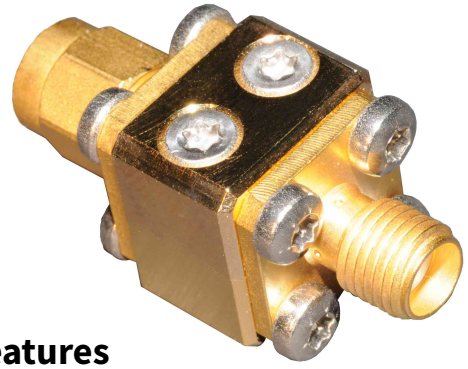
Transient Voltage Suppressor TVS-70MF-10

Advanced TLP/HMM/HBM Solutions



1 Features

- Input overload protection for 50 Ω high speed oscilloscopes and other RF measurement equipment up to 2 kV input voltage in 50 Ω (100 ns pulse width)
- Can be used for protection up to ±25 kV according IEC 61000-4-2 (contact discharge)
- DC to 6 GHz (−1 dB) bandwidth
- DC working voltage range max. ±5 V (at 27 °C)
- Clamping voltage typ. 41 V at 2 kV (50 Ω) or 74 A input overload (100 ns pulse width)
- Insertion loss typ. 0.2 dB at 1 GHz
- Return loss typ. 25 dB at 1 GHz

2 Description

The TVS-70MF-10 transient voltage suppressor can be used to protect sensitive high speed oscilloscope inputs against possibly too high input overload from high voltage pulse generators or IEC ESD guns. **Please note that the protection device TVS-70MF-10 shall only be used in strict compliance with the hardware manual for TLP-3010C/4010C/8010A-C, and that the TVS-70MF-10 is intended and approved for the use with TLP-3010C/4010C/8010A-C only.**

3 Electrical Characteristics

3.1 DC Chararcteristic

Since the DC breakdown voltage of the bidirectional ESD protection diode is approximate ±8 V (Fig. 1), voltage pulses of long duration beyond ±5 V have to be avoided. This holds especially true for DC voltages. Applying a DC voltage exceeding ±5 V has to be absolutely avoided. Transient spikes may cause snapback to about ±6 V.

3.2 Frequency Response

Fig. 2 shows the typical insertion loss of the TVS-70MF-10. In Fig. 3 the typical return loss is presented.

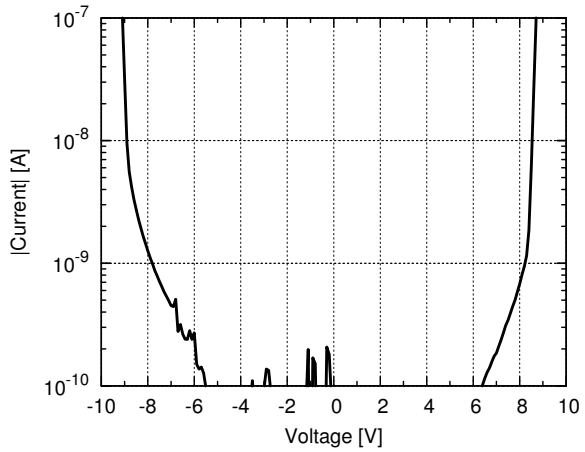


Figure 1: Typical DC characteristic: the current is plotted as absolute value for negative voltages.

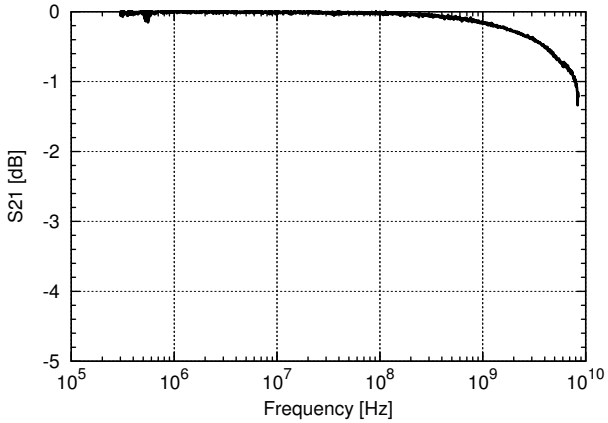


Figure 2: Typical frequency response (insertion loss) S21 (=S12) versus frequency.

