



Small IPM (Intelligent Power Module)

P642 Series

6MBP\*\*XT\*065-50

## Application Manual

## Cautions

This Instruction contains the product specifications, characteristics, data, materials, and structures as of April 2024. 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 relaying equipment      • Medical equipment

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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 7 Notes

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## 1. Precautions for Use

- This product shall be used within its maximum rating (voltage, current, temperature, and so on) described in this specification. This product may be broken in case of using beyond the maximum ratings. The specified value in the absolute maximum ratings are guaranteed value for the rating, not for any combination of ratings or characteristics. Even if this product is used within absolute maximum ratings, expected product lifetime may not be obtained depending on the temperature or usage environment. Please refer to the absolute maximum rating of this product, and judge the suitability of this product for your system / equipment after evaluation and verification by yourself.
- It shall be confirmed that IGBT's operating locus of the turn-off voltage and current are within the RBSOA specification. If the IGBT is used beyond the range of RBSOA, this product may be destroyed.
- If a voltage exceeding  $V_{CE(chip)}$  is applied, avalanche breakdown may occur and this product may be destroyed. Use this product so that  $V_{CE(chip)}$  is within the maximum rating.
- FWD of this product is not designed to be used as a diode rectifier (AC-DC conversion circuit).
- If a transient overvoltage that exceeds the voltage rating of the device in this product is propagated from the electric power supply to this product due to a lightning strike, etc., the overvoltage may destroy this product. If any transient overvoltage is expected to be applied from the electric power supply to line-line or line-ground, insert a surge absorber, etc. to suppress the voltage applied to this product in order to avoid damage.
- This product is not designed for use in parallel connection, so it cannot be used in parallel connection.
- If applied Printed Circuit Board is not suitable, the main pin terminals may have higher temperature than  $T_C$  (Case temperature). Also the main pin terminals shall be used within temperature range of  $T_C$  (Case temperature).
- This product are made of incombustible material. However, if this product fails, it may emit smoke or flame. Also, operating this product near any flammable place or material may cause this product to emit smoke or flame in case this product become even hotter during operation. Design the arrangement to prevent the spread of fire.
- Install surely a adequate fuse or breaker between the commercial power supply (three-phase line) and this product in case the system / equipment is destroyed by an accident to prevent secondary destruction such as fire, explosion, and fire spread.
- Do not directly touch the leads or package of this product while power is supplied or during operation in order to avoid electric shock and burns.
- In any environment containing corrosive gases, corrosive liquids, corrosive solids (acids, alkalis, organic substances, etc., ex: hydrogen sulfide, sulfurous acid gas, cutting fluid, cement powder etc.), this product may oxidize or corrode, resulting in poor contact, disconnection, short circuit, ground fault, etc. In such cases, avoid to use this product as it may cause malfunctions. In the unlikely event that a short circuit or ground fault occurs to this product, there is a secondary risk of smoke, fire, or explosion, etc. If this product is used under conditions containing these corrosive substances, Fuji Electric Co., Ltd. is not responsible regardless of the conditions (temperature, humidity, concentration, etc.).

- If this product is used in an environment with sudden temperature changes, it is expected that short circuits and ground faults will occur due to dew condensation. In the unlikely event that a short circuit or ground fault occurs to this product, there is a secondary risk of smoke, fire, or explosion, etc. Fuji Electric Co., Ltd. is not responsible for any use of the product in an environment where condensation may occur.
- If the product is used in a high humidity environment or after storage the equipment after assembling, operate the equipment after sufficiently releasing the moisture. If the product is operated in a moisture-absorbed state, it may cause electrical wiring defects or insulation defects inside of this product, and Fuji Electric Co., Ltd. is not responsible for the matters.
- This product is not designed for use in a dusty environment. When used in an environment where dust is generated, heat dissipation may deteriorate due to clogging of the heat sink, and short circuits or ground faults may occur due to leaks between terminals or creeping discharge. (Even if the dust is an insulating material such as fiber, it may leak due to moisture absorption.)
- In general, semiconductor devices have accidental failure modes due to high-speed particles (cosmic rays) derived from space or radiation. The failure rate in this failure mode varies depending on the installation location (latitude, longitude, altitude), installation environment, and operating conditions (voltage). In case the product is used under high altitude and/or voltage condition, please contact to Fuji Electric Co., Ltd.
- Clearance distance and creepage distance of this product are designed for adapting use environment in 2000 m sea level or below, Fuji Electric Co., Ltd. is not responsible for the use in an environment where the altitude exceeds 2000 m above sea level or in an environment where the atmospheric pressure is similarly low.
- If this product is used beyond its lifetime, this product performance and quality of the product may deteriorate before the target lifetime of the system / equipment, and in the worst case, this product may be destroyed. Use this product after fully understanding the usage environment of the system / equipment in which this product is installed and considering that this product satisfies the target lifetime.
- Consider the possible temperature rise not only for the junction and case, but also for the outer leads.
- When designing a new equipment, always refer to the latest mounting instructions.
- Make sure you follow the instructions in the application manual for a detailed usage, PCB layout and the installation, etc.
- Please connect an adequate ceramic capacitor near the VCCH(U)-COM terminal, VCCH(V)-COM terminal, VCCH(W)-COM terminal and VCCL-COM terminal in order that VCCH(U), VCCH(V), VCCH(W) and VCCL terminal might be not directly impressed high frequency noise such as switching noise.
- When the noise is input to each control terminal of this product, this product may malfunction. Please confirm that neither the instable operation nor the malfunction occurs by the noise and use this product.
- When  $V_{B(U)}$ ,  $V_{B(V)}$  and  $V_{B(W)}$  are less than  $V_{B(off)}$  due to noise, the corresponding upper side IGBTs may turn OFF. Please connect an adequate ceramic capacitor near the VB(U)-VS(U) terminal , VB(V)-VS(V) terminal and VB(W)-VS(W) terminal, respectively.

