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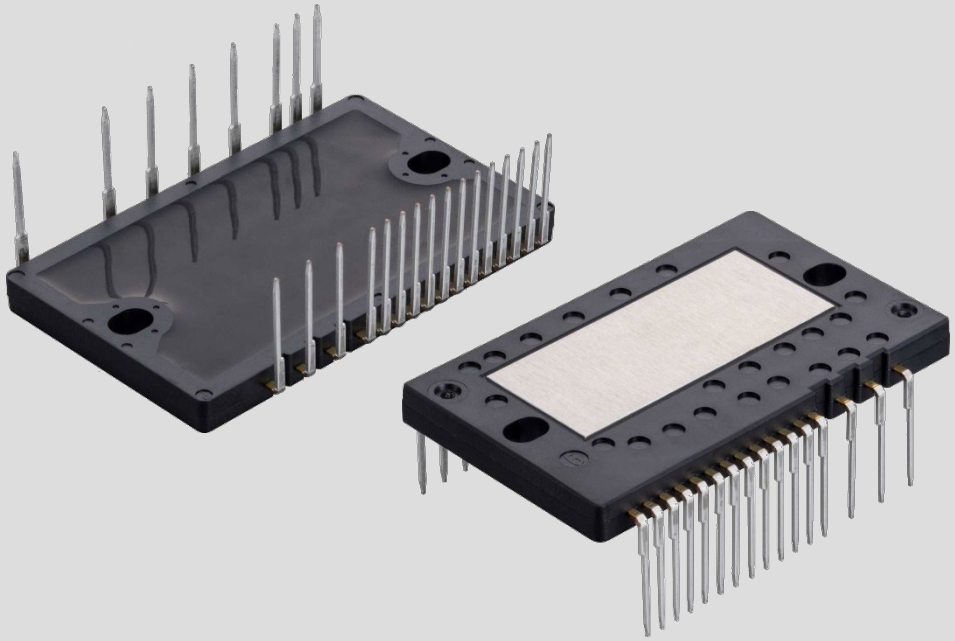


Small IPM (Intelligent Power Module)
P633C Series
6MBP**XS*065-50

Application Manual

August 2023

Fuji Electric Co., Ltd.

MT6M16945

Cautions

This Instruction contains the product specifications, characteristics, data, materials, and structures as of August 2023. The contents are subject to change without notice for specification changes or other reason. When using a product listed in this Instruction be sure to obtain the latest specifications.

The application examples in this note show the typical examples of using Fuji products and this note shall neither assure to enforce the industrial property including some other rights nor grant the license.

Although Fuji Electric Co., Ltd. continually strives to enhance product quality and reliability, a small percentage of semiconductor products may become faulty. When using Fuji Electric semiconductor products in your equipment, be sure to take adequate safety measures such as redundant, flame-retardant and fail-safe design in order to prevent a semiconductor product failure from leading to a physical injury, property damage or other problems.

The products described in this application manual are manufactured with the intention of being used in the following industrial electronic and electrical devices that require normal reliability.

- Compressor motor inverter
- Fan motor inverter for room air conditioner
- Compressor motor inverter for heat pump applications, etc.

If you need to use a semiconductor product in this application note for equipment requiring higher reliability than normal, such as listed below, be sure to contact Fuji Electric Co., Ltd. to obtain prior approval. When using these products, take adequate safety measures such as a backup system to prevent the equipment from malfunctioning when a Fuji Electric's product incorporated in the equipment becomes faulty.

- Transportation equipment (mounted on vehicles and ships)
- Trunk communications equipment
- Traffic-signal control equipment
- Gas leakage detectors with an auto-shutoff function
- Disaster prevention / security equipment
- Safety devices, etc.

Do not use a product in this application note for equipment requiring extremely high reliability such as:

- Space equipment
- Airborne equipment
- Atomic control equipment
- Submarine repeater equipment
- Medical equipment

If you have any question about any portion of this application note, ask Fuji Electric Co., Ltd. or its sales agencies. Neither Fuji Electric Co., Ltd. nor its agencies shall be liable for any injury or damage caused by any use of the products not in accordance with instructions set forth herein.