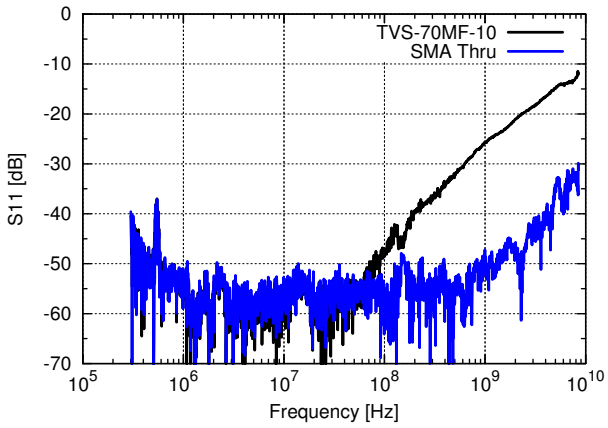


Figure 3: Typical return loss S11 (=S22) versus frequency. As a reference the return loss of a SMA (female/female) thru is also shown.

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3.3 Clamping Characteristic

Fig. 4 and Fig. 5 show the high current clamping characteristics of the TVS-70MF-10 for positive and negative polarities. The device can absorb energies up to ±25 kV according IEC 61000-4-2 with R = 330 Ω, C = 150 pF at contact discharge. Please note, that at >100 ns TLP pulse width the energy absorbtion capability of the device is decreased significantly.

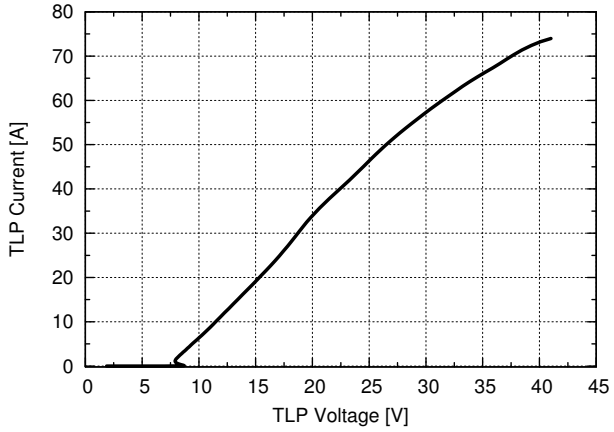

Figure 4: Typical positive clamping characteristic. TLP parameter: 50 Ω, 100 ns pulse width, 0.6 ns rise time, 70 ns to 90 ns averaging window.

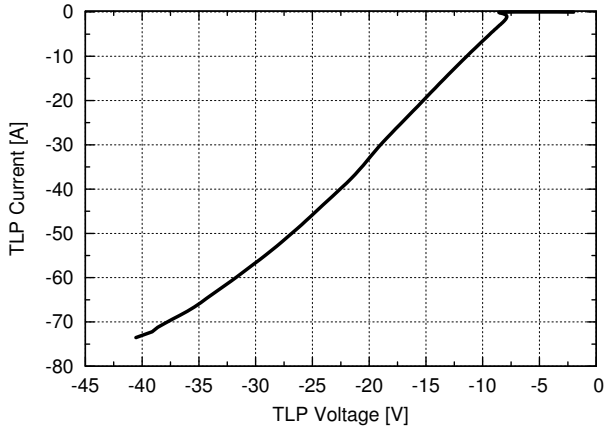

Figure 5: Typical negative clamping characteristic. TLP parameter: 50 Ω, 100 ns pulse width, 0.6 ns rise time, 70 ns to 90 ns averaging window.

4 Application Note

The TVS-70MF-10 overvoltage protection device shown in Fig. 6 is used to protect the sensitive high-speed sampling oscilloscope input from overload in case of a possibly error in the TLP measurement set-up. The TVS-70MF-10 is based on a bi-directional ultra-low capacitance transient voltage suppressor (TVS) diode. It protects the sensitive oscilloscope input against overload and destruction. In general, oscilloscopes from different vendors have different input maximum ratings of pulsed overstress at ESD/EOS condition. Therefore, HPPI cannot specify or guarantee any resulting level of protection. The resulting level of protection may be evaluated together with the oscilloscope vendor using the clamping characteristic of the TVS-70MF-10 shown in Fig. 4 and Fig. 5. The TVS-70MF-10 can be used from DC up to 6 GHz. Applying a DC voltage exceeding ±5 V has to be absolutely avoided.

