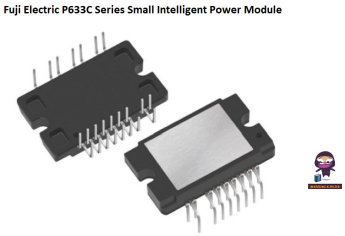

Fuji Electric P633C Series Small Intelligent Power Module User Manual

Contents

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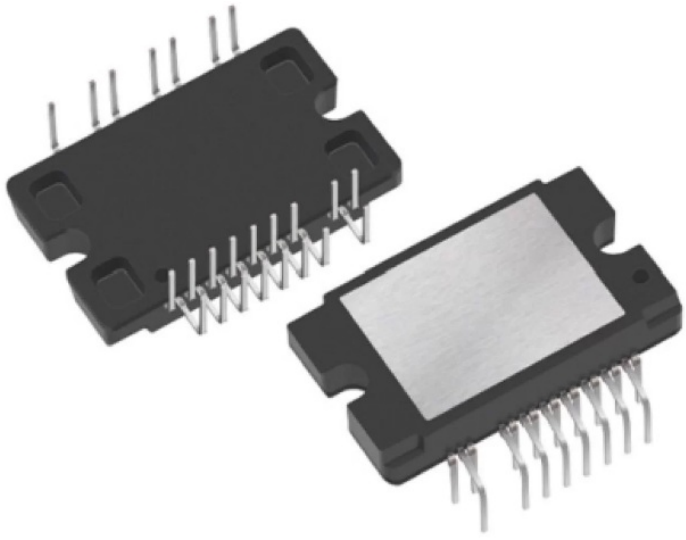
Fuji Electric P633C Series Small Intelligent Power Module



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 reasons. 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 enforcement of 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 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 to be 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 product is incorporated into 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

Chapter 5 Recommended wiring and layout

In this chapter, recommended wiring and layout are explained. In this section, tips and precautions in PCB designs are described with examples of application circuits.

Examples of Application Circuits

Fig. 5-1 and Fig.5-2 show examples of application circuits and their notes. In these figures, although two types of current detection methods are shown, and the notes are common.

