Chapter 7

Trouble Shooting

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1 Trouble Shooting

In comparison to standard modules, IPMs have various protection functions (overcurrent, overheating, etc.) built in, so that their devices are not easily destroyed by abnormal conditions. However, destruction may occur depending on the abnormality, so that countermeasures are required once the cause and state of occurrence have been clarified. An analysis diagram indicating the cause of destruction is shown on page 2 and should be used to investigate the causes of destruction.
(For element fault judgment, refer to the Module Application Manual, chapter 4, item 2 "Fault Judgment Method".)

Also, in the case of alarm output from the IPM, use the alarm cause analysis diagrams of Fig. 7-2 to investigate the cause.

2 Fault Analysis Diagrams

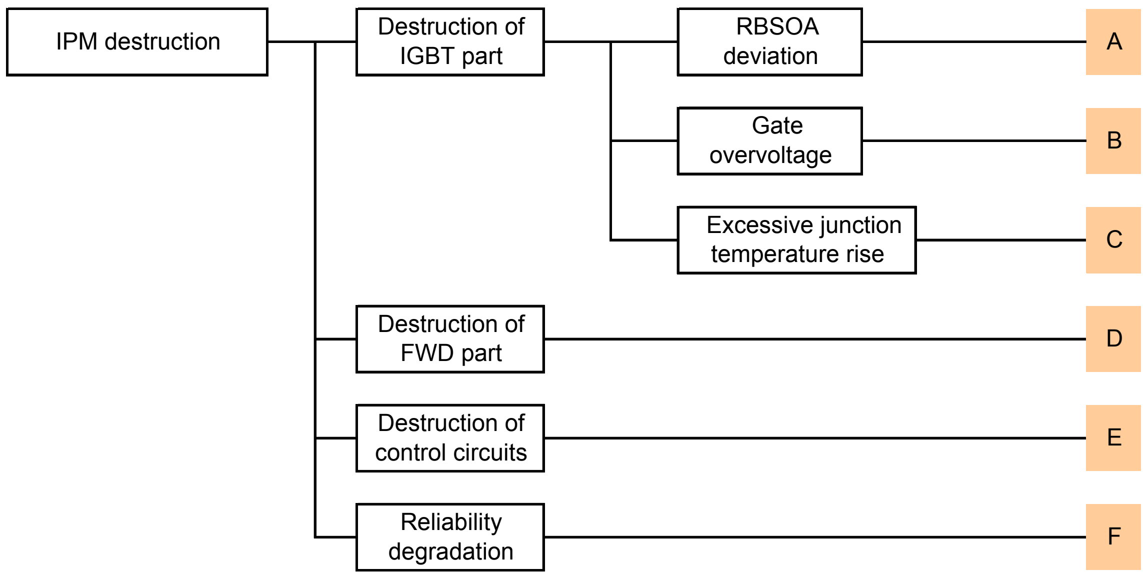

Fig. 7-1 (a.) IPM Fault Analysis Diagram (The letters A to F connect to the following diagrams.)

