AN5381

Case Non-rupture Current Ratings

Application Note

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INTRODUCTION

The non-repetitive surge current I_{TSM} and the I^2t value define the limit of the electrical stress in the forward direction of a thyristor provided that it is triggered with sufficient gate current. These characteristics of the semiconductor are used to design short circuit protection, namely fuses or circuit breakers. By definition, this level of stress does not destroy the thyristors or diodes.

If a thyristor becomes short circuit in the forward direction and a current flows which is greater than the surge current limit, destruction of the encapsulation will not normally occur until this current is substantially greater than the surge current. This is because the thyristor is effectively triggered on by the fault current and normal injection over a large area of the silicon takes place.

If the thyristor becomes defective in the reverse blocking state, a short circuit current can flow in the reverse direction. The cathode area that remains undamaged does not take part in carrying the current. A small edge around the failure melts and an arc develops inside the case. The intense heat generated by the arc will lead to either cracking of the ceramic case through thermal shock or melting of the metal flanges of the encapsulation. Hot plasma then escapes through the break in the enclosure. In high power installations where strong magnetic fields exist, an equipment short circuit or even burn down of the equipment may be the consequence.

The case non-rupture current rating is the value of the peak current, which can flow in the reverse direction through a failed device, that does not cause a mechanical failure of the encapsulation of the semiconductor.

Destructive tests in the reverse direction of thyristors show a large variation in the value of the non-rupture current depending on the location of the destroyed spot on the silicon pellet. The thick copper electrodes that contact the wafer restrain arcs at failure sites in the body of the silicon. Arcs at the edge of the silicon are the worst and produce the lowest values of case non-rupture current.

For large diameter thyristors, the case non-rupture current is often smaller than the non-repetitive surge on-state current I_{TSM}. Even for smaller devices, the use in parallel sets can cause problems

For ease of measurement and also direct comparison with the surge current, case non-rupture currents are most commonly quoted for single half sine waves of 50Hz current.

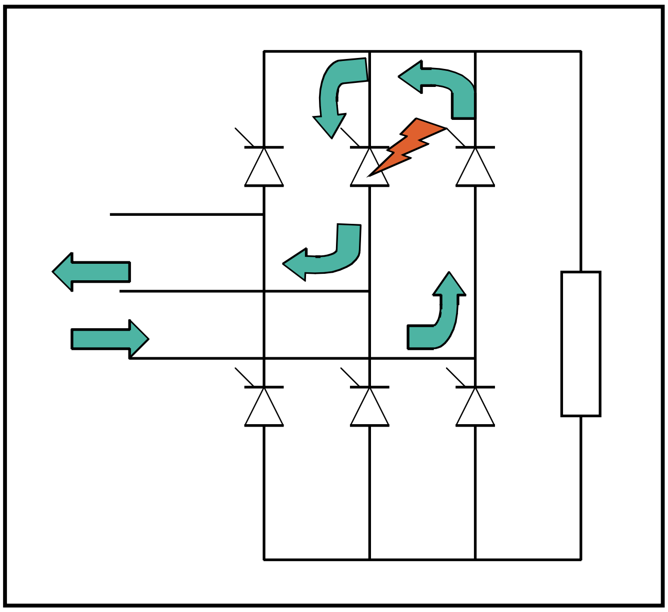

Fig. 1 Fault current flowing back through a failed thyristor in a 3 phase bridge which shorts out two phases of the supply

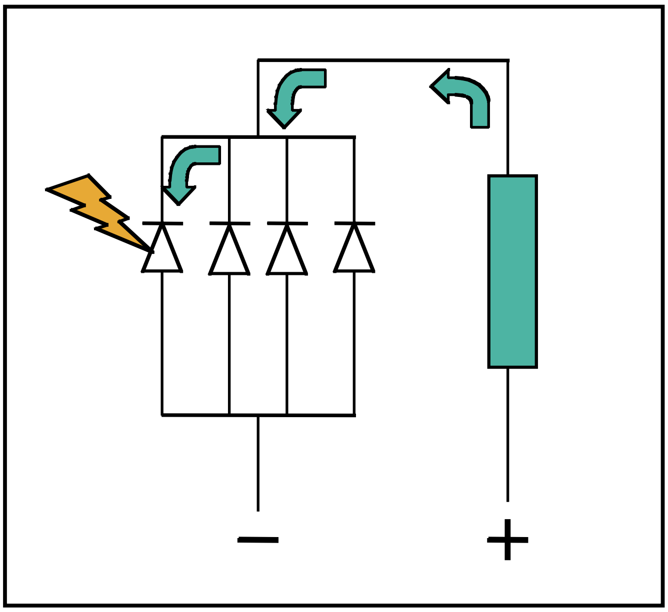

Fig.2 A failed device in a parallel application can experience a current equal to the full forward current through all parallel paths

The calculations of case non rupture currents for other current waveforms, such as those encountered with fuses, based on the half sine wave values can at best be viewed as approximations.

Dynex Semiconductor has conducted case non-rupture tests on its most popular outlines of encapsulation. It has been found that it is the ceramic and the internal design of the encapsulation and ancillary components that determine the case non-rupture rating and not the type of device.

BASIS OF TESTS

The test method was based on that described in IEC test method IEC47 (CO) 892. The test current source was a 50Hz generator and single phase transformer capable of delivering 500V RMS at up to 200kA peak. Varying the circuit voltage varied the test current. The circuit was capable of delivering discrete half cycles of current. All tests were conducted at room temperature.

DESCRIPTION OF TEST SAMPLES

Device types tested were from outlines G, F, Y and Z. The basic units were specially prepared before assembly. A cut was made on the edge of each basic unit by air abrasion. At this stage the voltage blocking capability was still about 600V or 700V in both forward and reverse direction. This is too high to guarantee breakdown, so the fault was worsened by discharging a 16mF capacitor, charged to around 1000V, through each device. The reverse voltage was then seen to be degraded to below 200V.

TEST RESULTS

		Case Non-rupture Rating	
Device Types	**Package Types**	**I^2t (A^2s)**	**Peak Current (kA)**
DCR803/806	"G"	10×10^6	44
DCR1002/1003/1006/1008	"F"	50×10^6	100
DCR1473/1474/1475/1476/1478	"Y"	47×10^6	97
DCR1673/1674/1675	"Z"	9.5×10^6	44

Table 1

POWER ASSEMBLY CAPABILITY

The Power Assembly group was set up to provide a support service for those customers requiring more than the basic semiconductor, and has developed a flexible range of heatsink and clamping systems in line with advances in device voltages and current capability of our semiconductors.

We offer an extensive range of air and liquid cooled assemblies covering the full range of circuit designs in general use today. The Assembly group offers high quality engineering support dedicated to designing new units to satisfy the growing needs of our customers.

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HEATSINKS

The Power Assembly group has its own proprietary range of extruded aluminium heatsinks which have been designed to optimise the performance of Dynex semiconductors. Data with respect to air natural, forced air and liquid cooling (with flow rates) is available on request.

For further information on device clamps, heatsinks and assemblies, please contact your nearest sales representative or Customer Services.

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Preliminary Information: The product is in design and development. The datasheet represents the product as it is understood but details may change.

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