EOS: What Is It and How to Manage It

Our thanks to 3M for allowing us to reprint the following article.

Electrical overstress, or EOS, occurs when excessive electrical signals are applied to components and circuits. Electrostatic discharge (ESD) is only a partial case of electrical overstress and is generally considered as a separate phenomenon. While an ESD event lasts a few nanoseconds, EOS lasts much longer – it is not limited to any duration – and can inflict significant damage, often more severe than ESD. According to Intel, "EOS is the number one cause of damage to IC components." [1]For technical details on EOS exposure, see the referenced sources at the end of this document.

In the static control field, the following sources of EOS may be considered the most common:

- Overvoltage from soldering irons
- Overvoltage from power tools such as electric screwdrivers, etc.
- Overvoltage from the difference in voltage between grounds (e.g. when a circuit is electrically connected to one ground while a tool – manual or automatic – is connected to another ground)
- Overvoltage from test fixtures that can produce undesirable voltage artifacts during commutation or test
- Spikes on power supply during the test
- Many other sources, often unpredictable

EOS is not a new phenomenon – it has existed for a long time. However, with increasing sensitivity of electronics components, EOS is gaining more attention as a significant factor in product yield and reliability.

Without quantifying EOS, it is impossible to manage and control it – this is true for ESD as well. Monitoring EOS is a key in its prevention and management. Continuous monitoring of EOS in production provides a key utility in identifying not only occurrences of ESD, but also in singling out the boards and components that were exposed to EOS levels above desired levels so that these parts are not shipped to the customer.

3M™ Iron Man and Iron Man Plus Workstation Monitors, models CTC330 and CTC331, are designed to provide continuous EOS monitoring in most circumstances. The most frequent question regarding the Iron Man family of monitors is to which alarm level they should be set. Often, a link between ESD and EOS damage levels is being sought. Currently, there is no conclusive information on the correlation between ESD and EOS damage levels for the same devices. It is not that such a correlation is fundamentally impossible; it is that currently there isn't enough published research that exists to establish such a correlation, if one is at all possible. The industry is in the early stages of such developments and it may take several years until this issue is put to a satisfactory end.

There are several documents in the industry, however, that do indicate recommendations on potential damage levels to common electronics components. IPC Standards provide very specific recommendations. IPC-A-610 Acceptability for Electronic Assemblies and IPC Standard for Rework of Electronics Assemblies IPC-7711 state:

- From the outline:
  - Electrical overstress (EOS) is the internal result of an unwanted application of electrical energy that results in damaged components. This damage can be from many different sources, such as electrically powered process equipment or ESD occurring during handling or processing.
- From 3.11 (IPC-A-610) and 2.11 (IPC-7711):
  - With today's products in mind, we can see that EOS is serious and will be even more critical in the future.
  - Current research indicates that voltages and spikes less than 0.5 volt are acceptable. However, an increasing number of extremely sensitive components require that soldering irons, solder extractors, test instruments and other equipment must never generate spikes greater than 0.3 volt.

The IPC Standard is perhaps the most relevant document that can be used by board assembly houses. Most contract manufacturers follow IPC standards (or their equivalents, depending on the industry) for assembly quality. While EOS, along with ESD, make up

only a small portion of the total standard, they are significant and should not be ignored. The ESD coordinator in the factory plays a major role in understanding the EOS/ESD recommendations in these documents; however, involvement of the quality control and/or production manager is critical as well. Compliance with industry standards, such as IPC, are a responsibility of the total factory management team, and therefore it is critical that EOS/ESD be understood by all involved.

There are other documents that provide guidance on EOS levels, specifically for soldering irons. MILSTD-2000A, for example, specifies no more than 2mV of voltage between the tip of the soldering iron and ground. This number, however, may be unrealistic. If the measurements are restricted solely to DC voltage or to 50/60Hz under a very controlled environment, these numbers can be met by some of the top-line soldering irons. In a real-life production environment with all the ground loops and wide-band noise with lots of transients, the realistic numbers are closer to tens of millivolts, if

not higher.

When using the 3M™ Iron Man Workstation Monitor (set at 1V threshold) to monitor EOS on a board, if the alarm is triggered, this indicates that the board may be holding enough charge to cause EOS. For an electric circuit to receive a jolt, it is not only the tool (i.e. soldering iron) that must be holding a voltage on it. The circuit itself may be the culprit, while the tool itself is perfectly fine. The difference in voltage is what creates EOS. If you observe the Iron Man/Plus monitor alarming at a relatively high level, you need to:

a) Check the grounding

b) Check whether the Iron Man/Plus monitor is connected properly

c) Try to reduce the noise level on the monitored board. Since this can be difficult, contact 3M for assistance.

There are a number of noise sources in a typical production environment. The worst culprits are high-current tools that generate significant spikes on ground or power lines. Such spikes may then propagate through the factory, often manifesting themselves far away from the source. For more details, reference the article below: http://www.credencetech.com/products/more/Conformity_2007_1.pdf

Remember, it is not the soldering iron that needs EOS protection, it is the sensitive electronic components on the board. Therefore the measurements must be done in a real-life environment and the EOS signal must be monitored on these boards, not on the iron. After all, protection against overstress of sensitive components is the main goal of an ESD/EOS program.

References:

[1] Intel EOS/ESD Report, 2000, http://www.intel.com/design/packtech/Ch_06.pdf

http://credencetech.com/products/more/ESDA_2005_EMI.pdf

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