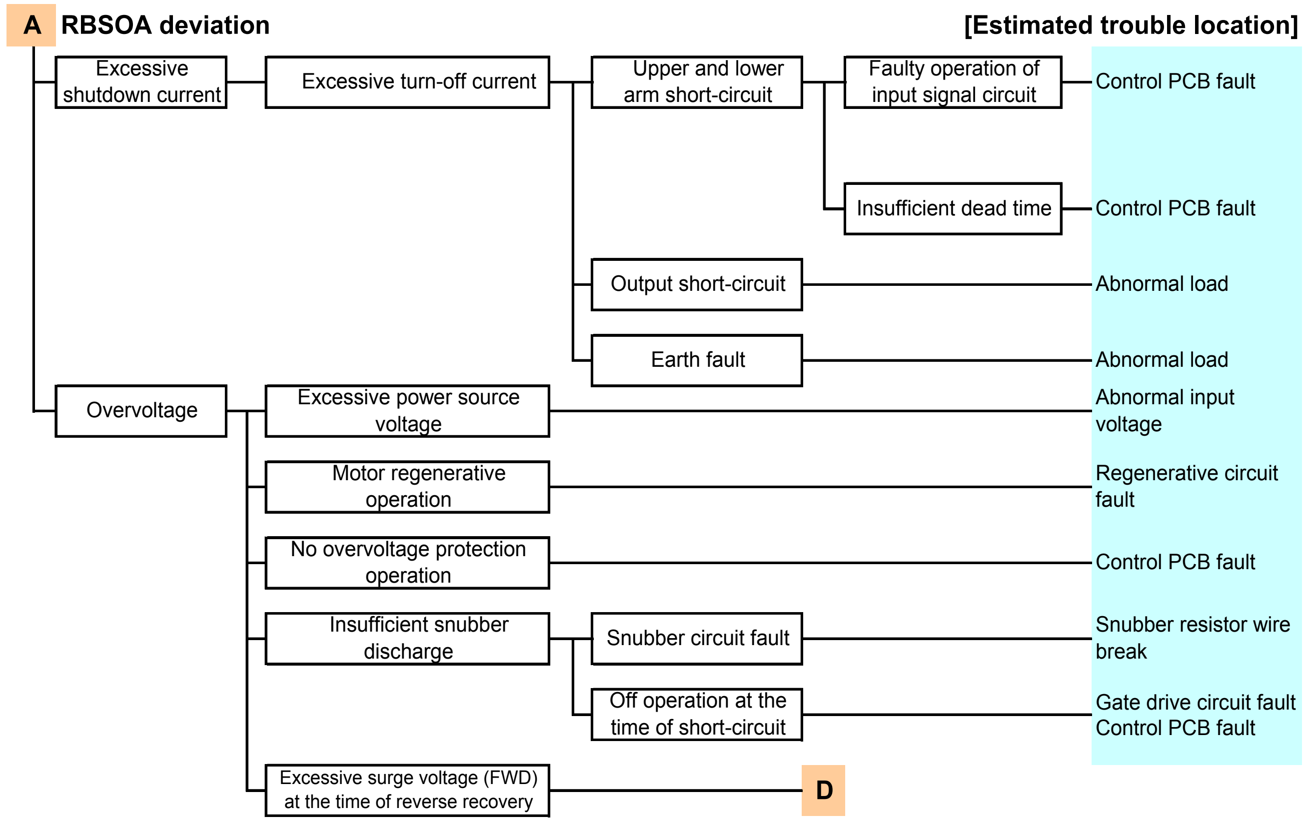

Fig. 7-1 (b) Mode A: RBSOA Deviation

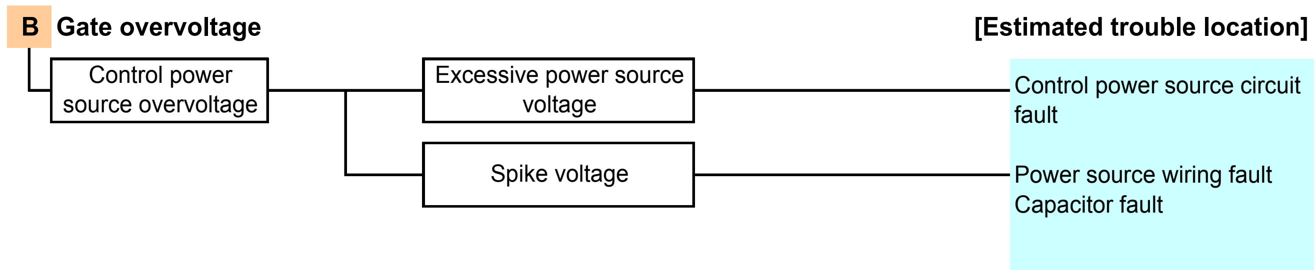

Fig. 7-1 (c) Mode B: Gate Overvoltage

C Excessive junction temperature rise (rapid temperature rise)

[Estimated trouble location]