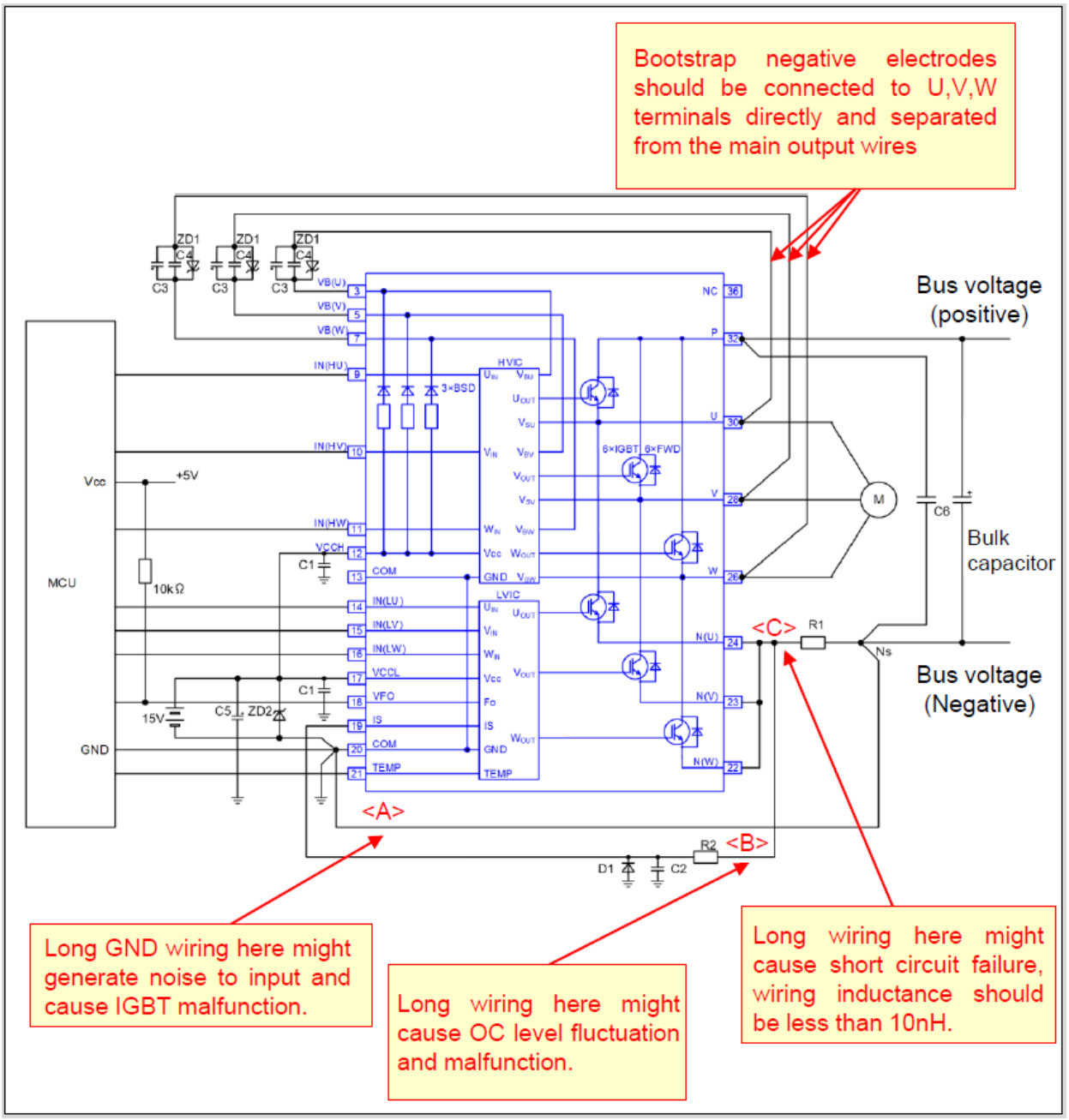
