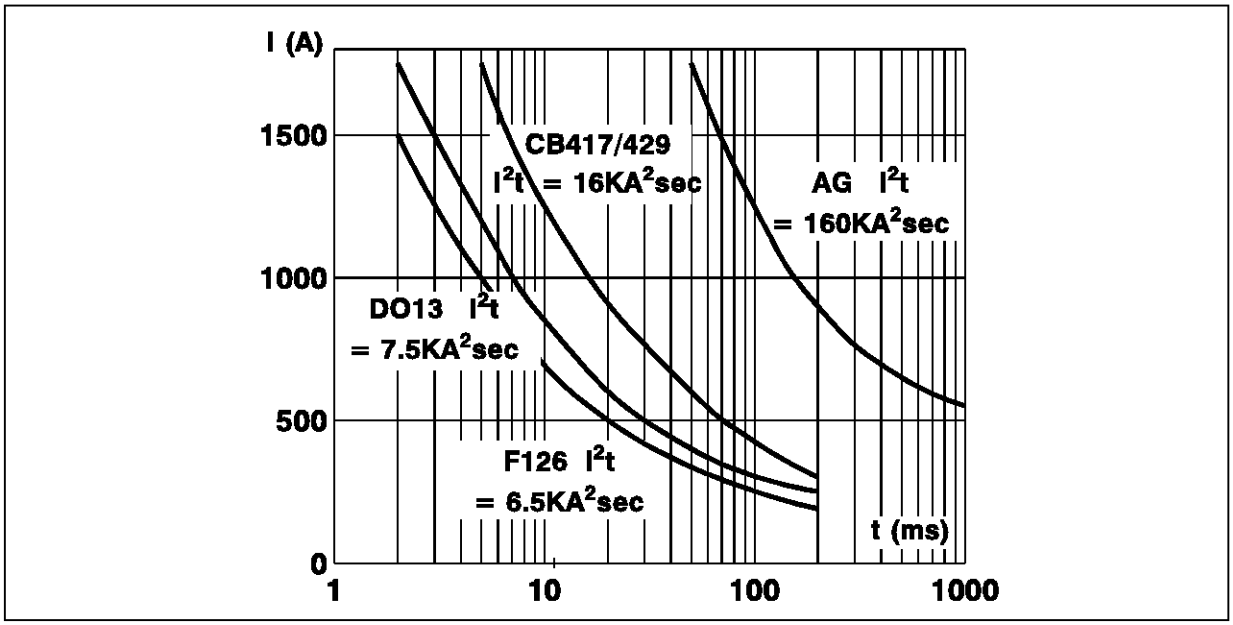
SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

PROTECTION BY TRANSIL HOW TO ENSURE ABSOLUTE SAFETY

The function of a protection diode is to limit the voltage across the device being protected in case of accidental overloads. The accidents (atmospheric overvoltages, switching on the mains, failures of the equipment) are defined by standards. But selecting the ratings of a protection diode in accordance with the standards does not always guarantee satisfactory safety. In certain cases accidental overloads higher than those covered by the standards can destroy the protection diode. The user can accept this destruction due to an exceptional accident, but he requires ABSOLUTE SAFETY, i.e. the equipment can stop operating but in no case must it be destroyed. The protection diode should thus remain a short-circuit after the overload. The purpose of this publication is to provide the designer with the elements necessary to define this absolute safety. Fig. I gives the current limits below which TRANSIL diodes cannot be made open-circuits. By analogy with fuses, these limits can be characterized within the 10 µs to 1 s interval by I^2t (A^2sec).

Figure 1 : Values of I^2t for pulse durations less than a second



BEHAVIOUR OF TRANSIL DIODES IN CASE OF OVERLOADS

If an overload exceeds the limit Ipp specified for the Transil protection diode, it can be destroyed.

- Destruction **always** begins by an anode-cathode short-circuit.
- If a very high current then flows through the diode, the connections can melt and vaporize and the diode becomes an open circuit.