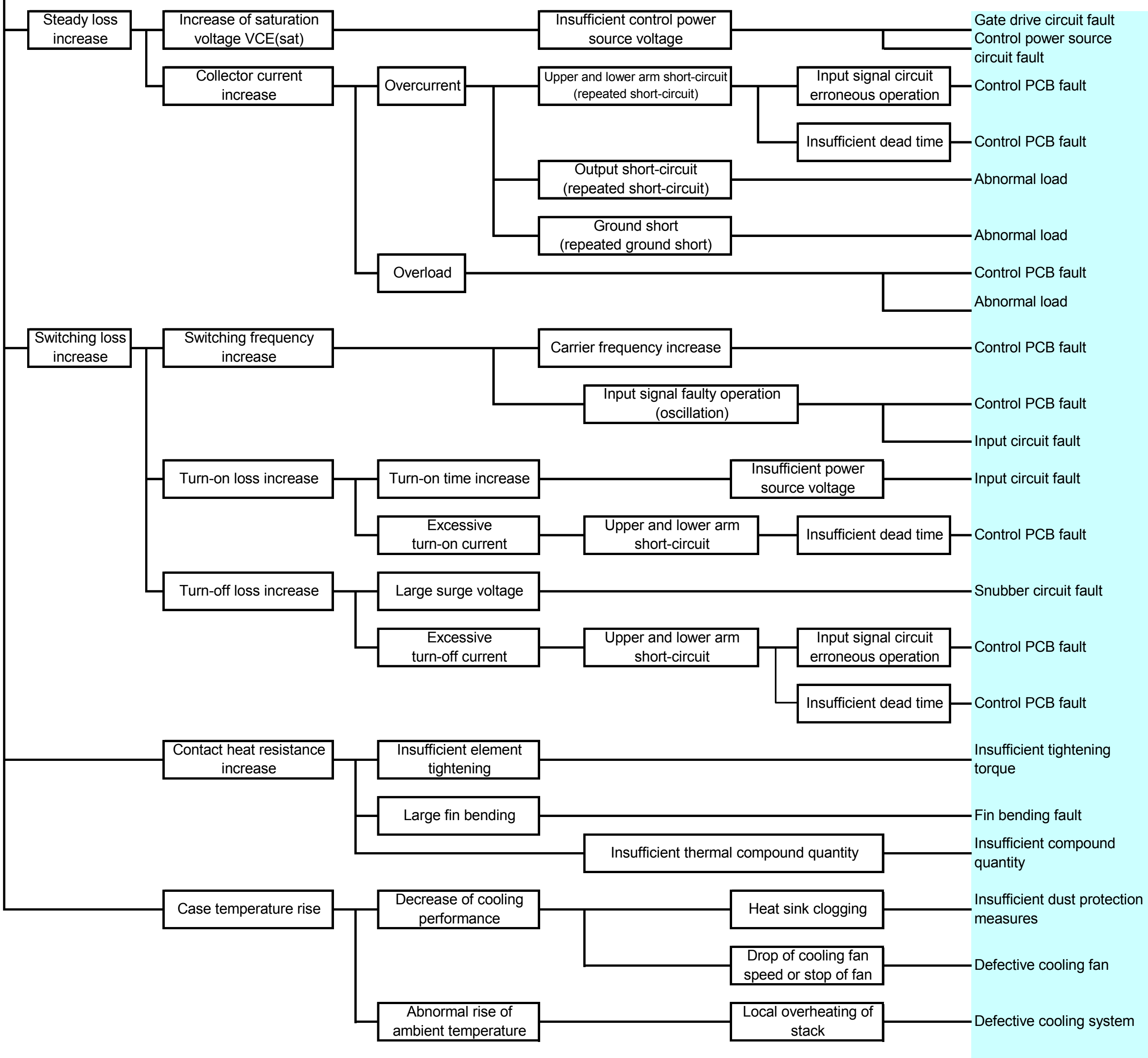

Fig. 7-1 (d) Mode C: Excessive Rise in Junction Temperature

D Destruction of FWD part

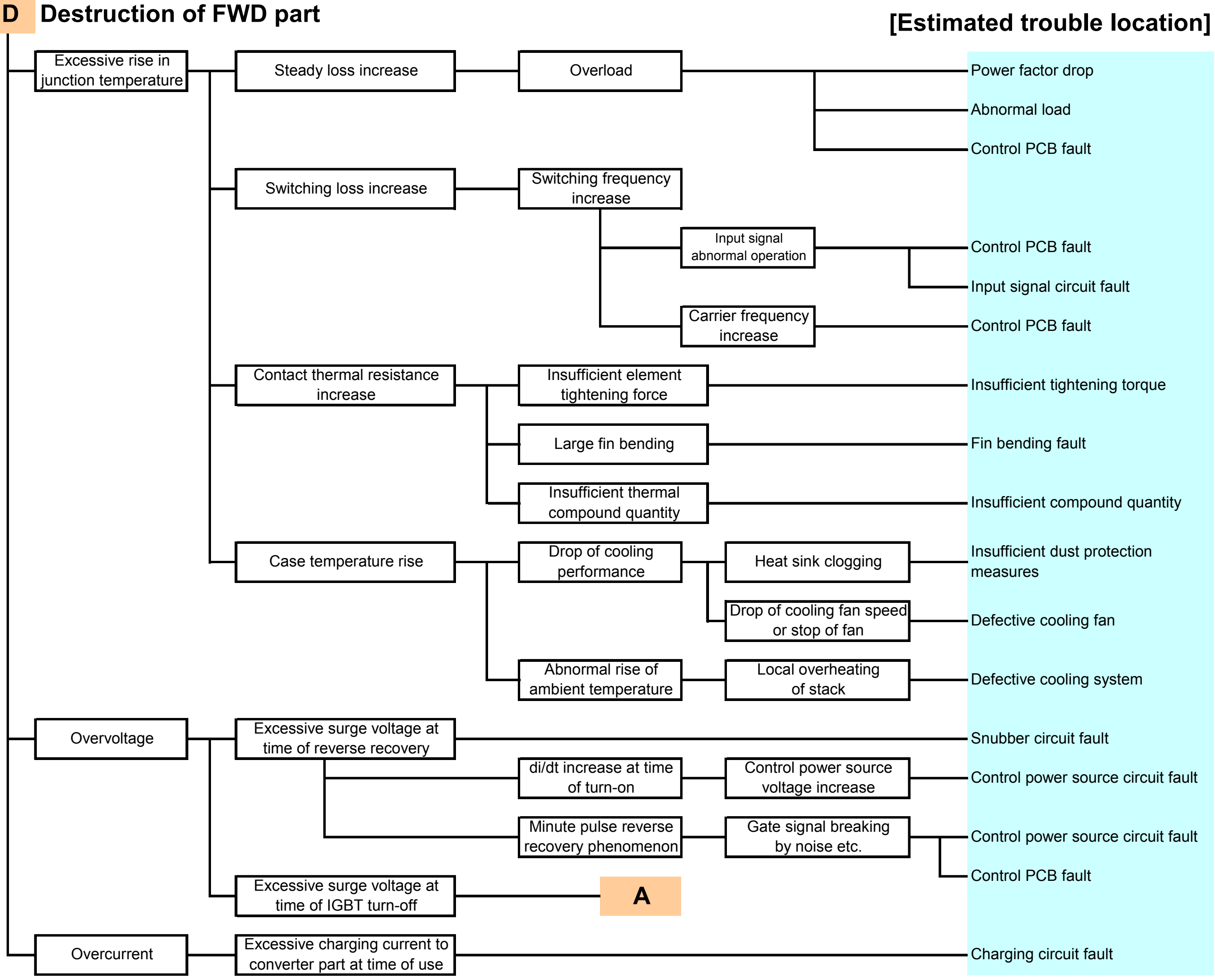

Fig. 7-1 (e) Mode D: Destruction of FWD Part

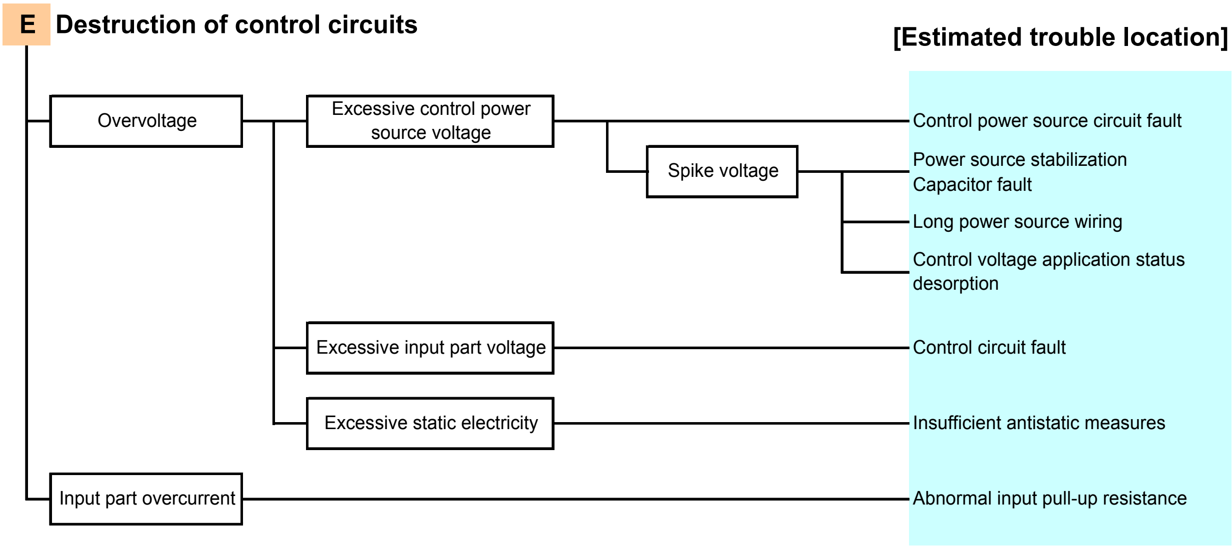

Fig. 7-1 (f) Mode E: Destruction of Control Circuit

F Damage related to reliability and product handling

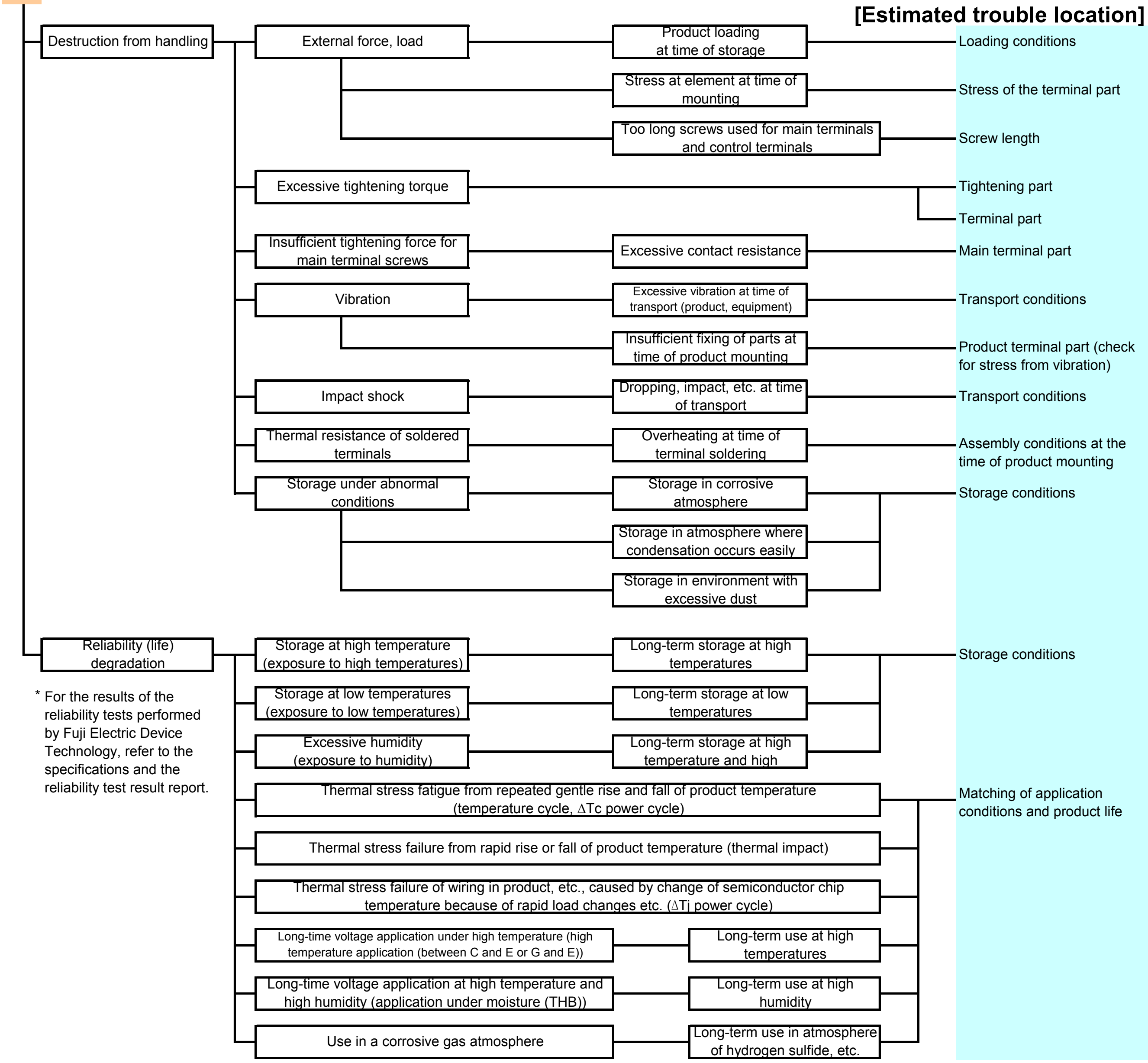

Fig. 7-1 (g) Mode F: Damage Related to Reliability and Product Handling

3 Alarm Cause Analysis Diagram

3.1 Cause analysis in the event an IPM alarm occurs

When an inverter using an IPM comes to an alarm stop, a survey must first be done to find out whether the alarm was output from the IPM or from a device control circuit (other than the IPM).

If the alarm was output by the IPM, determine the cause according to the following cause analysis diagram.

For observation of whether there is an IPM alarm or not via the alarm output voltage, the presence or absence of an alarm output can be confirmed easily by inserting a 1.5 kΩ resistor between the IPM alarm terminal and the cathode of the alarm photodiode and measuring the IPM alarm terminal voltage.

