# Product Outline

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1. Introduction

The objective of this note is introducing Fuji IGBT Intelligent-Power-Module “Compact Type”. 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 Built-in drive circuit

- IGBT gate drives operate under optimal conditions.
- Control IC of upper side arms are built-in the high voltage level shift circuit (HVIC).
- This IPM is possible for driven directly by the microprocessor. Of course, the upper side arm can also drive directly. 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 devices require four control power sources. One of power supplies is IGBT drive of the lower side arm and a power supply of control IC. The other three power supplies are power supplies of the IGBT drive of the upper side arm with proper circuit isolation.
- Thanks to the built-in bootstrap diodes for the power supplies of high side drive, it is needless to prepare other isolation power supplies for high side drive.

![Fig.1-1 Block Diagram of Internal circuit](image-url)
1.2 Built-in protection circuits

- The following built-in protection circuits are included in this IPM devices:
  - (OC): Over current protection
  - (UV): Under voltage protection for power supplies of control IC
  - (LT): Temperature sensor output function or (OH): Overheating protection
  - (FO): Fault status output

- The OC protection circuits provide protection against IGBT damage caused by over current, load short-circuits or arm short-circuits.
  These circuits monitor the emitter current using external shunt resistor in each lower side IGBT and thus can minimize the possibility of severe damage to the IGBTs.
  They also protect against arm short-circuits.
- The UV protection circuit is in all of the IGBT drive circuits.
  This circuit monitors the $V_{CCH}$, $V_{CCL}$ and $V_B^{(*)1}$ supply voltage level against the IGBT drive voltage.
- The OH protection circuit protects this IPM from overheating.
  This OH protection circuit is built into control IC of a lower side arm (LVIC).
- The FO function outputs an fault signal, making it possible to shutdown the system reliably by outputting the fault signal to the micro processor unit which controls this IPM when the circuit detects abnormal conditions.

1.3 Compact

- The package of this product with an aluminum base, which further improves the heat radiation ability.
- The control input terminals have a shrink pitch of 1.778mm(70mil).
- The power terminals have a standard pitch of 2.54mm(100mil).
- By improvement of the trade-off between the Collector-Emitter saturation voltage $V_{ce(sat)}$ and switching loss, the total loss has been improved.
2. Product line-up

<table>
<thead>
<tr>
<th>Type name</th>
<th>Rating of IGBT</th>
<th>Isolation Voltage [Vrms]</th>
<th>Variation</th>
<th>Main Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voltage [V]</td>
<td>Current [A]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6MBP15VRA060-50</td>
<td>600</td>
<td>15</td>
<td>LT*1</td>
<td>Room Air Conditioner Compressor drive</td>
</tr>
<tr>
<td>6MBP15VRB060-50</td>
<td>600</td>
<td>15</td>
<td>OH*1</td>
<td>Heat pump applications</td>
</tr>
<tr>
<td>6MBP15VRC060-50</td>
<td>600</td>
<td>15</td>
<td>LT*1</td>
<td>Fan Motor drive</td>
</tr>
<tr>
<td>6MBP15VRD060-50</td>
<td>600</td>
<td>15</td>
<td>OH*1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>15</td>
<td>LT*1</td>
<td></td>
</tr>
</tbody>
</table>

*1 (LT): Temperature sensor output function
(OH): Overheating protection
3. Definition of Type Name and Marking Spec.

- **Type Name**

6 MBP 15 VR A 060 –50

- Additional model number
  - 50 : RoHS

- Voltage rating
  - 060 : 600V

- Additional number of series
  - A, D: Temperature sensor output function
  - B : Case temperature overheating protection
  - C: Temperature sensor output and Over heating protection

- Series name
  - VR: Package type

- IGBT current rating
  - 15: 15A

- Indicates IGBT-IPM

- Number of transistor elements
  - 6: 6-chip circuit of three phase bridge

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**Fig.1-4 Marking Specification**

- **Trademark**
- **Type Name**
- **Country of Origin mark**
  - "(Blank) : Japan
  - P : Philippines

- **Products code**

- **DATE CODE & Serial number**
  - YMNNNN
  - Y: Year (00 to 99)
  - M: Month (1 to 9 and O,N,D)
  - NNNN: Serial number

- **Year Code (0 to 9)**
- **Month Code (1 to 9 and O,N,D)**
4. Package outline dimensions