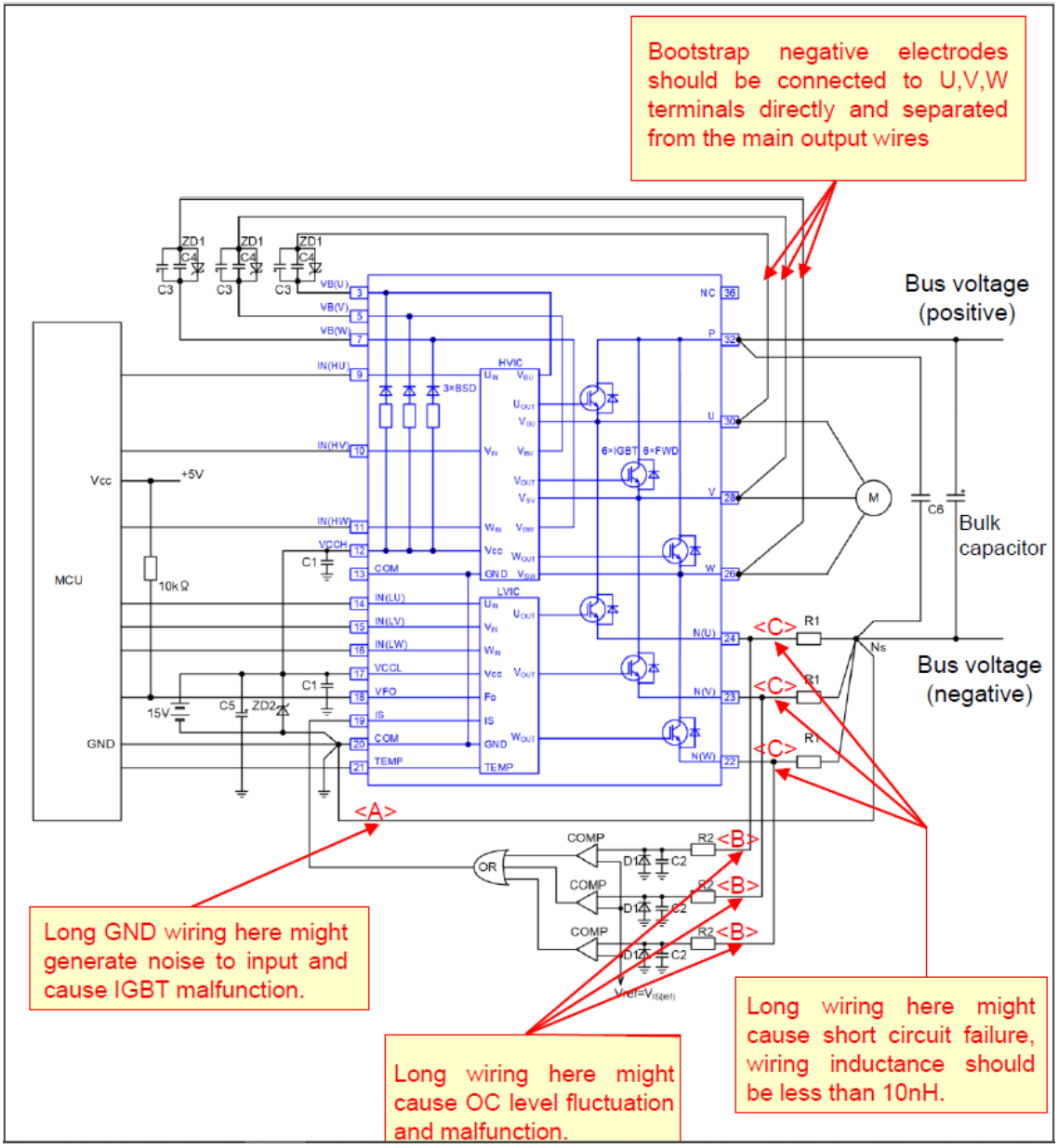


