**Sources of Transients : Lightning**

Lightning is an atmospheric discharge of electricity resulting from the accumulation of static charges, usually during a thunderstorm. Inside of a thundercloud, static charges are generated by the impact of water and ice particles and separated in strong air currents. Lightning occurs when enough charge has been separated inside the cloud to cause localized electric breakdown of the air.

Lightning is one of the most common causes of transients in electronic systems. Power and telecommunication systems being the most vulnerable. At any given time, there are approximately 1800 thunderstorms in progress around the world generating lightning strikes on the surface of the earth about 100 times every second. Each cloud-to-ground event generally contains 3-5 distinct strokes, but as many as twelve have been observed. Mean peak current for the first stroke is 20kA with subsequent strokes decreasing by 50% or more. While a direct lightning strike is dramatic, it is significant to note that lightning produces intense electric and magnetic fields which can couple into nearby power lines, communication lines, and circuit wiring causing catastrophic or latent damage to semiconductor equipment. The magnitude of the induced voltage varies with the distance from the strike (Figure 1).

**Lightning Standards & Waveforms**

Transient voltage waveforms representative of induced lightning transients are often described by a double exponential impulse waveform. A double exponential surge waveform is defined as having an exponential rise to the peak and an exponential decay from that peak (Figure 2). The pulse is specified by a rise time from 10 to 90% of the peak value and a decay to 50% of the peak value. Industry standards such as **ANSI/IEEE C62.41** define a 1.2/50µs voltage waveform and 8/20µs current waveform for induced lightning on power lines. One of the most common double exponential waveforms for induced lighting in U.S. telecommunication systems is the 10/1000µs impulse waveform as defined by Bellcore **TR-NWT-001089** and Rural Electrification Administration **REA PE-60**. International telecommunication standards such as **ITU K17-K20** often specify the 10/700µs impulse for lightning induced transients. The telecommunication lightning waveform is different from the power line waveform because a lightning strike into a large telecommunication cable is distributed among several internal lines. This has the effect of slowing down the rise time and increasing the decay time of the waveform.
**IEC 61000-4-5** was set forth by the European Community to define the lightning threat to both power and telecommunication lines. The standard specifies double exponential impulses of 1.2/50µs for power and 10/700µs for telecommunication lines to describe the threat.

*References:*
*1. Stringfellow, Dr Michael F. "Lightning" Power Quality & Assurance, Sept/Oct 1995*
*2. Clark, O.M. "Lightning Protection for Computer Data Lines" EOS/ESD Symposium Proceedings, Sept., 1981*

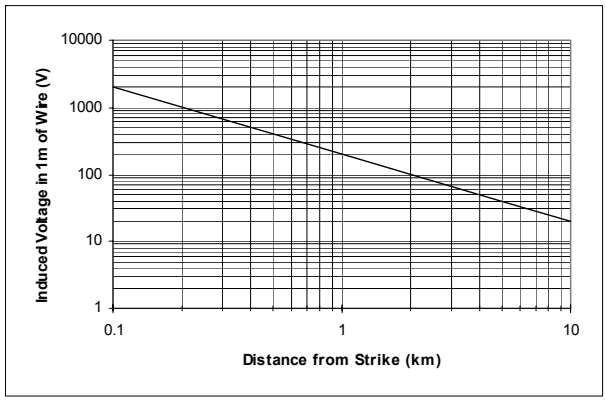


**Figure 1 - Lightning Induced Voltages**

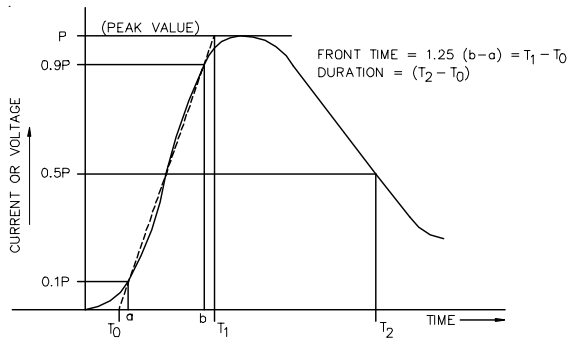


**Figure 2 - Lightning Waveform**