Chapter 2 Description of Terminal Symbols and Terminology

1. Description of Terminal Symbols

Table 2-1 describes the terminal symbols, and Table 2-2 to 2-6 explain the terminology.

Table 2-1 Description of Terminal Symbols

Pin No.	Pin Name	Pin Description
3	VB(U)	High side bias voltage for U-phase IGBT driving
5	VB(V)	High side bias voltage for V-phase IGBT driving
7	VB(W)	High side bias voltage for W-phase IGBT driving
9	IN(HU)	Signal input for high side U-phase
10	IN(HV)	Signal input for high side V-phase
11	IN(HW)	Signal input for high side W-phase
12	VCCH	High side control supply
13	COM	Common supply ground
14	IN(LU)	Signal input for low side U-phase
15	IN(LV)	Signal input for low side V-phase
16	IN(LW)	Signal input for low side W-phase
17	VCCL	Low side control supply
18	VFO	Fault output
19	IS	Over current sensing voltage input
20	COM	Common supply ground
21	TEMP	Temperature sensor output
22	N(W)	Negative bus voltage input for W-phase
23	N(V)	Negative bus voltage input for V-phase
24	N(U)	Negative bus voltage input for U-phase
26	W	Motor W-phase output
28	V	Motor V-phase output
30	U	Motor U-phase output
32	P	Positive bus voltage input
36	NC	No Connection

2. Description of Terminology

Table 2-2 Description of Terminology(Inverter block)

Item	Symbol	Description
Zero gate Voltage Collector current	I_{CE}	Collector current when a specified voltage is applied between the collector and emitter of an IGBT with all input signals L (=0V)
Collector-Emitter saturation voltage	$V_{CE(sat)}$	Collector-emitter voltage at a specified collector current when the input signal of only the element to be measured is H (= 5V) and the inputs of all other elements are L (=0V)
Forward voltage	V_F	Forward voltage at a specified forward current with all input signals L (=0V)
Turn-on time	t_{on}	The time from the input signal rising above the threshold value until the collector current becomes 90% of the rating. See Fig. 2-1.
Turn-on delay time	$t_{d(on)}$	The time from the input signal rising above the threshold value until the collector current decreases to 10% of the rating. See Fig. 2-1.
Turn-on rise time	t_r	The time from the collector current becoming 10% at the time of IGBT turn-on until the collector current becomes 90%. See Fig. 2-1.
V_{CE}-I_C Cross time of turn-on	$t_{c(on)}$	The time from the collector current becoming 10% at the time of IGBT turn-on until the V_{CE} voltage of IGBT dropping below 10% of the rating. See Fig. 2-1.
Turn-off time	t_{off}	The time from the input signal dropping below the threshold value until the V_{CE} voltage of IGBT becomes 90% of the rating. See Fig. 2-1.
Turn-off delay time	$t_{d(off)}$	The time from the input signal dropping below the threshold value until the collector current decreases to 90%. See Fig. 2-1.
Turn-on fall time	t_f	The time from the collector current becoming 90% at the time of IGBT turn-off until the collector current decreases to 10%. See Fig. 2-1.
V_{CE}-I_C Cross time of turn-off	$t_{c(off)}$	The time from the V_{CE} voltage becoming 10% at the time of IGBT turn-off until the collector current dropping below 10% of the rating. See Fig. 2-1.
Reverse Recovery time	t_{rr}	The time required for the reverse recovery current of the built-in diode to disappear. See Fig. 2-1.