Fig. 5-1 Example of application circuit 1



(In case of sensing all 3 phase currents at once with a single shunt resistor)

1. The input signal for IGBT driving is High-Active. The input circuit of the IC has a built-in pull-down resistor. To prevent malfunction, the wiring of each input should be as short as possible. When using an RC filter, please make sure that the input signal level meets the turn-on and turn-off threshold voltage.
2. The product has built-in HVIC and thus it is possible to be connected to MPU directly without any photocoupler or pulse transformer.
3. VFO output is open drain type. It should be pulled up to the positive side of a 5V power supply by a resistor of about 10kΩ.
4. To prevent erroneous protection, the wiring of (A), (B), and (C) should be as short as possible.
5. The time constant R2-C2 of the protection circuit should be selected at approximately 0.7μs. Over-current (OC) shutdown time might vary due to the wiring pattern.
6. Tight tolerance and temp compensated type are recommended for R2 and C2.
7. It is recommended to set the threshold voltage of the comparator reference input to be the same level as the product OC trip reference voltage VIS(ref).
8. Please use a high-speed type comparator and logic IC to detect OC conditions quickly.
9. If a negative voltage is applied to R1 during the switching operation, connecting a Schottky barrier diode D1 is

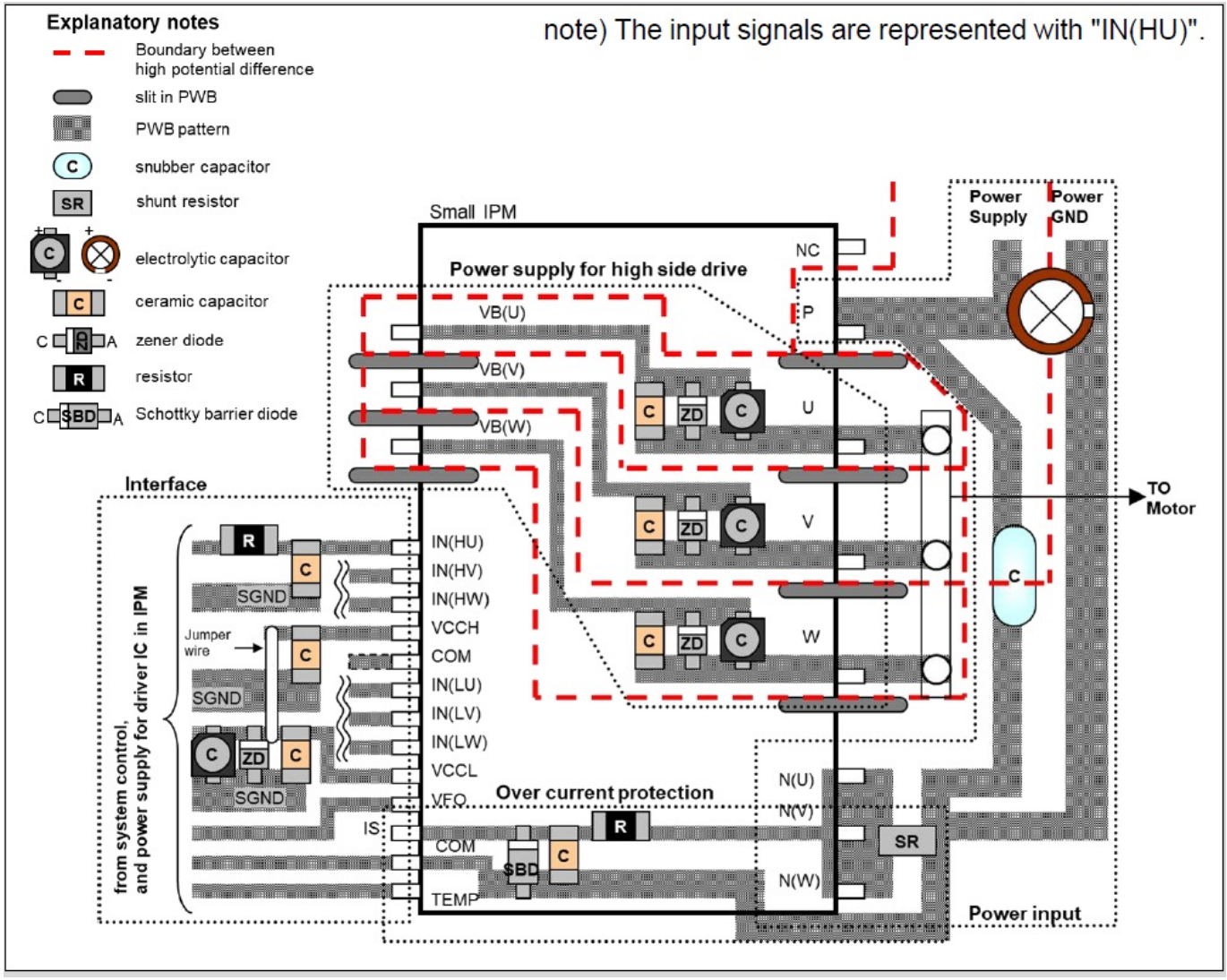
recommended.

10. All capacitors should be connected as close to the terminals of the product as possible. (C1, C4: ceramic capacitors with excellent temperature, frequency and DC bias characteristics are recommended; C3, C5: select an electrolytic capacitor considering the ripple current capability and lifetime.)
11. To prevent the destruction caused by surge voltage, the wiring between the snubber capacitor C6 and P terminal, Ns node should be as short as possible. Generally, a snubber capacitance of 0.1μF~0.22μF is recommended.
12. Two COM terminals (13 & 20 pins) are connected internally. Please connect either of the terminals to the signal GND and leave the other terminal open.
13. It is recommended to connect a Zener diode (22V) between each pair of control power supply terminals to prevent destruction caused by surge voltage.
14. If signal GND is connected to power GND by board pattern, there is the possibility of malfunction due to fluctuations at the power GND. It is recommended to connect signal GND and power GND at a single point.

