A Cost Effective Approach for Transient Voltage Suppression (TVS) in Interconnect Devices

As the aircraft industry strives for robust protection from lightning strikes, EMP and voltage surge for its sophisticated state of the art electronic systems, the role of interconnect device capabilities at providing protection from voltage spikes to internal systems becomes imperative. The interconnect system can serve as the gatekeeper into these costly systems that are highly sensitive to any voltage spikes. Protection is most effective when it is at the interface to the system, placed within the connector. In most of today's applications, protection includes capacitive filtering following the protection device to maximize the surge protection to the system. Historically, interconnect manufacturers have been providing solutions within the connectors that have been effective but costly.

Transient voltage suppression in interconnects is typically accomplished by attaching a device that shorts voltage spikes to the connector shell. The two most common devices are zener diodes (uni-directional or bi-directional) and metal oxide varistors (MOV's, inherently bi-directional). The device parameters, generically referred to as a "transorb," are customer-specified by an operating voltage and a clamping/breakdown voltage as determined by the circuit being protected. Voltage spikes exceeding what will damage circuitry are 'clamped' to a maximum voltage by the transorb.

True protection may only be provided by attaching a transorb to every contact in the interface connector. This is traditionally accomplished using one of the two following methodologies:

The first method involves physically attaching a device to the side of each contact within the connector and grounding them to the connector shell. This incorporates processes that solder the device and then overmold it to isolate and insulate the poles of the device from each other. Surge and leakage current testing of the contact assembly is always mandatory since the processing greatly effects the performance of the product. The small physical size of the device required to accomplish this method minimizes its power dissipation capabilities and results in a longer connector due to TVS and filtering.

The second method involves attaching a pre-tested JANTX-certified device with leads to the contact via circuit boards or other similar techniques, the other end

being connected to the shell. This method offers the ability to use off-the-shelf devices with a wide range of power handling capabilities. However, the larger physical size of the leaded devices necessitates increased connector size, usually both in length and diameter.

Both of the methods described above are labor-intensive and costly. As such, in 2006, ITT Interconnect Solutions' Cannon launched the Chip-on-Flex (CoF) filtering technology, providing the groundwork for a new cost-effective methodology of incorporating TVS devices in a connector. The original CoF technology was developed to handle high shock and vibration, extreme temperature fluctuations, and provide a lightweight solution. The Chip-on-Flex design replaces the fragile ceramic planar array block capacitor with a patented state-of-the-art flexible circuit where individual chip capacitors are surface mounted on a pad adjacent to the feed-thru contact. Since the feed-thru contacts are not soldered directly to the capacitor, stress points that impact performance during thermal shock and vibration have been virtually eliminated. The resulting design is a robust filter connector with superior mechanical performance and improved reliability. These CoF filter connectors provide standard filtering capabilities including individual isolated pin filtering of high-frequency noise, built-in ground plane barriers in the connector inserts, and filtering at the face of system boxes.

This CoF technology utilizes off-the-shelf chip capacitors based on the connector's DWV (dielectric withstanding voltage) voltage rating mounted on flex circuits to provide the required filtering. TVS devices are commercially available in the same package size as chip capacitors. TVS protection can be accomplished utilizing the CoF technology by simply surface-mounting devices on one of the flex layers or adding a separate layer with the TVS devices.

The CoF technique provides many advantages, including:

- Use of off-the-shelf pre-tested devices;
- Compact connector size for 38999 / ARINC 600 / ARINC 404 types, same as a standard filtered connector (slightly longer if an added layer of devices is chosen);
- Automated device and contact attachment;
- Cost effectiveness (priced similar to a standard filtered connector);
- Robust CoF style design, proven to withstand 1000 cycles of thermal shock.

ITT Interconnect Solutions' Cannon has identified the following TVS values to provide guidance for the selection of the appropriate device.

Preferred CoF TVS device values:

BIPOLAR			
BREAKDOWN VOLTAGE (V_{BR})	V_{BR} TEST CURRENT	MAX WORKING VOLTAGE (V_{RM})	MAX LEAKAGE CURRENT AT V_{RM}
7.1 to 9.3	10mA	5.5	20µA
11 to 16	1mA	9	20µA
15.9 to 21.5	1mA	14	20µA
22 to 28	1mA	18	20µA
37 to 46	1mA	30	20µA

UNIPOLAR			
BREAKDOWN VOLTAGE (V_{BR})	V_{BR} TEST CURRENT	MAX. WORKING VOLTAGE (V_{RM})	MAX. LEAKAGE CURRENT AT V_{RM}
11.4 to 12.7	5mA	8	0.1µA
14.3 to 15.8	5mA	10.5	0.05µA
16.8 to 19.1	5mA	12.6	0.05µA
18.8 to 21.2	5mA	14	0.05µA
20.8 to 23.3	5mA	15.4	0.05µA
64.6 to 71.4	2mA	47.6	0.05µA

Chip-on-Flex filtering technology from ITT Interconnect Solutions' Cannon provides a superior, cost-effective alternative to traditional methods of transient voltage suppression. Through the use of CoF technology and surface-mounting

devices on one of the flex layers, or adding a separate layer with the TVS devices, CoF connectors play a key role in protecting aircraft electronic systems from voltage surge, EMP, and lighting strikes.