Numerous tests have been performed at the SGS-THOMSON characterization laboratory using current generators (3 to 1800 A) to determine the limits below which the user can be sure that the diode will remain a short-circuit after destuction of the silicon chip. The results of these tests are given for all TRANSIL diodes in figures 1 and 2.

Figure 2 gives the permanent short-circuit current I_{CP}.

It can be noted that Transil diodes withstand very high transient overloads. For example, a diode in a plastic case (CB-429) withstands an "I2t" of 16000 A2sec, i.e. more than the chip of a 150 A thyristor ! This is due to the particular technology of Transils in which the silicon chip is mounted between two piston- shaped leads with very high thermal capacity. By contrast, the current-handling capability of a Transil in continuous opertion is similar to that of a diode in the same package.

Figure 2 : Limits of the continuous rms current I_{CP} which do not result in the open-circuiting of a TRANSIL diode previously destroyed by an accidental overload

TRANSILS				
Case	**F126**	**DO13**	**CB417 CB429**	**AG**
I_{CP} (A)	3	3.5	4.5	5

PRACTICAL CONSEQUENCES

A: NON-REPETITIVE PULSE OVERLOADS

In pulse operation (duration 1 second) the electromechanical capacity of the case is very much higher than that of the silicon chip (figure 1).

For example, if we consider the CB-429 case diodes of the "1.5 kW" series, the specifications of the maximum values Vcc and Ipp give an "I2t" for the silicon chip between 0.01 (high voltage) and 15 A^2s (low voltage). For the package, the value of "I^2t" is 16000 A^2sec, i.e. a THOUSAND TIMES higher.

The risk of a TRANSIL diode becoming an open circuit after a pulse overload is thus negligible in practice. The data in figure 1 thus enables the designer to check if his circuit falls within the absolute safety area.

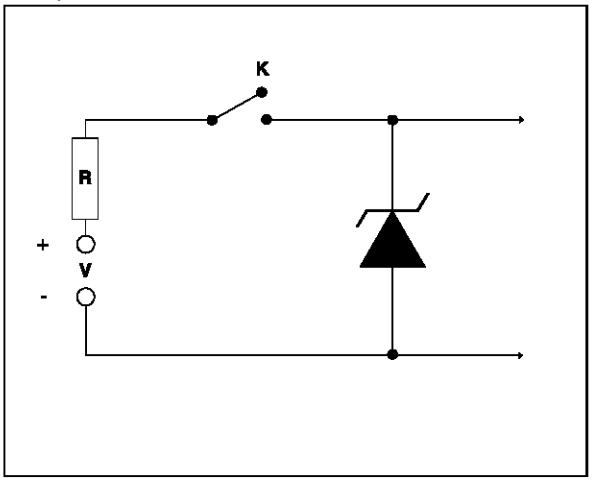
B: PROTECTION DIODES AFTER A VOLTAGE SOURCE

After an overload exceeding the limit Ipp, the Transil diode whose silicon chip has been destroyed is subjected to a current given by :

$$I_{CP} = \frac{V}{R}$$

In many cases this current can result in destruction of the Transil diode contacts, i.e. an open circuit which can have disastrous consequences.

To avoid this, it is necessary to add a device K which breaks the circuit after the failure. This device can be a fuse or a circuit-breaker. The data in figures 1 and 2 will enable the designer to determine the fuse (or circuit-breaker) which will break the circuit before the diode becomes an open circuit.



CONCLUSION

The specification of the new I2t and Icc parameters represents notable progress in the characterization of TRANSIL diodes. It enables the designer to define his protection with absolute safety, a vital precaution since the overloads encountered in practice do not always correspond with the standards. The building of absolutely safe equipment enables the damage due to unforeseeable accidents to be limited, which is considered important by SGS-THOMSON with our years of experience in the field of protection.