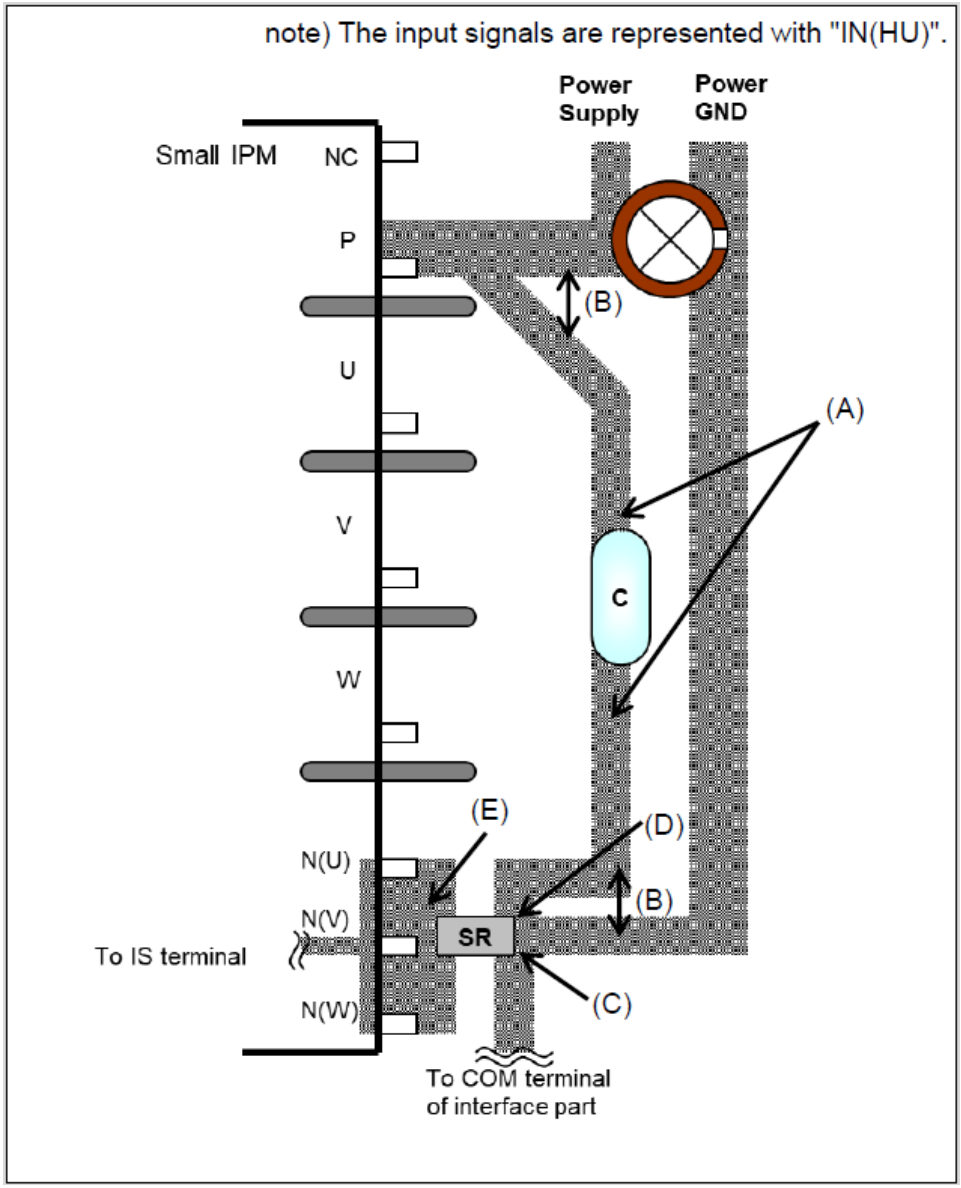
Recommendations and Precautions in PCB Design

In this section, the recommended pattern layout and precautions in PCB design are described. Fig.5-3 to Fig.5-7 show the images of the recommended PCB layout (referring to the example application circuit in Fig.5-1 and Fig.5-2). In these figures, the input signals from system control are represented with “IN(HU)”. The recommendations and precautions are as follows, Keep a relevant creepage distance at the boundary. (Place a slit between there if needed.)

The pattern of the power input (DC bus voltage) part and the power supply for high-side drive parts should be separated to prevent the increase of conduction noise. In case of crossing these wirings on the pattern in a multi-layer PCB, please take note of stray capacitance between wires and the insulation performance of the PCB. The pattern of the power supply for high side drive part and the input circuit of each phase part should be separated to avoid malfunction of the system. In the case of using multi-layer PCB, it is strongly recommended not to cross these wirings. Details of each part are described on the next page.

