AN574

Application note

Transient voltage suppressor (TVS) / Thyristor surge suppressor (TSS) crowbar protection comparison

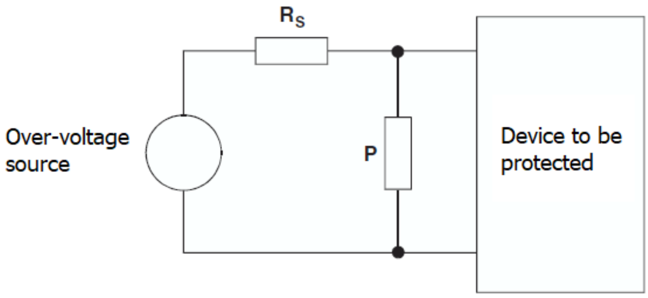
Introduction

To protect a sensitive device there are two different approaches.

The first one is to use series protectors, the second one parallel suppressors. The technologies used in both cases are such that the series devices are suitable for long duration surges, while parallel protectors are very efficient for the high current short duration stresses which represent the great majority of cases.

For the parallel protection solutions, two philosophies can be used. The first one is represented by a breakdown based device and the second one by a breakover based protector, respectively known as the transient voltage suppressor and the thyristor surge suppressor (TSS or trisil crowbar protection).

Figure 1. Classical schematic of parallel protection



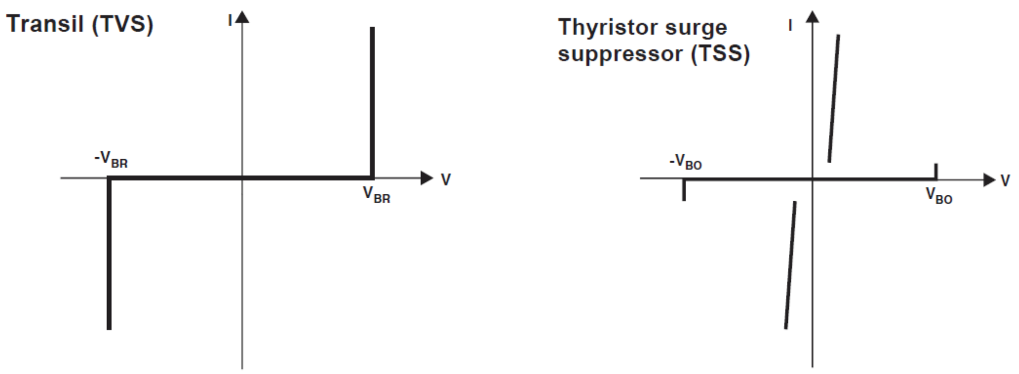
1 Transient voltage suppressor (TVS) / Thyristor surge suppressor (TSS)

1.1 Electrical characteristics

The transient voltage suppressor is a clamping device which suppresses all overvoltages above the breakdown voltage (V_{BR}).

The TSS is a crowbar device which switches on when overvoltages rise up to the breakover voltage ($\pm V_{BO}$).

Figure 2. Electrical characteristics

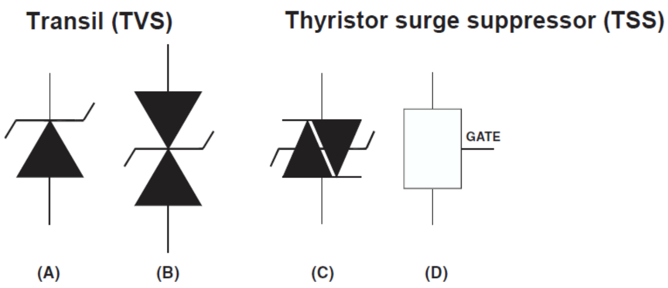


1.2 Electrical schematics

The transient voltage suppressor (TVS) may be unidirectional (Figure 3 (A)) or bidirectional (Figure 3 (B)). In unidirectional form, it operates as a clamping device in one sense and like a rectifier in the other.

