AND9007/D

Understanding TLP Datasheet Parameters

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APPLICATION NOTE

Introduction

Transmission Line Pulse (TLP) is a measurement technique used in the Electrostatic Discharge (ESD) arena to characterize performance attributes of devices under ESD stresses. TLP is able to obtain current versus voltage (I−V) curves in which each data point is obtained with a 100 ns long pulse, with currents up to 40 A. TLP was first used in the ESD field to study human body model (HBM) in integrated circuits, but it is an equally valid tool in the field of system level ESD. The applicability of TLP to system level ESD is illustrated in Figure 1, which compares an 8 kV IEC 61000−4−2 current waveform with TLP current pulses of 8 and 16 A. The current levels and time duration for the pulses are similar and the initial rise time for the TLP pulse is comparable to the rise time of the IEC 61000−4−2's initial current spike. This application note will give a basic introduction to TLP measurements and explain the datasheet parameters extracted from TLP for ON Semiconductor's protection products. For more information on TLP measurements please see application note AND9006/D, "Using Transmission Line Pulse Measurements to Understand Protection Product Characteristics".

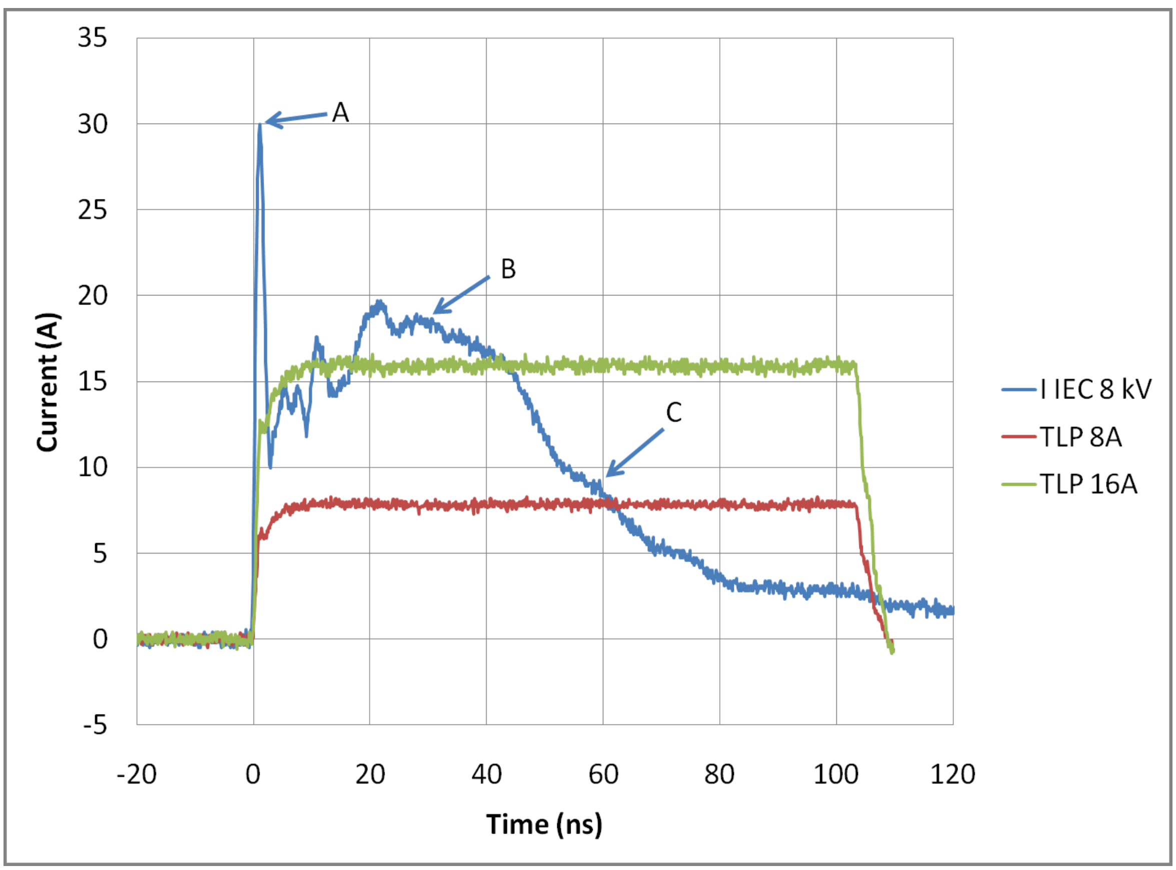

Figure 1. Comparison of a Current Waveform of IEC 61000−4−2 with TLP Pulses at 8 and 16 A

Note that the IEC 61000−4−2 ESD waveforms is true to the Standard and is shown here as captured on an oscilloscope. The points A, B, and C show the points on the waveforms specified in IEC 61000−4−2.