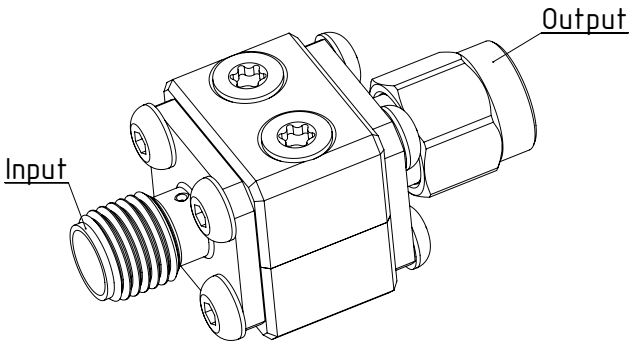

Figure 6: TVS-70MF-10 overvoltage protection with 50 Ω SMA(female) input and SMA(male) output.

Input: 50 Ω input connected usually to the pulse sense signal.

Output: 50 Ω output connected usually to the oscilloscope channel 3 input (TLP voltage or pulse sense voltage measurement channel).

The input and output can be exchanged. The TVS-70MF-10 is a symmetrical, bi-directional device.

Fig. 7 shows how the TVS-70MF-10 may be used in a typical standard TLP measurement setup to protect the oscilloscope input.
The attenuator A3 is optional if high signal (voltage) amplitudes occurs. An additional attenuator A3 is required if the following inequality becomes valid:

$$V_{DUT,max} \cdot \frac{50}{R+50} \geq V_{IN,max} \tag{1}$$

where $V_{DUT,max}$ is the maximum voltage[1] at the DUT, R is the picoprobe probe tip resistance and $V_{IN,max}$ is the maximum allowed voltage at the oscilloscope input. If Eqn. 1 is valid, then the attenuator A3 can be calculated in dB

$$A3 \geq 20 \cdot \log\left(\frac{V_{DUT,max}}{V_{IN,max}} \cdot \frac{50}{R+50}\right) \tag{2}$$

Example: $V_{DUT,max}$ = 1 kV, $V_{IN,max}$ = 5 V, R = 5 kΩ results in $A3 \geq 5.934$ dB ≈ 6 dB.

[1] If the DUT represents an open load, the maximum open load pulse amplitude of the pulse generator may occur!

