What is TLP?

TLP is a short pulse (50ns to 200ns) measurement of the current-voltage (I/V) characteristics of the ESD protection built into an integrated circuit. The short TLP pulses are used to simulate the short ESD pulse threats that the input-output (I/O) pins of an IC must withstand without damage being caused to the complex silicon structures.

The TLP acronym stands for Transmission Line Pulse testing. A constant impedance transmission line is used as a pulse source because it can create a constant amplitude rectangular pulse shape. A flat top rectangular pulse is used because the amplitude at different points along its length can be measured more accurately than can be done with other pulse shapes.

The TLP cable used to generate the rectangular pulse for testing is usually 50 ohm because of the universal availability of coaxial cables and matched coaxial connectors. The coaxial cable is charged with a DC power supply to the desired voltage and then quickly discharged with a low inductance switch. The fastest pulses are made with a switch that is placed in a constant impedance coaxial housing to preserve the fastest possible risetime. A fast pulse can be made into a slower Gaussian risetime by using a matched impedance risetime filter. Such filters slow the pulse risetime without causing any other distortions. This concept is covered more fully in our Application Note #3.

TLP testing is done by applying the rectangular test pulse to the two pins of the Device Under Test (DUT) to be tested. The most common method of introducing the pulse to the DUT has been to split the pulse between a grounded 56-ohm resistor and a 500 to 1500 ohm resistor in series with the DUT pin to be tested. The common pin is connected to the ground lead to provide a return path for the pulse current.

TLP testing typically begins with low voltage pulses that are successively increased in amplitude to provide sufficient points to fill out an I/V plot. Higher or lower amplitude steps can be chosen to provide more or less data points for the areas of interest on the I/V plot. Usually the amplitude of the test pulse is increased until the DUT is damaged to learn its precise pulse current limit. The TLP pulse amplitude increases can be made smaller to add additional test points to some particular area of interest.

Damage to the DUT will occur when the test pulse amplitude becomes high enough to produce enough heat in the DUT to melt some structure and cause a permanent change in the device. Damage is usually accompanied by an immediate increase in the leakage current between the two pins.

A TLP test system includes a leakage measurement after each test pulse as a sensitive monitor of DUT damage. It helps identify precisely which test pulse created sufficient damage to increase the leakage current.

The precise current and voltage amplitudes of the pulse that cause damage to the DUT are then identified by the increased leakage current.

The TLP level of damage information can be compared to HBM damage levels found for the same type of device. TLP testing allows more precise information on damage levels than can be obtained from HBM testing. It allows precise comparisons between different test/production structures as well as providing an I/V plot of the complete electrical operation of the structure throughout its' full range.

The different (I/V) data points are plotted by measuring the pulse current through the device and the voltage across the device near the end of the test pulse. The testing is done near the end of the pulse after the current through the device and voltage across the device have stabilized. Damage to the device will occur near the end of the test pulse that causes enough heating/melting to effect a permanent change. An advantage of TLP testing is to identify the exact test pulse that caused damage to occur.

The temperature, in the silicon structure that absorbs the ESD threat, increases during the rectangular test pulse. The hottest temperatures will be found at the end of the pulse. As the amplitude of each pulse is increased, damage to the device will occur near the end of the test pulse if the step increases in amplitude are made sufficiently small. The goal is to measure the I and V near the end of the pulse to identify the exact pulse where the damage occurred.