The TSS may be designed to function with a fixed breakover value (Figure 3 (C)) or a value which can be programmed by the gate (Figure 3 (D))

Figure 3. Electrical schematics



1.3 Electrical behavior

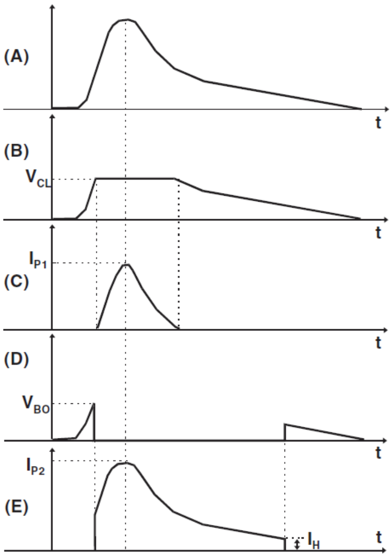


Figure 4. Electrical behavior in a transient voltage suppressor (TVS) and a thyristor surge suppressor (TSS)

For the same surge (A), Figure 4 shows the electrical behavior of a transient voltage suppressor (TVS) and a TSS.

The parts (B) and (C) of Figure 4 give the voltage across the transient voltage suppressor (TVS) and the current through it. It is important to note that the current flows through the protection device only during the clamping phase. This fact has to be taken into account when the protector is chosen, because the current duration is always shorter than that of the overvoltage surge.

The parts (D) and (E) of Figure 4 relate to the thyristor surge suppressor (TSS) behavior. In this case the device fires when the voltage across it reaches the breakdown voltage V_{BO} and remains in the on-state until the current falls under the holding value I_H. The current flows through the TSS during all of the on-state phase.

1.4 Power dissipation

The dissipated power in both the transient voltage suppressor (TVS) and the TSS is due to the presence of voltage across and current through the protection device.

Note that for the same package, the current-handling capability of a transient voltage suppressor depends on the breakdown voltage, whereas this is not the case for a TSS.

For example, with the SMB package we have the transient voltage suppressor series SMBJ and the thyristor surge suppressor (TSS) family SMP100LC which have different behavior in terms of current suppression.

Table 1. Current capabilities of transient voltage suppressor (TVS) SMBJ and thyristor surge suppressor SMP100LC

	Current capability for 1ms wave			
	8 V	65 V	140 V	200 V
Transient voltage suppressor (TVS)	61 A	6.7 A	3 A	2 A
Thyristor surge suppressor SMP100LC (TSS)	100 A	100 A	100 A	100 A

As shown in Table 1 the current rating of SMP100LC devices is always 100 A whatever the V_{BR} value, while it depends on the V_{BR} for the SMBJ series.

2 Summary

Figure 5. Transient voltage suppressor (TVS) / Thyristor surge suppressor (TSS)

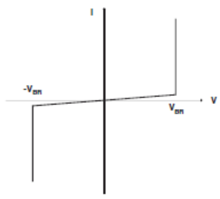
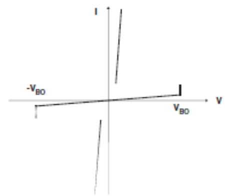
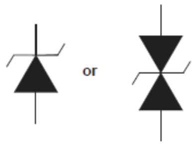
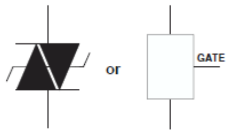
	Transil (TVS)	Thyristor surge suppressor
Type of action	**Clamping**	**Crowbar**
Electrical characteristics		
Schematics		
Electrical behaviors		
Action start	Vsurge > V_{BR}	Vsurge > V_{BO}
Action stop	Vsurge < V_{BR}	I < Holding current

Table 2. Transient voltage suppressor (TVS) / Thyristor surge suppressor (TSS) distinctive advantages

Transient voltage suppressor (TVS)	Thyristor surge suppressor (TSS)
No short - circuit across low - impedance lines, eg - power-supply.	Greater power handling due to lower voltage across terminals.
No need to ensure device switch - off after transient subsides.	Available with programmable breakover voltage.

Figure 5 and Table 2 summarize the different behavior and advantages of both transient voltage suppressor (TVS) and TSS devices. It is not possible to say "transient voltage suppressors (TVS) are better than TSS" or the opposite, only that their application areas are different. STMicroelectronics produces both types of devices meeting the widest protection requirements range.

Revision history

Table 3. Document revision history

Date	Revision	Changes
November-1997	1	First Issue
10-May-2004	2	Stylesheet update. No content change.
24-May-2004	3	Minor text changes, no content change.
09-Sep-2004	4	Minor text changes to improve readability, no content change.
21-Jul-2021	5	Updated Table 1. Minor text changes.

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List of figures