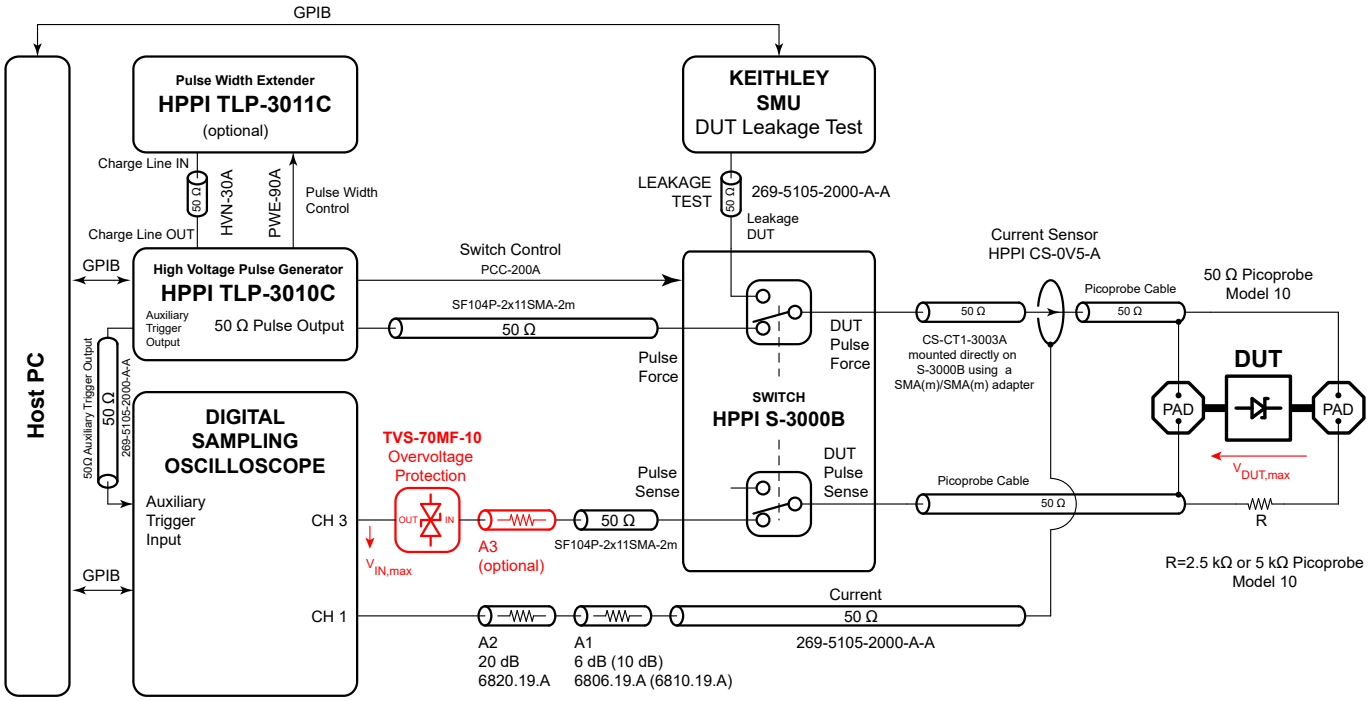

Figure 7: TVS-70MF-10 overvoltage protection device (red) connected in a typical TLP measurement setup.

4.1 How to Check the TVS-70MF-10 is Functional ?

It is highly recommended to check from time to time the functionality of the device since it might be destroyed by misuse in the proposed measurement set-up.

4.1.1 TVS-70MF-10 Electrical Characteristics Verification Procedure

The following section explains the parameter verification procedure for DC, frequency response and clamping characteristics of the TVS-70MF-10.

1. **Measurement of the S-Parameters:**
   - Connect the TVS-70MF-10 to a vector network analyzer as shown in Fig. 8.
   - Measure the 2-port S-parameter from 300 kHz to 10 GHz.
   - Compare the measurement results with the typical characteristics shown in Fig. 2 and Fig. 3.
2. **Measurement of the DC-Characteristics:**
   - Connect the TVS-70MF-10 in the TLP test setup as shown in Fig. 9.
   - Take care that the additional 20 dB attenuator is connected in front of the oscilloscope input channel 3 (see Fig. 9).

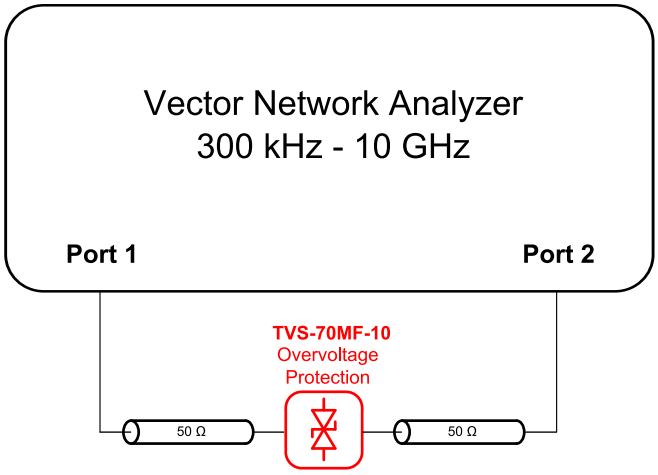

Figure 8: S-Parameter test setup.

- Make a DC sweep with the TLP software from −10 V to 10 V in 0.1 V steps and 1 µA current compliance. Check the ”start sweep from zero” and ”log scale” check boxes.
- Compare the measurement result with Fig. 1. Note that the lower current measurement limit of the SMU is dependent on the vendor and SMU model.

