Protection in R-IPM Ground Fault Mode

This supplement applies to the types of devices that do not have or do not use upper arm alarm output (except the P617 and P619 packages).

1 Concept of device protection (alarm) against ground faults

Suppose that V-phase output causes a ground fault while an IPM is utilized in a three-phase general-purpose PWM inverter. In this case, a short-circuit current from alternating current flows to ground (ground line) through V-phase elements (Figure 1). The overcurrent protection function provided on the upper IPM arm instantaneously shuts off the ground-fault current. As for an R-IPM, the overcurrent protection in the IPM is latched for 2ms, during which the V phase is kept in the shut-off state regardless of the signals input. Because the fault signal is not fed back outside (inverter side), device operation continues. Therefore, the short-circuit current flows every 2ms, depending on the operating conditions. Under this operating condition, that is, a short circuit every 2ms, the dose tolerance of an R-IPM is 500ms.

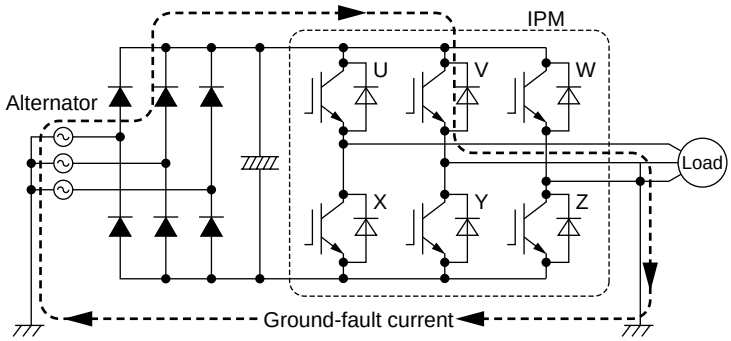

Fig. 1 Ground-fault current path

When inverter operation continues and current flows to the lower arm (Y phase), the ground-fault current flows as shown in Figure 2. Overcurrent is then detected, and the lower arm elements are shut off. Simultaneously, the associated alarm output is sent to the control circuit, and the inverter is stopped by an overcurrent trip. Thus, the device can be protected against a ground fault in an R-IPM, even if the upper arm has no alarm terminal.

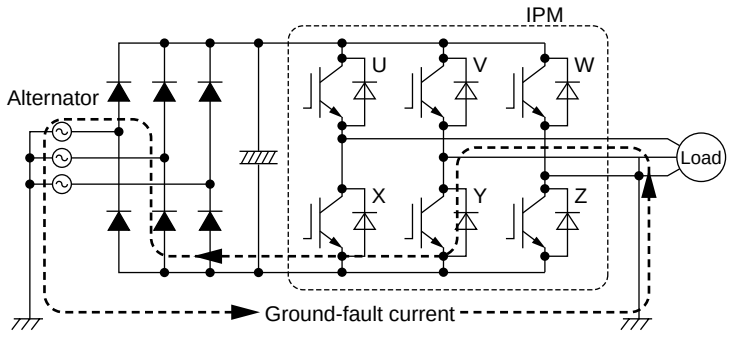

Fig. 2 Ground-fault overcurrent path when triggered by the lower arm

The operations described above can be represented with the following timing chart.

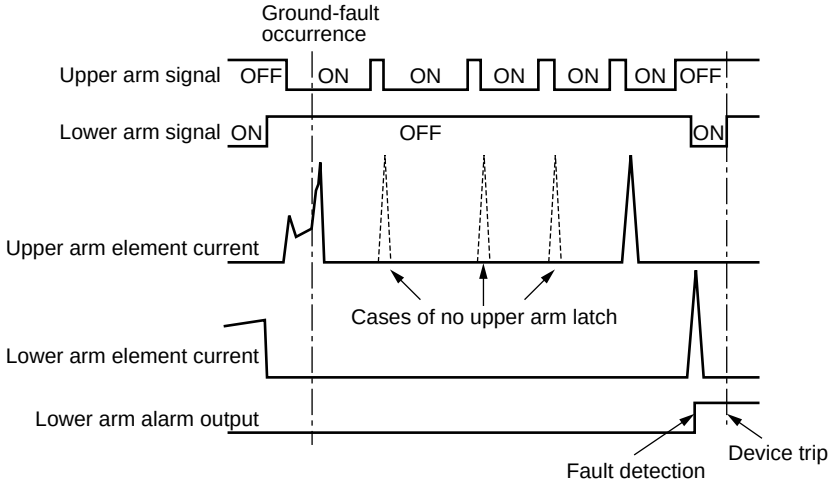

Fig. 3 Timing chart of operation at the time of a ground fault

Note:

Following the occurrence of a short circuit, the R-IPM short-circuit protection operation provides a dead time of about 6μs before an alarm signal is output (protection latch only for the upper arm).

If the duration of the short-circuit current flow is shorter than the dead time (2ms) and the flow is continuous, the protection latch does not work and the consequent rapid increase in temperature may cause thermal damage in an IGBT.

Note especially the shorter duration of the short-circuit current flow after the device is started with inverter output short-circuited. Set 12μs or greater as the duration of the first short-circuit current flow at startup. This enables secure protection against a short-circuit current (the dead time provided by the chip overheating protection function is about 1ms).