~ +150	°C	Junction temperature of the IGBT and FWD chips during continuous operation

Table 1-2 Absolute Maximum Ratings at Tj=25°C,Vcc=15V (Continued)

Item	Symbol	Rating	Unit	Descriptions
High-side Supply Voltage	V_{CCH}	-0.5 ~ 20	V	Voltage that can be applied between COM and V_{CCH} terminal
Low-side Supply Voltage	V_{CCL}	-0.5 ~ 20	V	Voltage that can be applied between COM and V_{CCL} terminal
High-side Bias Supply Voltage	$V_{B(U)-COM}$ $V_{B(V)-COM}$ $V_{B(W)-COM}$	-0.5 ~ 620	V	Voltage that can be applied between VB(U) terminal and COM, VB(V) terminal and COM,VB(W) terminal and COM.
High-side Bias Voltage for IGBT Gate Driving	$V_{B(U)}$ $V_{B(V)}$ $V_{B(W)}$	20	V	Voltage that can be applied between U terminal and VB(U) terminal , V terminal and VB(V) terminal , W terminal and VB(W) terminal.
Input Signal Voltage	V_{IN}	-0.5 ~ V_{CCH}+0.5 -0.5 ~ V_{CCL}+0.5	V	Voltage that can be applied between COM and each IN terminal
Input Signal Current	I_{IN}	3	mA	Maximum input current that flows from IN terminal to COM
Fault Signal Voltage	V_{FO}	-0.5 ~ V_{CCL}+0.5	V	Voltage that can be applied between COM and VFO terminal
Fault Signal Current	I_{FO}	1	mA	Sink current that flows from VFO to COM terminal
Over Current Sensing Input Voltage	V_{IS}	-0.5 ~ V_{CCL}+0.5	V	Voltage that can be applied between IS and COM terminal
Maximum Junction Temperature of Control Circuit Block	T_j	+150	°C	Maximum junction temperature of the control circuit block
Operating Case Temperature	T_c	-40 ~ +125	°C	Operating case temperature (temperature of the aluminum plate directly under the IGBT or the FWD)
Storage Temperature	T_{stg}	-40 ~ +125	°C	Range of ambient temperature for storage or transportation, when there is no electrical load
Isolation Voltage	V_{iso}	AC 1500	Vrms	Maximum effective value of the sine-wave voltage between the terminals and the heat sink, when all terminals are shorted simultaneously. (Sine wave = 60Hz / 1min)

The Collector Emitter Voltages specified in absolute maximum rating

The absolute maximum rating of collector-emitter voltage of the IGBT is specified below.

During operation of the IPM, the voltage between P and N(*) is usually applied to one phase of upper or lower side IGBT. Therefore, the voltage applied between P and N(*) must not exceed absolute maximum ratings of IGBT. The Collector-Emitter voltages specified in absolute maximum rating are described below.

N(*): N(U),N(V),N(W)

V_{CES} :Absolute Maximum rating of IGBT Collector Emitter Voltage.

V_{DC} :DC bus voltage Applied between P and N(*).

$V_{DC(Surge)}$:The total of DC bus voltage and surge voltage which generated by the wiring (or pattern) inductance from P-N(*) terminal to the bulk capacitor.

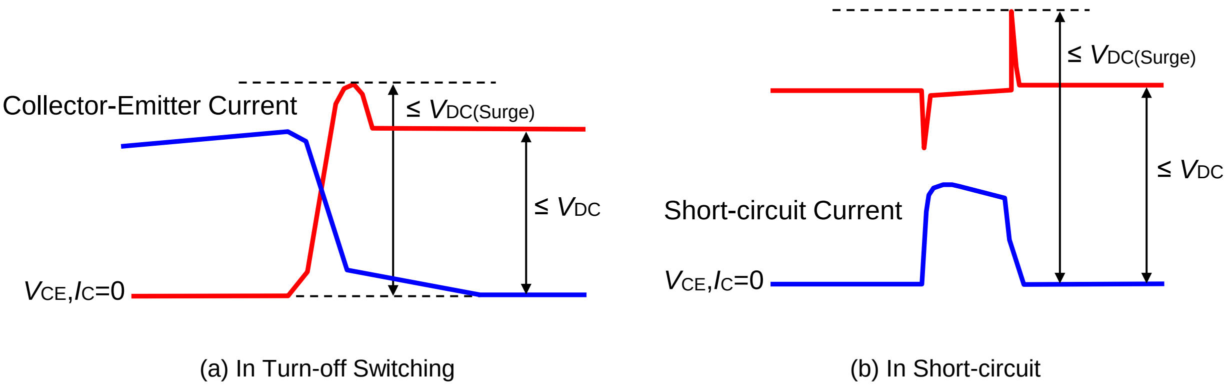


Fig. 1-6 The Collector- Emitter voltages to be considered.

Fig. 1-6 shows an example waveforms of turn-off and short-circuit of the IPM. The $V_{DC(surge)}$ is different in the each situation, therefore, V_{DC} should be set considering these situation.
V_{CES} represents the absolute maximum rating of IGBT Collector-Emitter voltage. And $V_{DC(Surge)}$ is specified considering the margin of the surge voltage which is generated by the wiring inductance in this IPM. Furthermore, V_{DC} is specified considering the margin of the surge voltage which is generated by the wiring (or pattern) stray inductance between the P-N(*) terminal and the capacitor.