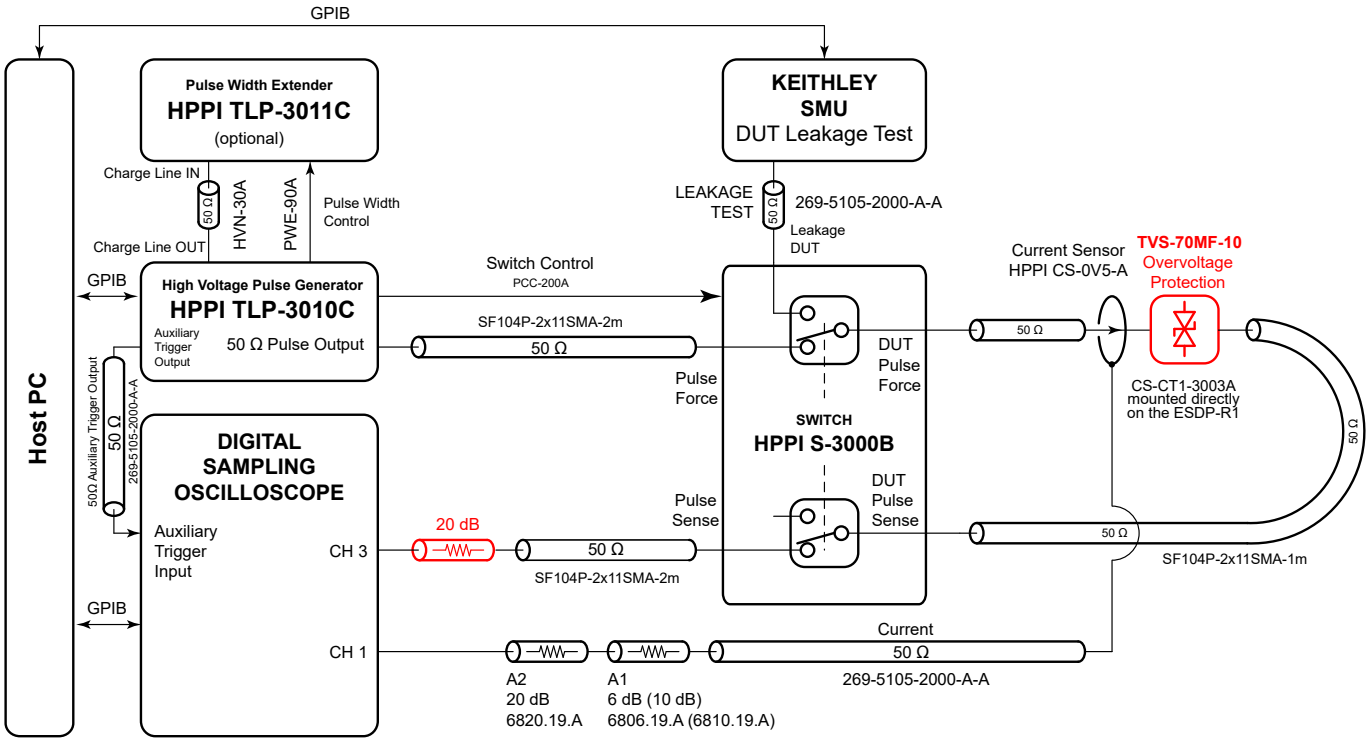

Figure 9: TLP test setup.

3. **Measurement of the Clamping Characteristics:**

   - Set-up the TLP system according to Fig. 9.
   - Take care that the additional 20 dB attenuator is connected in front of the oscilloscope input channel 3 (see Fig. 9).
   - Set the TLP for 100 ns pulse width and 1 ns rise time.
   - Set voltage channel scale factor to 10 (because of 20 dB).
   - Calibrate the current channel without DUT in the 50 Ω system up to 200 V pulse voltage.
   - Connect the TVS-70MF-10 in the TLP test setup as shown in Fig. 9.
   - Set pulse amplitude from 5 V to 200 V in 1 V steps and measure the TLP characteristic for positive and negative polarity.
   - Compare the measurement result with Fig. 10.

If the measurements according the above given description and those shown in Fig. 4, Fig. 5 and Fig. 10 differ significantly, please raise query with HPPI.

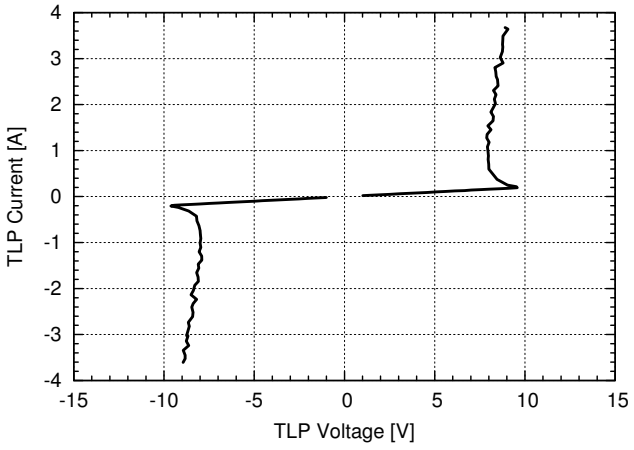

Figure 10: TLP test result with setup shown in Fig. 9.

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5 Ordering Information

Pos.	Description	Part No.
01	Transient Voltage Suppressor, SMA (male/female)	TVS-70MF-10

General

The product data contained in this data-sheet is exclusively intended for technically trained staff. You and your technical departments will have to evaluate the suitability of the product for the intended application and the completeness of the product data with respect to such application. Our products are solely intended to be commercially used internally and should not be sold to consumers. This data-sheet is describing the specifications of our products for which a warranty is being granted by HPPI GmbH. Any such warranty is granted exclusively pursuant the terms and conditions of the respective supply agreement. There will be no guarantee of any kind for the product and its specifications. For further information on technology, specific applications of our product, delivery terms, conditions and prices please contact HPPI:

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