Case non rupture current
High power Semiconductors

DIN IEC 60 747 – 2 (Diodes) and DIN IEC 747 – 6 (Thyristors)

The case non rupture current is the current value by which the housing neither breaks nor opens in such a way that explosive plasma can come out. We find the lowest value of case non rupture current if the destruction can be found as a small spot at the edge of the semiconductor, outside the contacted area, and if high surge currents flow in reverse direction.

1) Preparation of test devices:

First the semiconductor pellet is damaged mechanically at its edge in reverse direction. Most of the high current test equipments work at a relatively low voltage, therefore a possible rest of reverse blocking capability has to be eliminated, e.g. by capacitor discharge.

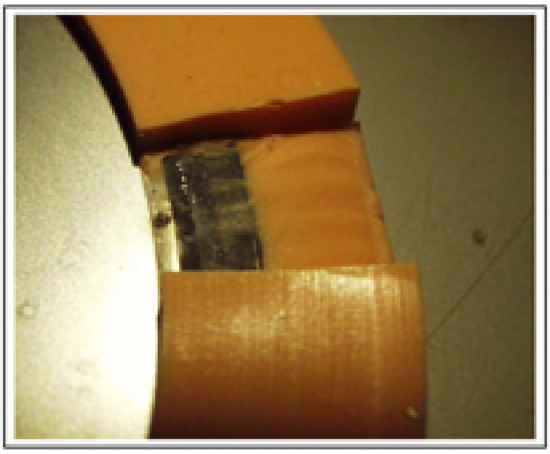
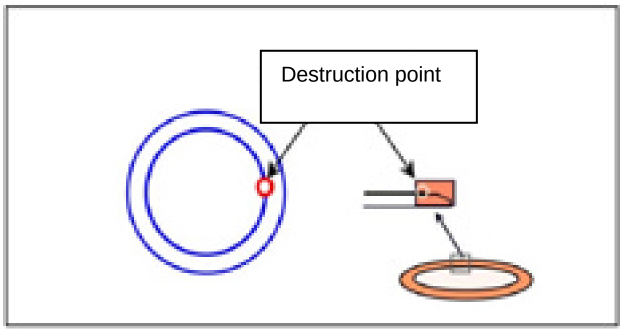


Fig. 1 Typical Destruction



With thyristors, an aimed installation of the destruction point exactly where the gate lead comes out is realized.

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2) Current demand:

Because of better comparability most data indications are based on half sine waves of 10 ms pulse duration. The I^2t values derived from these pulses can be transferred to 60 Hz cycles, too. In many applications, however, essentially differing demands arise, requiring an individual consideration and special tests.

2.1 High current converter

For applications with high, continuous load current, e.g. electrolysis, aluminium melts, etc., the construction usually consists of approximately 6 MW blocks, in which up to 14 semiconductors per arm are connected in parallel. Because of the relatively low voltage, series connections are not necessary.
These units normally cannot be switched off in case of defects of the individual semiconductors, because this would mean danger to the equipment or to the product being manufactured. The aluminium pots, for example, can freeze, this would mean they would become useless. Defect semiconductors therefore by fuses are separated from the circuit. Until these fuses have switched off, the housing may neither break, nor may explosive plasma be emitted.