Basic TLP System

A basic time domain reflection (TDR) TLP system is shown in Figure 2. (Coaxial cables are a special case of a transmission line and the terms *transmission line* and *coaxial cable* will be used interchangeably in this document.) An approximately 10 m long 50 Ω coaxial cable, which can be charged to a high voltage, serves as the pulse source. A charged coaxial cable will create a rectangular pulse when discharged into a load. The length of the pulse depends on the length of the coaxial cable. The charged cable is connected to the device under test (DUT) via a switch, an attenuator and a short 50 Ω coaxial cable. Voltage and current probes on the output end of the attenuator are connected to a high speed oscilloscope so that the current and voltage of the pulses can be measured.

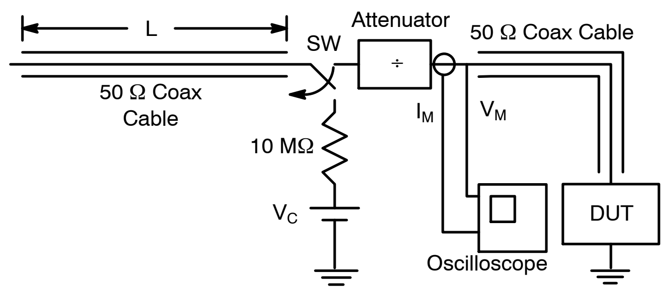

Figure 2. Basic TLP System

A TLP measurement follows a specific sequence. The transmission line is charged to a voltage and the switch SW in Figure 2 is closed. This creates the TLP pulse. The pulse passes through the attenuator, travels down the coax cable to the DUT, reflects off the DUT and travels back toward the attenuator and into the pulse source transmission line. The impedance matched attenuator is included to prevent multiple reflections, which can degrade measurements. The incident and reflected signals captured by the oscilloscope are used to determine the voltage and current at the DUT.

To obtain a current/voltage pair from the measurements a measurement window is defined during the pulse, usually toward the end of the pulse, as shown in Figure 3a. The voltage and current during the measurement window are plotted as a point on the I−V curve, as shown in Figure 3b. To obtain a full I−V curve the process is repeated at a variety of charging voltages for the pulse source transmission line, usually starting at low charging voltages and progressing to higher voltages.