- The voltage of input signal must exceed the threshold voltage.
- Use this product below the power cycle lifetime curve (Technical Document No. : MT6M14324). Power cycle withstand capability is classified to  $\Delta T_{vj}$  mode which is stated as above and  $\Delta T_C$  mode. Since the  $\Delta T_C$  power cycle lifetime of this product depends on the thermal stress due to the rise and fall of the case temperature ( $T_C$ ), the lifetime of this product is greatly affected by the cooling design of the equipment installing this product. If the case temperature rises and falls frequently, or if the operating time at high temperature is long, use this product with paying sufficient attention to the product lifetime.
- If excessive stress (tension, pushing, bending) is applied to the main terminal and control terminal, the terminal may be deformed and the case resin may crack, causing poor contact and poor insulation. For the maximum allowable stress of the main terminal and control terminal, refer to the application manual of each package.
- If excessive static electricity is applied to the terminals, this product may be broken.
- When handling this product, be careful to avoid any breakdown due to the static electricity, take measures against static electricity.
- When handling this product, hold the case (package body) and do not touch the terminals. In case of touching the terminals of this product, discharge static electricity adhering to body or clothing by grounding through a high impedance resistor (approx.  $1M\Omega$ ) before touching.
- Work on grounded conductive floor or table mat are recommended.
- When soldering, in order to protect this product from static electricity, use antistatic soldering iron or soldering bath to prevent static electricity, and solder with low impedance resistor between soldering iron and ground.
- When jointing this product terminals with solder, soldering at an excessive high temperature may cause deterioration of the package. Please be careful about the soldering process. When used in the reflow soldering process, the solder inside this product may remelt and impair its quality. In this case, Fuji Electric Co., Ltd. is not responsible for this product performance and appearance.
- Use the tightening torque of the screws that mounting the product within the specified values. If the tightening torque is excessive, insulation failure may occur due to cracking of the case, and if the torque is small, the contact thermal resistance may increase and the heat generation of the device may increase. In addition, it is expected that the screws will loosen due to vibrations in the usage environment, so select screws that are difficult to loosen, tighten with appropriate torque, and retighten to prevent loosening.
- The product mounting surface of the heat sink should have flatness of  $50\ \mu\text{m}$  or less per  $100\ \text{mm}$  between the screw mounting positions and surface roughness of  $10\ \mu\text{m}$  or less. Excessive convex warpage may cause isolation breakdown of this product, resulting in a serious accident. Excessive concave warpage or distortion may create gaps between the product and the heat sink, resulting in poor heat dissipation and thermal destruction. When mounting this product on a heat sink, use thermal grease or equivalent to ensure cooling. In order to spread the thermal grease thinly and evenly, the flatness and surface roughness of the heat sink should be within the recommended values described in this specification. Due to insufficient applied amount or improper spreading method, thermal grease may not spread sufficiently over the entire mounting surface of this product, leading to thermal destruction due to poor heat dissipation. When applying thermal grease, make sure that the thermal grease is spread over the entire surface of the product. (By removing this product after mounting, the spread of thermal grease can be confirmed.)

- If the amount of thermal grease near this product mounting hole is excessive, the thermal grease acts as a spacer, hindering the spread of the thermal grease and causing deterioration of heat dissipation. In addition, depending on the type or application method of thermal grease, deterioration or depletion of thermal grease may occur during high-temperature operation or temperature cycle, which may shorten this product lifetime. Pay close attention to the selection and application method of the thermal grease. Please refer to the mounting instructions of this product for selection and application method of the thermal grease.

## 2. Precautions for Handling and Storage

- This product must be stored at a normal temperature of 5 to 35°C and relative humidity of 45 to 75%. If the storage area is very dry, a humidifier may be required. In such a case, use only deionized water or boiled water, since the chlorine in tap water may corrode the leads.
- This product should not be subjected to rapid changes in temperature to avoid condensation on the surface of this product. Therefore store this product in a place where the temperature is steady.
- This product should not be stored on top of each other, since this may cause excessive external force on the case.
- This product should be stored with the lead terminals remaining unprocessed. Rust may cause presoldered connections to fail during later processing.
- This product should be stored in antistatic containers or antistatic shipping bags.
- Under the above storage condition, use this product within one year.