Phenomenon		Explanation of alarm cause	How to determine alarm cause
IPM alarm occurrence			
Normal alarm	TjOH	The chip temperature Tj is detected by the temperature detection element (diode) built into all IGBTs. When TjOH exceeds the trip level continuously for 1 ms or longer, the IGBT is switched off for protection.	• Measure the control power source voltage Vcc, the DC input voltage d, the output current Io. • Measure the case temperature Tc directly under the chip, calculate ΔTj-c, and estimate Tj. • Confirm the IPM installation method. (Fin flatness, thermal compound, etc.) • The alarm holding time in many cases is longer than 2 ms.
	OC	The collector current is detected by the current flowing through the current sensing IGBT built into all IGBT chips. When the overcurrent trip level is exceeded continuously for approximately 5 μs or longer, the IGBT is switched off for protection.	• Observe the alarm and the output current (U, V, W) with an oscilloscope. • Observe the alarm and the DC input current (P, N) with an oscilloscope. • Observe the current change 5 μs before alarm output. • Confirm the trip level and the detection location in case of current detection with CT, etc. • The alarm holding time in many cases is 2 ms.
	UV	When the control power source voltage Vcc drops below the undervoltage trip level continuously for 5 μs or longer, the IGBT is switched off for protection.	• Observe the alarm and Vcc with an oscilloscope. • Observe the power source voltage change 5 μs before alarm output • In case of instantaneous voltage drops, the alarm holding time in many cases is 2 ms.
	TcOH	The insulation substrate temperature is detected by the temperature detection element (IC) installed on the same ceramic substrate as the power device. When the TcOH trip level is exceeded continuously for 1 ms or longer, the IGBT is switched off for protection.	• Measure the temperature at the side of the copper base with a thermocouple. • Observe the alarm output period with an oscilloscope. • The possibility that the alarm is TcOH is large when output is made for a longer period than the 2 ms of the alarm holding time.
Faulty alarm		• When the control power source voltage Vcc exceeds the absolute max. rating of 20 V or when an excessive dv/dt or ripple is applied, the drive IC may be damaged or a faulty alarm output. • When noise current flows in the IPM control circuit, the IC voltage may become unstable and a faulty alarm output.	• A short pulse alarm in the order of μs is output. • Observe the Vcc waveform during motor operation with an oscilloscope, preferably in the vicinity of the IPM control terminals. • Vcc < 20 V, dv/dt ≤ 5 V/μs, and Vripple ≤ 2 Vp-p shall apply (all four power supplies). • Confirm that there is no external wiring between IPM control GND and main terminal GND. In case of wiring, noise current flows into the IPM control circuit. • When the drive IC is damaged, there is a high possibility of abnormal increase of Icc. Ex.: If Iccp ≥ 10 mA @Vin = "High", confirm the abnormality of IPM peripheral circuits. Refer to "Cautions for Design and Application" and "Application Circuit Examples" in the delivery specifications.

Fig. 7-2 Alarm Cause Analysis Diagram

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