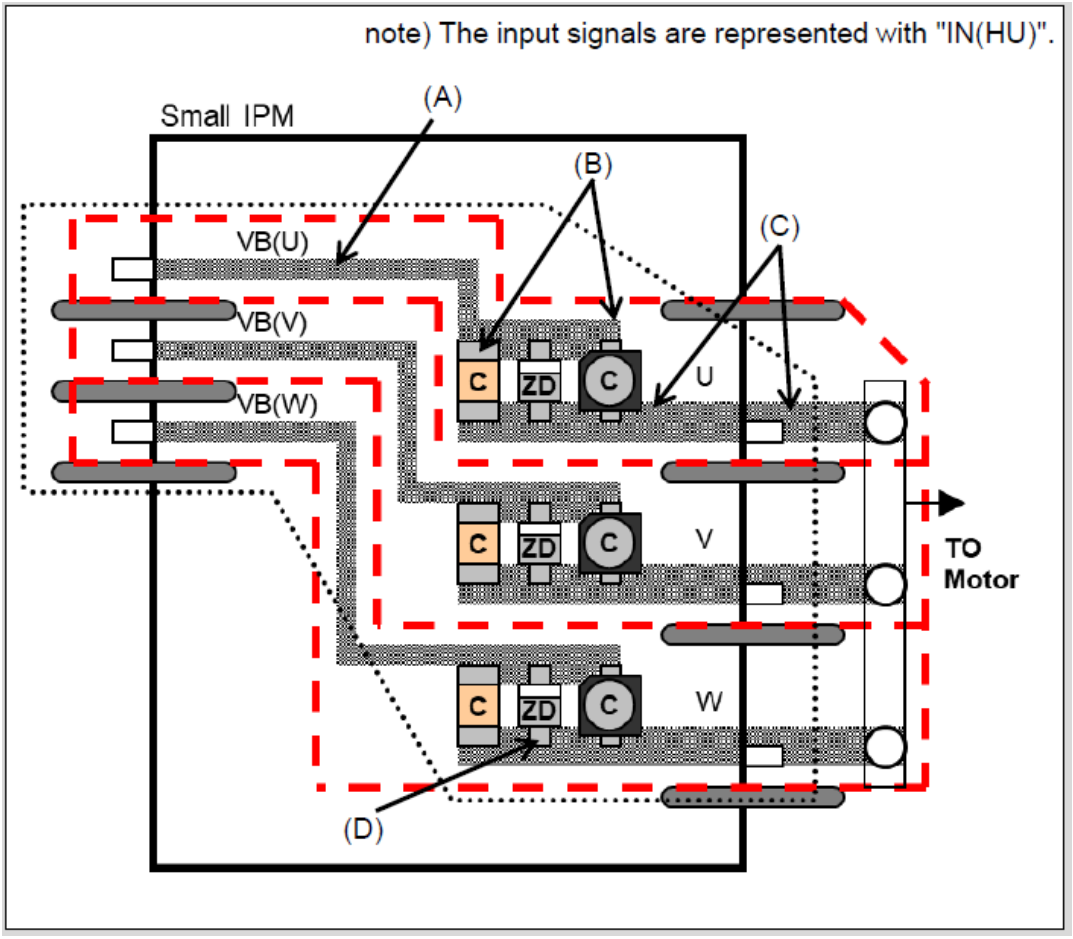


(A) Connect the snubber capacitor between the P terminal and the negative node of the shunt resistor as closely as possible. The pattern between the snubber capacitor and P terminal, and shunt resistor should be as short as possible to avoid the influence of pattern inductance. (B) The pattern of the bulk capacitor and snubber capacitor should be separated near the P terminal and shunt resistor. (C) The pattern from the power GND and COM terminal should be connected as close as possible to the shunt resistor with single-point grounding. (D) Please use a low-inductance shunt resistor. (E) The pattern between N(U), N(V), and N(W) terminals and the shunt resistor should be as short as possible.