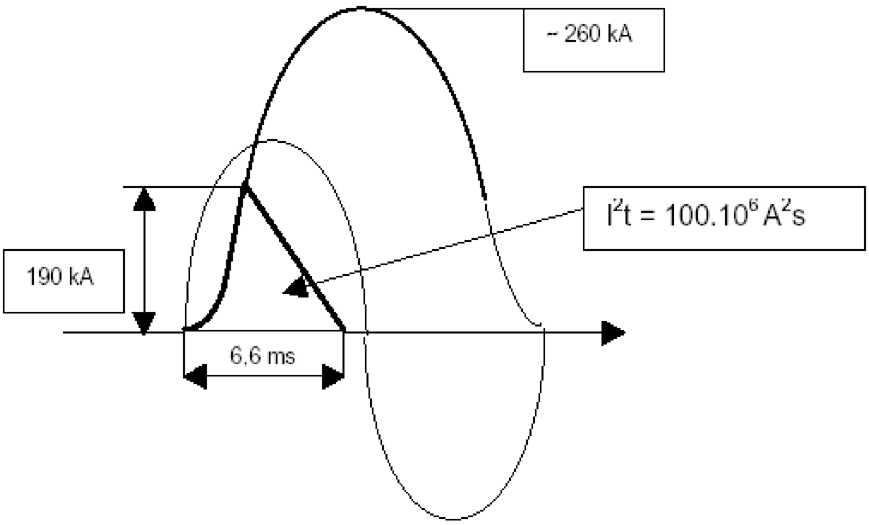

Fig. 2 Typical semiconductor load at fuse switching.

2.2 Drives

For current source inverter line bridges and power controllers in static direct inverters one can observe a trend towards fuse-less design. This means in forward direction the definition of surge currents (in accordance to Fig.3), followed by negative and/or positive (thyristors) blocking voltage. If the short circuit is detected in time, it is possible to operate with a gate barrier after one half wave in case of thyristors. Alternatively 3 half waves followed by negative blocking voltage till the main circuit breaker turns off. While trying to use cheaper (=slower) circuit breakers, the interest in 5 half current waves is increasing.
The requirements concerning the case non rupture current are the same than in forward direction.

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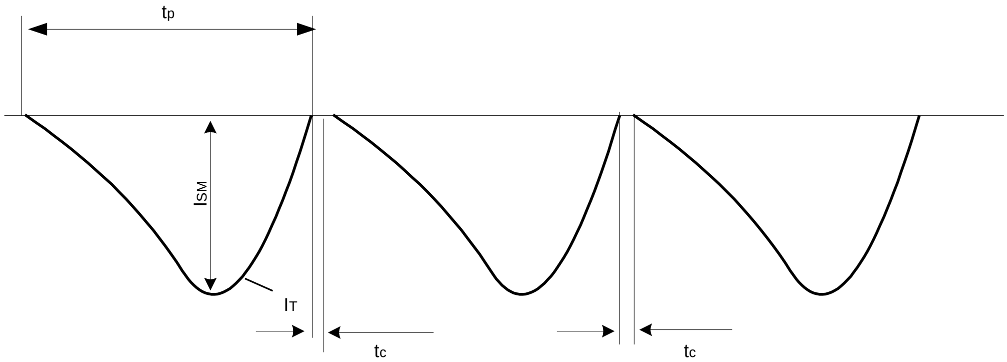

Fig. 3 Typical current load at multiple pulses

2.3) HVDC, SVCs

The requirements are similar to those of drive technologies. There are differences in pulse durations and after 3 half waves, the system is switched off. Because of the high number of the elements connected in series and a redundant n+2 design, the case non rupture current in these applications is not of such a high importance as it is in high current converters and drives.

3) Protective measures

3.1) Ceramics - Protection against burst.

It is well known that in case of local heating, as it is caused by a plasma beam, ceramic parts are affected negatively by traction forces resulting from the high internal pressure. To protect the ceramic ring, Teflon parts are inserted, which take over the heat in the first moment and divert the plasma beam.

3.2) Flanges - protection against opening of the housing

eupec relies on means which prevent the housing from opening, while the competition tries to divert the plasma coming out by plastic rings attached at the outside. Fig. 4 shows the cross section of a modern eupec thyristor for propulsion technologies.

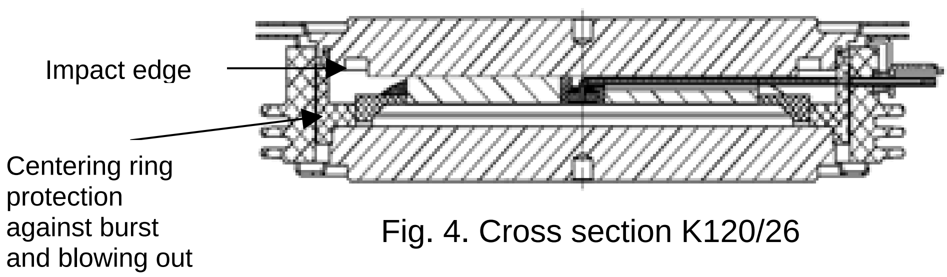

Fig. 4. Cross section K120/26

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For high current converters, using increasingly thyristors with 100mm pellets, this protection may possibly not be sufficient. For this reason eupec developed a special housing, which at present is used for the types T4301N and T3401N.