Table 2-3 Description of Terminology(Control circuit block)

Item	Symbol	Description
Circuit current of Low-side drive IC	I_{CCL}	Current flowing between control power supply V_{CCL} and COM
Circuit current of High-side drive IC	I_{CCH}	Current flowing between control power supply V_{CCH} and COM
Circuit current of Bootstrap circuit	I_{CCHB}	Current flowing between upper side IGBT bias voltage supply VB(U) and U,VB(V) and V or VB(W) and W on the P-side (per one unit)

Table 2-3 (Continued)

Item	Symbol	Description
Input Signal threshold voltage	$V_{th(on)}$	Control signal voltage when IGBT changes from OFF to ON
	$V_{th(off)}$	Control signal voltage when IGBT changes from ON to OFF
Input Signal threshold hysteresis voltage	$V_{th(hys)}$	The hysteresis voltage between $V_{th(on)}$ and $V_{th(off)}$.
Operational input pulse width of turn-on	$t_{IN(ON)}$	Control signal pulse width necessary to change IGBT from OFF to ON. Refer to Chapter 3 section 4.
Operational input pulse width of turn-off	$t_{IN(OFF)}$	Control signal pulse width necessary to change IGBT from ON to OFF. Refer to Chapter 3 section 4.
Input current	I_{IN}	Current flowing between signal input IN(HU,HV,HW,LU,LV,LW) and COM.
Input pull-down resistance	R_{IN}	Resistance of resistor connected between each input terminals IN(HU,HV,HW,LU,LV,LW) and COM.
Fault Output voltage	$V_{FO(H)}$	Output voltage level of VFO terminal under the normal operation (The low-side arm protection function is not actuated.) with pull-up resistor 10kW.
	$V_{FO(L)}$	Output voltage level of VFO terminal after the low-side arm protection function is actuated.
Fault Output pulse width	t_{FO}	Period in which an fault status continues to be output (V_{FO}) from the VFO terminal after the low-side arm protection function is actuated. Refer to Chapter 3 section 6.
Over Current Protection voltage level	$V_{IS(ref)}$	Threshold voltage of IS terminal at the over current protection. Refer to Chapter 3 section 5.
Over Current Protection delay time	$t_{d(IS)}$	The time from the Over current protection triggered until the collector current becomes 50% of the rating. Refer to Chapter 3 section 5.
Output Voltage of temperature sensor	$V_{(temp)}$	The output voltage of temp. It is applied to the temperature sensor output model. Refer to Chapter 3 section 7.
LVIC overheating protection	T_{OH}	Tripping temperature of overheating protection. The temperature is monitored by LVIC. All low side IGBTs are shut down when the LVIC temperature exceeds T_{OH}. See Fig.2-2 and refer to Chapter 3 section 8.
LVIC overheating protection hysteresis	$T_{OH(hys)}$	Hysteresis temperature that does not reset the overheating protection operation. See Fig.2-2 and refer to Chapter 3 section 8. T_{OH} and $T_{OH(hys)}$ are applied to the overheating protection model.
V_{CC} Under Voltage Trip Level of Low-side	$V_{CCL(OFF)}$	Tripping voltage of the low-side control IC power supply. All low side IGBTs are shut down when the voltage of V_{CCL} drops below this threshold. Refer to Chapter 3 section 1.
V_{CC} under voltage reset level of Low-side	$V_{CCL(ON)}$	Resetting threshold voltage from under voltage trip status of V_{CCL}. Refer to Chapter 3 section 1.
V_{CC} under voltage hysteresis of Low-side	$V_{CCL(hys)}$	Hysteresis voltage between $V_{CCL(OFF)}$ and $V_{CCL(ON)}$.