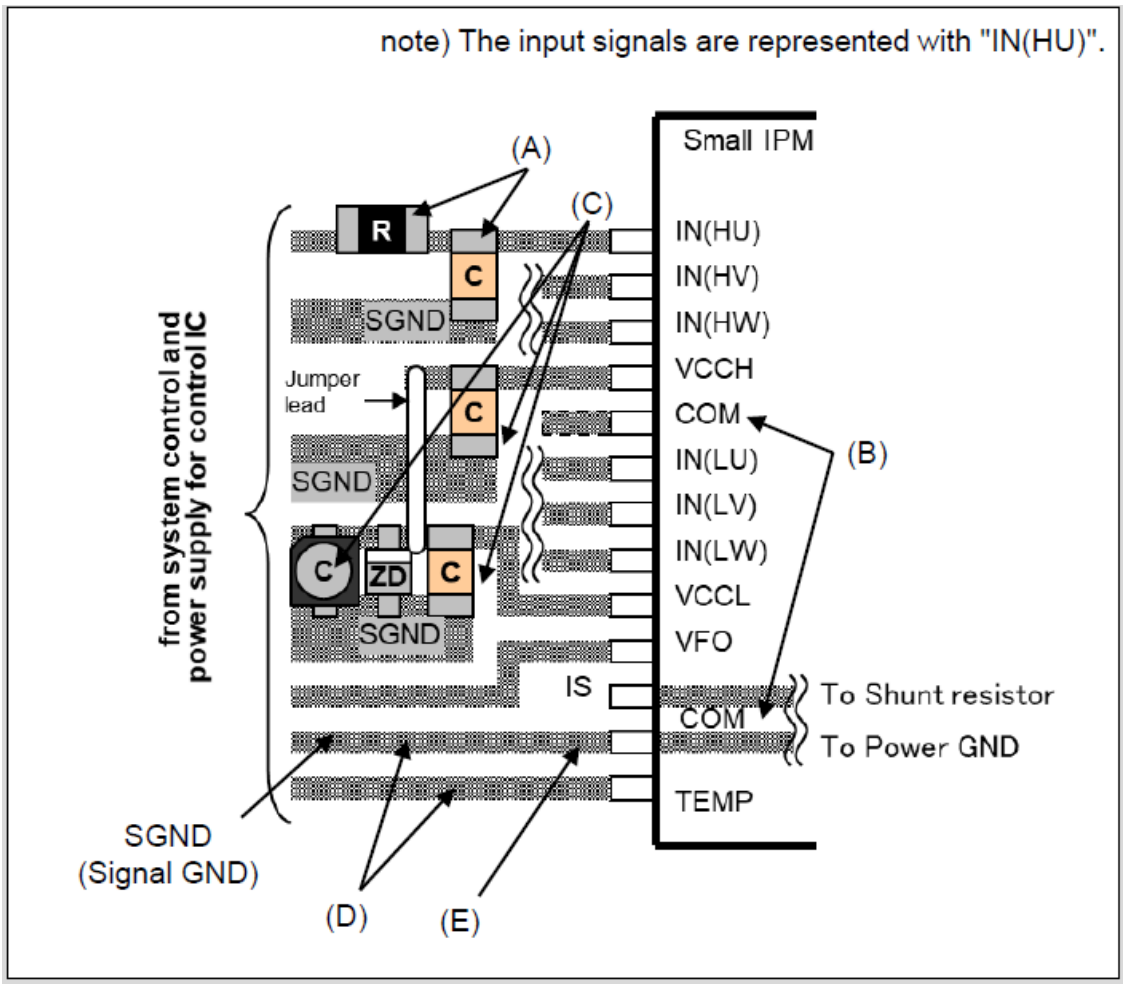
A) The pattern between VB(U), VB(V), VB(W) and the electronic components (ceramic capacitor, electrolytic capacitor and Zener diode) should be as short as possible to avoid the influence of pattern inductance. B) Please use the appropriate capacitor according to applications. Especially, please use ceramic capacitors or low-ESR capacitors close to VB(U), VB(V), and VB(W) terminals. C) The pattern to Motor output and negative pole of the capacitor connected to VB(U), VB(V), and VB(W) should be separated close to U, V and W terminals to avoid malfunction due to common impedance. D)

If the stray capacitance between VB(U) and power GND (or equal potential) is large, the voltage between VB(U) and U terminals might become overvoltage or negative voltage when IGBT turns on and off with high dV/dt. Therefore, connecting a Zener diode between VB(U) and U is recommended. It should be connected close to the VB(U) terminal. (The same applies to VB(V) and VB(W).)



(A) Please connect a capacitor between the input signal and COM terminal if the influence of noise from the power supply for the high side drive part (and so forth) is not negligible. The negative pole of the capacitor should be connected as close as possible to the pattern of signal GND near the COM terminal. If a filter resistor or capacitor is used, please take into account the internal pull-down resistors in this IPM and confirm the signal level in the actual system. (B) This product has two COM terminals that are connected internally.

