# Troubleshooting

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1 Troubleshooting

An IPM has various integrated protective functions (such as overcurrent protection and overheat protection) unlike a standard module, its failure hardly occurs at abnormal conditions. However, its breakdown may arise depending on the anomalous mode. When the IPM has failed, it is necessary to take countermeasures upon clarification of the situation and the root cause of the failure.

Failure tree analysis charts are shown in Figure 7-1. Carry out investigation of failure mode by using these charts. For the failure criteria, see Chapter 4, Section 2 [IGBT test procedures] of the IGBT Module Application Manual (RH984b).

Furthermore, when an alarm signal is generated from the IPM, investigate the factor by reference to the alarm factor analysis chart shown in Figure 7-2.

2 Failure analysis tree charts

![Failure Analysis Tree Chart](image_url)

Figure 7-1 (a) IPM failure tree analysis chart

(Codes A to F are linked with those indicated in separate FTA pages.)
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Figure 7-1 (b)  Mode A: Deviation from RBSOA specification

Figure 7-1 (c)  Mode B: Gate overvoltage
C Excessive junction temperature rise (rapid temperature rise)

- Increased steady-state loss
- Increased saturated voltage VCE (sat)
- Gate drive circuit disorder
- Increased collector current
- Over-current
- Insufficient control power supply voltage
- Short-circuit of upper and lower arms (repeated short-circuit current)
- Control PCB disorder
- Insufficient dead time
- Output short-circuit (repeated short-circuit current)
- Load disorder
- Ground short circuit (repeated short-circuit current)
- Load disorder
- Increased carrier frequency
- Over-load
- Insufficient dead time

- Increased switching loss
- Increased switching count
- Increased turn-off loss
- Increased turn-on loss
- Increased turn-on time
- Increased steady-state loss
- Insufficient control power supply voltage
- Short-circuit between upper and lower arms
- Insufficient dead time
- Excessive turn-off current
- Insufficient control power supply voltage
- Short-circuit between upper and lower arms
- Insufficient dead time
- Increased contact thermal resistance
- Over-current
- Insufficient compound weight adjustment
- Increased contact thermal resistance
- Tightening force
- Faulty fin warpage
- Increased thermal compound weight
- Faulty fin warpage
- Increased thermal compound weight
- Insufficient thermal compound weight
- Faulty fin warpage
- Faulty anti-shot measures
- Insufficient thermal compound weight
- Faulty anti-shot measures
- Case temperature rise
- Dropped cooling capacity
- Insufficient control power supply voltage
- Clogged heat sink
- Dropped or stopped cooling fan revolution
- Abnormal rise of ambient temperature
- Stack local overheating
- Cooling fan disorder
- Cooling system disorder

Figure 7-1 (d) Mode C: Excessive junction temperature rise
Figure 7-1 (e) Mode D: FWD breakdown
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Control circuit breakdown

- Overvoltage
- Excessive control power supply voltage
  - Spike voltage
  - Overvoltage Control power supply circuit disorder
  - Power supply instability
  - Excessive control power supply voltage
  - External noise
- Excessive minus voltage
- Excessive input unit voltage
- Excessive static electricity
- External noise
- Capacitor disorder
- Control circuit disorder
- Insufficient static electricity measures

Figure 7-1 (f)  Mode E: Control circuit breakdown
Breakdown related to reliability and product handling

- **External force, load**
  - Excessive loading during product storage
    - Loading conditions
  - Excessive stress applied to terminals and case at the time of IPM mounting
    - Mounting work
  - Excessive stress applied to terminals and case at the time of IPM dismounting
    - Forceful dismounting
  - Excessive screw length used for main terminals
    - Screw length

- **Insufficient main terminal tightening torque**
  - Excessive contact resistance
    - Torque applied to mounting portion
  - Excessive vibration during transportation (products, devices)
    - Main terminal screw tightening
  - Insufficient vibration during transportation
    - Torque applied to terminal portion

- **Vibration**
  - Excessive heating during terminal soldering
    - Conditions for assembly during product mounting
  - Excessive heating during terminal soldering
    - Conditions for storage
  - Excessive heating during terminal soldering
    - Conditions for storage

- **Impact**
  - Falling, impact, etc. during transportation
    - Conditions for transportation
  - Inferior fixing of components at the time of product mounting
    - Conditions for transportation

- **Heat resistance of soldered terminals**
  - Storage in corrosive gas atmosphere
    - Conditions for storage
  - Storage in condensable environment
    - Conditions for storage
  - Storage in dusty environment
    - Conditions for storage

- **Storage in inferior environment**
  - Storage in high temperature conditions (storing under high temperature)
    - Conditions for storage
  - Long-term storage in high temperature conditions
    - Conditions for storage
  - Storage in low temperature conditions (storing under low temperature)
    - Conditions for storage
  - Long-term storage in low temperature conditions
    - Conditions for storage
  - Storage in high temperature and high humidity conditions (storing under high temperature and high humidity)
    - Conditions for storage
  - Long-term storage in high temperature and high humidity conditions
    - Conditions for storage

- **Thermal stress fatigue generated by repeating of gradual up-down of product temperature (temperature cycle, \(\Delta T_c\) power cycle)**
  - Matching of applied conditions with product service life

- **Thermal stress breakdown generated by rapid rise or fall of product temperature (thermal impact)**
  - Thermal stress fatigue breakdown to product internal wiring, etc. generated by changes in semiconductor chip temperature caused by rapid load change (\(\Delta T_c\) power cycle)

- **Excessive tightening torque**
  - Excessive tightening torque
    - Excessive tightening torque
    - Excessive tightening torque
    - Excessive tightening torque

- **Insufficient main terminal tightening torque**
  - Insufficient main terminal tightening torque
    - Insufficient main terminal tightening torque
    - Insufficient main terminal tightening torque
    - Insufficient main terminal tightening torque

- **Reliability (service life) breakdown**
  - Storage in high temperature conditions (storing under high temperature)
    - Conditions for storage
  - Long-term storage in high temperature conditions
    - Conditions for storage
  - Storage in low temperature conditions (storing under low temperature)
    - Conditions for storage
  - Long-term storage in low temperature conditions
    - Conditions for storage
  - Storage in high temperature and high humidity conditions (storing under high temperature and high humidity)
    - Conditions for storage
  - Long-term storage in high temperature and high humidity conditions
    - Conditions for storage

- **Breakdown caused by erroneous handling**
  - Excessive loading during product storage
    - Loading conditions
  - Excessive stress applied to terminals and case at the time of IPM mounting
    - Mounting work
  - Excessive stress applied to terminals and case at the time of IPM dismounting
    - Forceful dismounting
  - Excessive screw length used for main terminals
    - Screw length

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  - Insufficient vibration during transportation
    - Torque applied to terminal portion

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3 Alarm factor analysis tree chart

When the system equipped with the IPM has stopped and an alarm signal is generated, first carry out investigation to identify where the alarm signal was generated from, the IPM or the device control circuit (other than IPM).

If the alarm was from the IPM, then identify the factor in accordance with the factor tree chart indicated below. V-IPM is easy to identify which protective function is activated by checking the alarm pulse width. Therefore, you can shorten the factor analysis time.

In addition, the alarm output voltage can be easily measured by connecting a 1.3 KΩ resistor in series between the IPM alarm terminal and the cathode terminal of the alarming photodiode.