Table 2-3 (Continued)

Item	Symbol	Description
V_{CC} Under Voltage Trip Level of High-side	$V_{CCH(OFF)}$	Tripping voltage of high-side control IC power supply. The IGBTs of high-side are shut down when the voltage of V_{CCH} drops below this threshold. Refer to Chapter 3 section 1.
V_{CC} Under Voltage Reset Level of High-side	$V_{CCH(ON)}$	Resetting threshold voltage from under voltage trip status of V_{CCH}. See Fig.3-3 Resetting voltage at which the IGBT performs shut down when the high-side control power supply voltage V_{CCH} drops. Refer to Chapter 3 section 1.
V_{CC} Under Voltage hysteresis of High-side	$V_{CCH(hys)}$	Hysteresis voltage between $V_{CCH(OFF)}$ and $V_{CCH(ON)}$.
V_B Under Voltage Trip Level	$V_{B(OFF)}$	Tripping voltage V_B(*) under voltage. The high-side IGBTs are shut down when the voltage of V_B(*) drops below this threshold. Refer chapter 3 section 2.
V_B Under Voltage Reset Level	$V_{B(ON)}$	Resetting voltage at which the IGBT performs shut down when the upper side arm IGBT bias voltage V_B(*) drops. Refer to Chapter 3 section 2.
V_B Under Voltage hysteresis	$V_{B(hys)}$	Hysteresis voltage between $V_{B(OFF)}$ and $V_{B(ON)}$.
Forward voltage of Bootstrap diode	$V_{F(BSD)}$	Forward voltage when a specified forward current flows through BSD.
Built-in limiting Series Resistance (BSD)	$R_{S(BSD)}$	Built-in current limiting resistor resistance value of bootstrap circuit.

*1 : $V_{B(*)}$ is applied between VB(U)-U, VB(V)-V, VB(W)-W.

Table 2-5 Thermal Characteristics

Item	Symbol	Description
Junction to Case Thermal Resistance (per single IGBT)	$R_{th(j-c)\_IGBT}$	Thermal resistance from the junction to the case of a single IGBT.
Junction to Case Thermal Resistance (per single FWD)	$R_{th(j-c)\_FWD}$	Thermal resistance from the junction to the case of a single FWD.

Table 2-6 Mechanical Characteristics

Item	Symbol	Description
Mounting torque of screws	M_S	Screwing torque when mounting the Small IPM to a heat sink with a specified screw.
Heat-sink side flatness	-	Flatness of a heat sink side. See Fig.2-3.
Weight	-	Weight of this product
Resistance to soldering heat	-	Soldering heat resistance