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_{OH}
13  COM
14  IN(LU)
15  IN(LV)
16  IN(LW)
17  V_{OL}
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 6MBP15VRA060-50 is shown in Table 1-2.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Bus Voltage</td>
<td>VDC</td>
<td>450</td>
<td>V</td>
<td>DC voltage that can be applied between P-N(U),N(V),N(W) terminals</td>
</tr>
<tr>
<td>Bus Voltage (Surge)</td>
<td>VDC(Surge)</td>
<td>500</td>
<td>V</td>
<td>Peak value of the surge voltage that can be applied between P-N(U),N(V),N(W) terminals in switching</td>
</tr>
<tr>
<td>Collector-Emitter Voltage</td>
<td>VCES</td>
<td>600</td>
<td>V</td>
<td>Maximum collector-emitter voltage of the built-in IGBT chip and repeated peak reverse voltage of the FWD chip</td>
</tr>
<tr>
<td>Collector Current</td>
<td>ICG25</td>
<td>15</td>
<td>A</td>
<td>Maximum collector current for the IGBT chip Tc=25 °C, Tj=150 °C</td>
</tr>
<tr>
<td>Peak Collector Current</td>
<td>ICPE25</td>
<td>45</td>
<td>A</td>
<td>Maximum pulse collector current for the IGBT chip Tc=25 °C, Tj=150 °C</td>
</tr>
<tr>
<td>Diode Forward current</td>
<td>IFG25</td>
<td>15</td>
<td>A</td>
<td>Maximum forward current for the FWD chip Tc=25 °C, Tj=150 °C</td>
</tr>
<tr>
<td>Peak Diode Forward current</td>
<td>IFP@25</td>
<td>45</td>
<td>A</td>
<td>Maximum pulse forward current for the FWD chip Tc=25 °C, Tj=150 °C</td>
</tr>
<tr>
<td>Collector Power Dissipation</td>
<td>PD_IGBT</td>
<td>38.5</td>
<td>W</td>
<td>Maximum power dissipation for one IGBT element at Tc=25 °C, Tj=150 °C</td>
</tr>
<tr>
<td>FWD Power Dissipation</td>
<td>PD_FWD</td>
<td>20.5</td>
<td>W</td>
<td>Maximum power dissipation for one FWD element at Tc=25 °C, Tj=150 °C</td>
</tr>
<tr>
<td>Operating Junction Temperature of Inverter block</td>
<td>Tj</td>
<td>-40 ~ +150</td>
<td>°C</td>
<td>Junction temperature of the IGBT and FWD chips during continuous operation</td>
</tr>
<tr>
<td>High-side Supply Voltage</td>
<td>VCCH</td>
<td>-0.5~20</td>
<td>V</td>
<td>Voltage that can be applied between COM and VCCH terminal</td>
</tr>
<tr>
<td>Low-side Supply Voltage</td>
<td>VCCL</td>
<td>-0.5~20</td>
<td>V</td>
<td>Voltage that can be applied between COM and VCCL terminal</td>
</tr>
<tr>
<td>High-side Bias Supply Voltage</td>
<td>VB(U),COM</td>
<td>-0.5~620</td>
<td>V</td>
<td>Voltage that can be applied between VB(U), terminal and COM, VB(V), terminal and COM, VB(W), terminal and COM.</td>
</tr>
<tr>
<td>High-side Bias Supply Voltage</td>
<td>VB(V),COM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VB(W),COM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-side Bias Voltage for IGBT gate driving</td>
<td>VB(U)</td>
<td>20</td>
<td>V</td>
<td>Voltage that can be applied between U terminal and VB(U), terminal, V terminal and VB(V), terminal, W terminal and VB(W) terminal.</td>
</tr>
<tr>
<td></td>
<td>VB(V)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VB(W)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Signal Voltage</td>
<td>VIN</td>
<td>-0.5 ~ VCCH+0.5</td>
<td>V</td>
<td>Voltage that can be applied between COM and each Vin terminal</td>
</tr>
<tr>
<td>Input Signal Current</td>
<td>IN</td>
<td>3</td>
<td>mA</td>
<td>Current that flows between COM and each Vin terminal</td>
</tr>
<tr>
<td>Fault Signal Voltage</td>
<td>VFO</td>
<td>-0.5 ~ VCCL+0.5</td>
<td>V</td>
<td>Voltage that can be applied between COM and VFO terminal</td>
</tr>
<tr>
<td>Fault Signal Current</td>
<td>INFO</td>
<td>1</td>
<td>mA</td>
<td>Sink current that flows from VFO to COM terminal</td>
</tr>
<tr>
<td>Over Current sensing Input Voltage</td>
<td>VIS</td>
<td>-0.5 ~ VCCL+0.5</td>
<td>V</td>
<td>Voltage that can be applied between COM and IS terminal</td>
</tr>
<tr>
<td>Operating Junction Temperature of Control circuit block</td>
<td>Tj</td>
<td>-40 ~ +150</td>
<td>°C</td>
<td>Junction temperature of the control circuit block</td>
</tr>
</tbody>
</table>
Table 1-2 Absolute Maximum Ratings at $T_j=25^\circ C, Vcc=15V$ (Continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Case Temperature</td>
<td>$T_c$</td>
<td>-40 ~ +125</td>
<td>°C</td>
<td>Operating case temperature (temperature of the aluminum plate directly under the IGBT or the FWD)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>$T_{stg}$</td>
<td>-40 ~ +125</td>
<td>°C</td>
<td>Range of ambient temperature for storage or transportation, when there is no electrical load</td>
</tr>
<tr>
<td>Isolation Voltage</td>
<td>$V_{iso}$</td>
<td>AC 1500</td>
<td>$V_{rms}$</td>
<td>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)</td>
</tr>
</tbody>
</table>
The Collector Emitter Voltages specified in absolute maximum rating

In the absolute maximum rating, some items are specified on the collector emitter voltage of IGBTs below. In operating mode, the voltage between P and N(*) is usually applied to the one side 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 in following.

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.

There are two situations to be considered like Fig. 1-6. In this Fig., \( V_{DC(Surge)} \) is different in each situation. Thus, \( V_{DC} \) should be set considering these situation.

\( V_{CES} \) represents 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) inductance from P-N(*) terminal to the bulk capacitor.