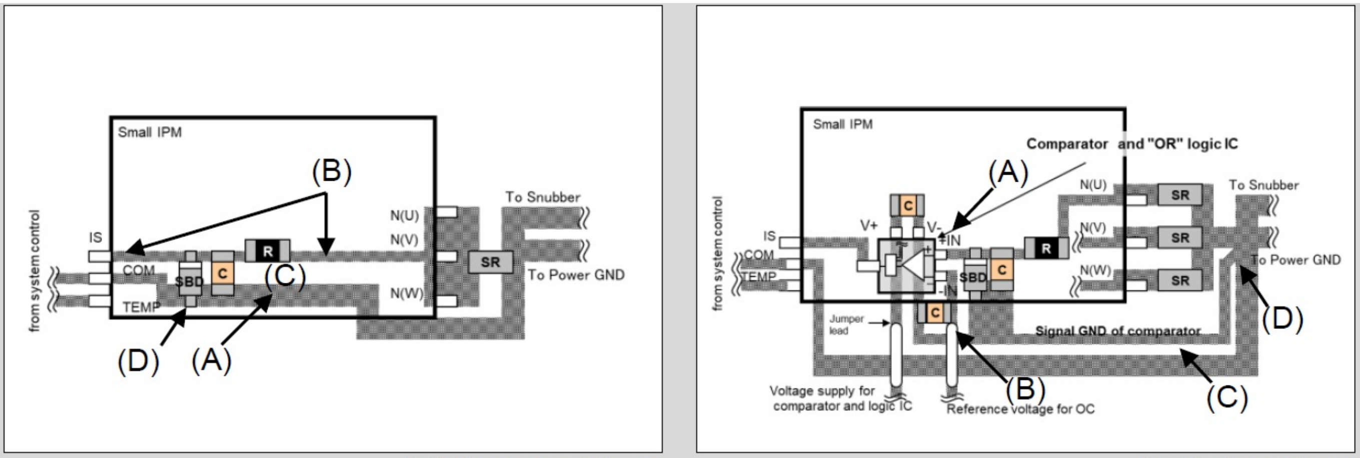
Please use either one. (C) Electrolytic capacitor and ceramic capacitor should be connected between VCCL and COM, VCCH and COM. These capacitors should be connected as close to each terminal as possible. (D) The output signal from the TEMP terminal should be parallel with Signal GND to minimize the effects of noise. (E) The pattern of Signal GND from system control and the pattern from the COM terminal should be connected at a single point ground. The single-point ground should be as close to the COM terminal as possible.



There are two methods to detect overcurrent (OC). Fig.5-7(a) shows the ‘one-shunt type’, and Fig.5- 7(b) shows the ‘3-shunt type’. Fig.5-7 (a) (A) The pattern between the negative pole of the shunt resistor and the COM terminal is very important. It is not only the reference zero level of the control IC but also the current path of the bootstrap capacitor charging current and gate driving current of low-side IGBTs.

Therefore, to minimize the impact of common impedance, this pattern should be as short as possible. (B) The pattern of the IS signal should be as short as possible to avoid OC level fluctuation and malfunction. (C) To prevent false detection during the switching operation, it is recommended to connect an RC filter to the IS terminal. The negative pole of this capacitor should be connected to the pattern of signal GND near the COM terminal. (D) If negative voltage is applied to the IS terminal during the switching operation, please connect a Schottky barrier diode between the IS and COM terminals or in parallel with the shunt resistor.

Fig.5-7 (b) (A) Please use high-speed type comparator and logic IC to detect OC conditions quickly. (B) The reference voltage level of OC which is inputted to the comparator should be coupled by a capacitor to signal GND. The capacitor should be as close to the comparator as possible. (C) The pattern of signal GND for the COM terminal and the pattern of signal GND for the comparator should be separated.



(a) One-shunt type (b) 3-shunt type

(D) The pattern of signal GND from COM and the pattern of signal GND of the comparator should be connected at a single point ground. The single-point ground should be as close to the shunt resistors as possible. (E) The other precautions and recommendations are the same as Fig.5-7 (a). Please refer to Chapter 4, Section 2 for more information on determining the circuit constant.

Documents / Resources

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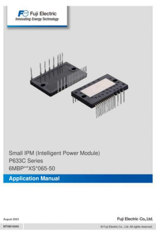	Fuji Electric P633C Series Small Intelligent Power Module [pdf] User Manual P633C Series Small Intelligent Power Module, P633C Series, Small Intelligent Power Module, Intelligent Power Module, Power Module, Module
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