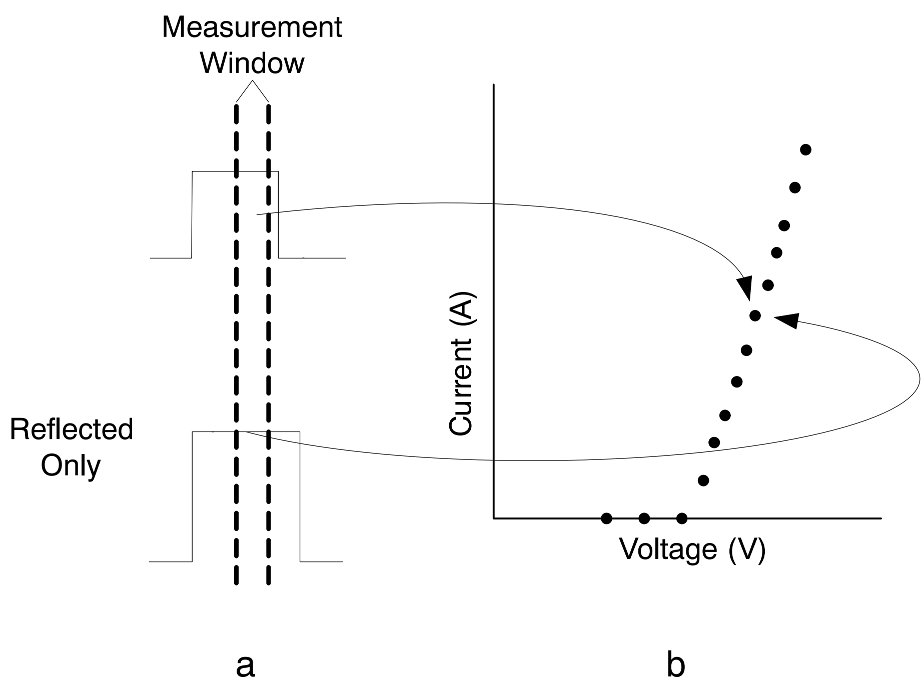

Figure 3. Explanation of How I−V Points are Determined from the TLP Pulses

TVS Device in Reverse Bias

Figure 4 shows sample TLP data for a Transient Voltage Suppressor (TVS) diode in the reverse bias direction. The first data point at just above 5 V is below the device's turn on voltage and therefore shows no current. The remainder of the data points map out a linear I−V curve with a voltage intercept of 7.4 V. There are a variety of ways in which the properties of this device could be represented in a data sheet. A straight forward method is to specify a voltage across the TVS device at specified current levels. ON Semiconductor has chosen this method at 8 and 16 A of current.

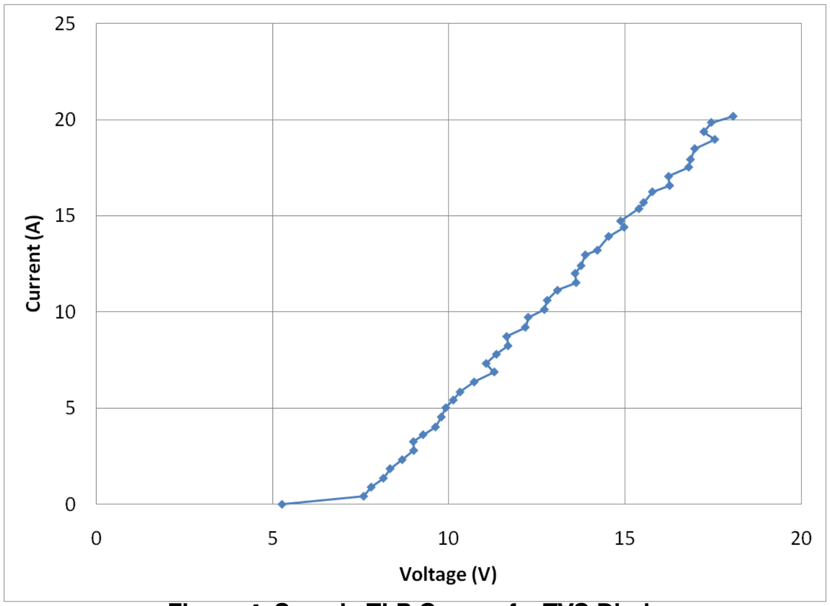

Figure 4. Sample TLP Curve of a TVS Diode

The choice of 8 and 16 A may seem arbitrary at first, but it is based on the waveform parameters in IEC 61000−4−2. 8 kV contact discharge is the highest voltage for which stress waveforms are specified in the Standard. Current is specified at three points in the IEC 61000−4−2, peak current and the currents at 30 ns and 60 ns. For 8 kV the Standard calls for 30 A peak current, 16 A at 30 ns and 8 A at 60 ns, as noted by the points A, B, and C in Figure 1. As shown in Figure 1 the peak current occurs during a very narrow current spike which can deposit very little energy into the system being stressed. It is also very unlikely that this full current spike will penetrate far into a system. The 16 A and 8 A current levels correspond to current levels which constitute the bulk of the stress to the system being tested. ON Semiconductor believes that voltages measured at 8 and 16 A of TLP current represent an excellent measure of the clamping capability of protection devices and provide fair comparison−points.

Summary

Transmission Line Pulse is one of the best ways to characterize the protection capability of ESD protection devices. In addition to displaying TLP I−V curves on its datasheets, ON Semiconductor publishes typical clamping voltages at 8 and 16 A of 100 ns TLP current. These measurements provide an excellent way to estimate a protection device's protection capability and it allows easy comparison between different protection products.

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