Detecting ESD Events

Kenneth Wyatt - December 26, 2013

In my experience, electrostatic discharge (ESD) issues have now become the second-most prevalent issue other than radiated emissions. If you find your product has exhibits random upsets, such as loss of data or unusual circuit resets, it could very well be caused by ESD. This article describes several methods to detect these events.

During the development of HP’s early logic analyzers, the designers noticed that the prototypes would false trigger randomly. It was eventually noted that the triggering would occur when nearby engineers stood up from their chairs (so called, furniture discharge) or when employees walked by their cube on the carpeting along the aisles. In this case, I placed a commercial ESD detector in the cube where the false triggering was occurring and we were able to confirm and correlate the events. In fact, the ESD detector would count hundreds of discharge events per day. Obviously, the R&D development area was not in a very ESD-protected area!

A lower cost solution for detecting ESD events is a simple AM broadcast radio. I recently upgraded my old Radio Shack AM radio, for the Grundig (Eton) model “Mini 400” AM/FM/SW pocket radio. This $30 (street price) pocket-sized radio (4.25 x 2.75 x .5 inch) seems to have plenty of sensitivity to nearby ESD events. By tuning in the AM band off-station, you can clearly hear the “clicking” from the ESD from several feet away. Using one of these radios is handy for correlating random product glitches with possible ESD events.

Figure 1 - An AM/FM broadcast radio, when tuned off-station in the AM band, works well as an ESD detector. It can detect ESD events from several feet away. This Grundig (Eton) “Mini 400” model also receives several shortwave bands.

I’m also finding it’s quite useful in locating low frequency switch mode power supply (SMPS) EMI. The shortwave bands are especially sensitive to this noise. For example, the CFL and newer LED lamps each have a switched-mode power supplies built into their bases. The multitude of these lamps in homes today can create a cacophony of EMI well above the shortwave spectrum. This is a real issue for amateur radio operators and those who enjoy radio astronomy.
The radio has an analog tuner with digital display. It runs on a pair of AAA cells and seems to have plenty of audio. It also comes with a padded case with belt loop. The only caution I might point out is that the power switch is a momentary button, which could get pressed inadvertently if activated during shipping or if packed tightly in your troubleshooting kit. The radio does have a “Lock” switch on the side that disables the power button, so that ought to alleviate that issue. You just have to remember to unlock the radio prior to use. It also exhibits a fair amount of “dark current” drain in the “off” position, so it’s actually best to remove the batteries during longer storage.

Frequency ranges:

- AM: 517 to 1782 kHz (1 kHz steps)
- SW1: 5.700 to 10.380 (5 kHz steps)
- SW2: 11.600 to 18.450 (5 kHz steps)
- FM: 85.8 to 108.7 MHz (0.1 MHz steps)

I bought mine from Radio Shack for $40, but you can find one on Amazon.com for $30. Recommended.

The AM radio does well at detecting events, but wouldn’t it be nice if you could build up a simple circuit to not only detect ESD, but beep when it occurred, as well as to count the events? I found a circuit for a “Lightning Detector” that also works quite well for detecting ESD. I added additional circuitry to light an LED and activate a piezoelectric “beeper”. I also found a low-cost digital totalizer with manual reset to tally events over a particular time period.

Figure 2 - A simple DIY ESD detector with flashing LED, a beeper and digital totalizer. The design is based on a lightning detector circuit. Sensitivity with a three-foot telescoping antenna is about 50 feet.

Details on the construction may be obtained from my web site (link below). The digital totalizer is a surplus Omron H7EC-series, available used from a number of sources for about $30. The other components are available from your local Radio Shack or other electronic parts supplier.
Figure 3 - This is the basic circuit for the DIY ESD detector. I added additional circuitry for the flashing LED, beeper and digital totalizer.

The circuit is based on a simple lightning detector designed by Charles Wenzel and written up later by Bob Radmore in the April 2002 issue of QST Magazine. It was since improved by Wenzel and described on his Web site (link below). With a three-foot telescoping antenna, the unit can detect ESD events from about 50 feet away. I also use this during the ESD demos for my seminars and other presentations.

One other clever method for discovering physical ESD event locations was developed by colleague and ESD expert, Doug Smith. Here, he’s using a pair of matched antennas and equal lengths of coax feeding separate channels of an oscilloscope. The scope is set to display the rising edges of the ESD events. By holding the antennas an equal distance from his body and rotating, the two rising edges, when coincident, means the radiated signal is hitting the two antennas equally and therefore Doug is either pointed “towards” or directly “away” from the event location. By walking around, you can quickly “direction-find” the location. This is exactly the principle of some radio direction finders in the frequency domain.
Figure 4 - ESD expert, Doug Smith, detecting the source of ESD during one of his High Frequency Measurements seminars.

For long-distance detection, you can’t beat a commercial ESD detector, such as this model with external antenna from 3M (was Credence Technologies). By networking several together and deploying them around a factory or manufacturing building, ESD events may be quickly located.
Figure 5 - A commercial ESD detector with external antenna from 3M.

I hope this article helps you the next time you need to correlate possible ESD events to circuit upsets or to track down the location of ESD discharges.

For more:

DIY low-cost ESD detector

An EMC troubleshooting kit - part 3 (detecting ESD)

Low-Cost ESD Detector

Doug Smith Web Site

Lightning Detectors (Charles Wetzel)