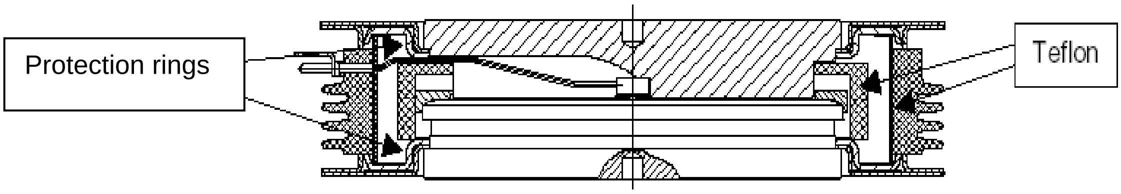

Fig. 5 Cross section K150/35

Tests at the ABB high voltage test laboratory confirmed the suitability of this housing for the demand shown in fig. 1.

4) Case non rupture currents

Diodes	flange	height	contact	kind of diodes	pellet	I_{RSMC} [A] T_{vj} = 25°C, T_p = 10ms, Sine half wave	I_{RSMC} [A] T_{vj} = 25°C, T_p = 10ms, 3 sine half waves	I_{RSMC} [A] T_{vj} = 25°C, T_p = 10ms, 5 sine half waves
Typ	mm	mm	mm		mm	A	A	A
D471N / D711N	54	26	34	rectifire	38	**14.000**		
D1481N	76	26	48	rectifire	55	**40.000**		
D2601N / D3041N	120	26	86	rectifire	76	**105.000**		**41.000**
D2601NH	120	26	86	Pulsed Power	76	**105.000**		**41.000**
D3001N / D3501N / D4201N	120	35	86	rectifire	76	**105.000**		**41.000**
D6001N	150	26	100	rectifire	101			
D911SH / D931SH / D1031SH	100	26	62,8	free - wheeling diode	65	**42.000**		
D1121SH / D1131SH / D1331SH	120	26	86	free - wheeling diode	76	**105.000**		**41.000**
D1951SH	150	26	100	free - wheeling diode	101			

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Thyristors	flange	height	contact	pellet	I_{RSMC} T_{vj} = 25°C, t_p = 10ms, Sine half wave	I_{RSMC} [A] T_{vj} = 25°C, T_p = 10ms, 3 sine half waves	I_{RSMC} T_{vj} = 25°C, t_p = 10ms, 5 sine half waves	I2t T_{vj} = 25°C, fuses up to 6500A / 1000V
Type	mm	mm	mm	mm	A	A	A	A2s
T201N	54	26	34	38	**14.000**			
T501N / T731N / T901N	76	26	48	55	**40.000**			
T551N	76	35	48	55	**40.000**			
T1081N / T1551N T1971N / T20011N	120	26	86	77	**85.000**	**55.000**	**38.000**	
T1201N / T1401N T1451N / T1601N	120	35	86	77	**85.000**	**55.000**	**38.000**	
T1851N / T2351N	120	26	86	88	**75.000**		**33.500**	
T1651N / T2161N	120	35	86	88	**75.000**		**33.500**	
T2251N / T3441N T3801N / T4771N	150	26	100	101	**80.000**		**35.800**	
T3401N / T4301N	150	35	100	101				**100.000.000**
T1901N / T2851N T2401N / T3101N	150	35	100	101	**70.000**		**36.000**	
T1503N	150	40	100	101				
T2871N	172	35	115	119	**65.000**		**29.000**	
T2563N / T4003N	172	40	115	119	**65.000**			

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