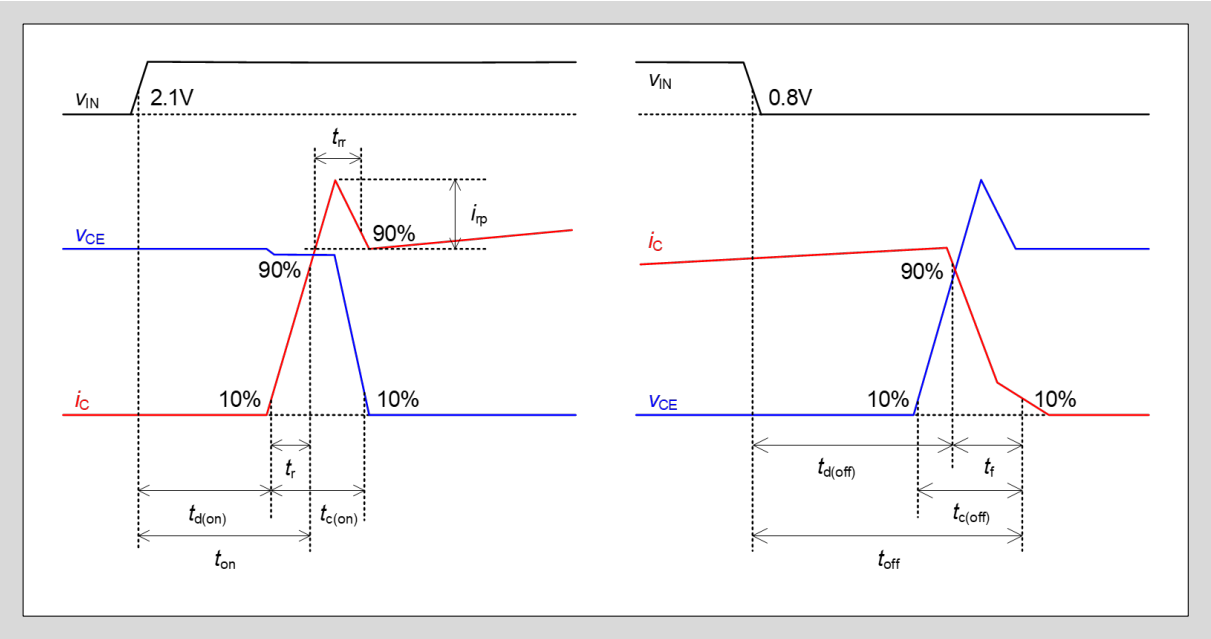


Fig.2-1 Switching waveforms

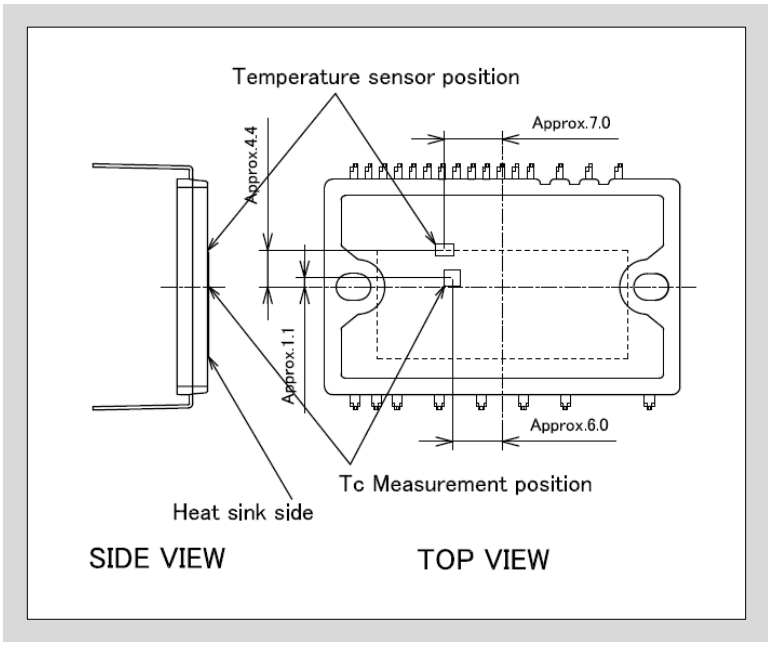
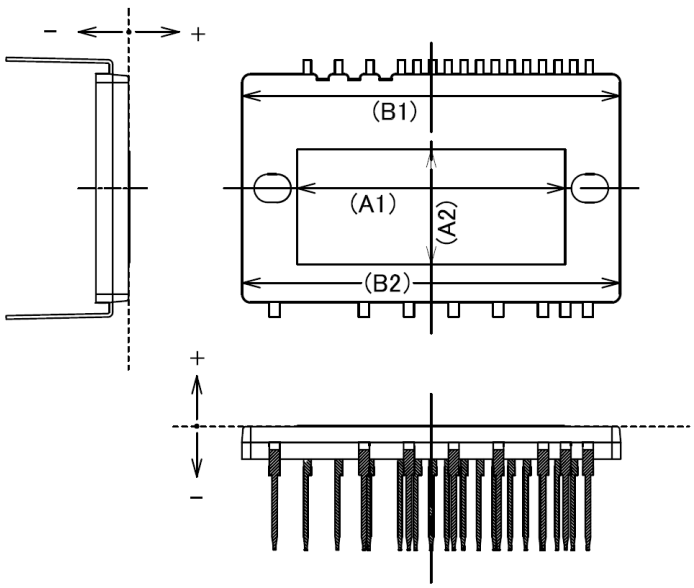


Fig.2-2 The measurement position of temperature sensor and Tc.



(A1),(A2): The AL-IMS part

(B1),(B2): The resin case part

Fig.2-3 The measurement point of heat-sink side flatness.