EMC and SIPI hardware experiments and demonstrations have always been a very popular symposium event, and this year will be no exception. The event’s purpose is to demonstrate important, fundamental EMC and SIPI topics and contemporary areas of interest through practical experiments and demonstrations that may be based on hardware configurations, software programming, or a combination of both. For the virtual symposium this year, many of these demonstrations will be available in video format.

1) Impedance Demonstration  
*Manny Soriano, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA*

This demonstration will introduce the theoretical concepts of Middlebrook criteria, gain/phase margin, and Nyquist stability with respect to source/load impedance and power stability/quality, and then demonstrate how impedance is measured at a power source and its respective load with a test setup, including calibration. Audience members will see how to measure a circuit with non-compliant input impedance against ISS or similar requirements, use analysis tools to visualize that non-compliance, and observe the resulting instability of the source/load network. The demonstration will additionally cover how to determine possible mitigation strategies and introduce them into the measurement setup, repeat the test and analyses with proposed mitigation strategies, and conclude by summarizing the necessity of designing a stable power subsystem and verifying it with respective test and analytical approaches, making adjustments when necessary.

2) EMI Noise Separation and Filter Design for a Switching Mode Power Supply  
*Michael Schutten and Cong Li, GE Global Research Center, Niskayuna, NY, USA*

This demonstration will show how to decouple differential-mode (DM) and common-mode (CM) noise from the conducted EMI measurements of a switch-mode power supply (SMPS). This DM/CM information is used to design an optimal EMI filter. A custom DM/CM separator box will be presented and used to decouple the SMPS DM and CM EMI components. The methods by which CM and DM EMI are created in the SMPS will be experimentally demonstrated. The DM and CM noise of the unfiltered SMPS will be experimentally shown. This information will be used to systematically design an optimal
EMI filter. The filter will be developed in multiple stages, to systematically show the EMI impact of the added stages.

3) Control of Electric and Magnetic Radiated Emissions at Low and High Frequencies

Pablo Narvaez and Katherine Dang, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

The Jet Propulsion Laboratory has participated in multiple projects whereby implementation of proper electric and magnetic field shielding has been a key component in successful space missions free of electromagnetic interference. This hardware experiment/demonstration will present typical radiated electric and magnetic field shielding methods similar to those applied on JPL hardware for typical flight programs. Emphasis will be on the need for proper shielded cable terminations at connector backshells.

4) Signal Integrity and EMC Analysis of PCBs and Cable Harnesses for Aerospace and Automotive Applications

Martin Vogel, Altair Engineering, Inc., Hampton, VA, USA

Aerospace and automotive platforms are using an increasing number of electronic systems involving PCBs with high-speed digital circuits and cable harnesses to connect various electronic modules. Signal integrity (SI) is as a result becoming an increasingly important element of PCB design. At high bit rates and over long distances or through various mediums, various effects can degrade the electrical signal to the point where, due to these errors, the system or device fails. In addition, cable harnesses connecting various electronic modules are a major concern in EMC/EMI: on the one hand, they radiate into the environment (radiated emissions); and on the other hand, external fields, e.g. from lightning or HIRF, induce currents on the harnesses that are connected to sensitive electronics (radiated susceptibility or irradiation). During this demonstration, a refresher will be provided on EMC simulations involving cable harnesses in 3D geometries like vehicles and aircraft, with focus on the practical consequences of certain necessary assumptions for shielded cables and unshielded cables. In this demonstration, two critical problems will be addressed: (1) determination of the common-mode component responsible for radiated emissions from the cable when the integrated circuit launches a mostly differential signal, and (2) simulation aspects of imperfect connections at the cable terminals and their effects. This demonstration will also provide insights into different modeling methods for SI and EMC applications related to aerospace and automotive applications.

5) Finding Resonances in Troubleshooting EMI/EMC Problems

Arturo Mediano, University of Zaragoza, Zaragoza, Spain

In EMI/EMC, resonances create many of the most common and difficult to solve problems. This demonstration will allow audience members to discover how to use near field probes attached to a network analyzer (VNA) or a spectrum analyzer, combined with a Voltage Standing Wave Ratio (VSWR) bridge, to find resonances in your electronic components, circuits, cables, PC boards, enclosures, etc. This technique is so powerful!

6) Debugging a Failed EMC Chamber Above 1 GHz Using Time Domain Measurements

Anoop Adhyapak and Zhong Chen, ETS-Lindgren, Cedar Park, TX, USA
If an anechoic chamber fails a performance validation test above 1 GHz using the sVSWR method specified in CISPR 16, it is very difficult to identify the root cause of the failure. Conducting the root cause analysis and identifying the failure through the conventional sVSWR method is often time-consuming and involves a cumbersome trial-and-error approach. However, the Time Domain sVSWR method that is described in the recently published ANSI C63.25.1-2019 standard for test site validation can help with chamber failure analysis and efficient debugging. This demonstration presents the utilization of the time domain transform of the measured S21 responses to derive the time of arrival information of the potential sources of failure. By using the time of arrival information and applying a ray tracing procedure to the geometry of the test setup, the sources of failure are quickly identified for corrective action. The demonstration illustrates the effectiveness of the measurement process, the data post-processing, and analysis of the results.

7) EMI Mitigation of Wide Bandgap Devices  
*Jared Quenzer, Würth Elektronik, Watertown, SD, USA*

Wide-bandgap switching devices are increasing in popularity, with advanced materials such as silicon carbide and gallium nitride becoming available technologies for designing end products. Because of the fast rise time of these devices, designing a circuit with EMC in mind is a high priority. This demonstration will show step-by-step how to design an EMI filter to mitigate conducted emissions caused by a SiC transistor with live measurements to prove the filter design. Techniques will also be discussed for mitigating radiated emissions.

8) Radiated Emissions as a Function of Common Mode Current  
*John McCloskey, Jen Dimov, NASA/Goddard Space Flight Center, Greenbelt, MD, USA*

For any product, an essential part of EMI testing is the radiated emissions test. However, it is often the case that product development engineers, concerned with more visible design problems, ignore EMI concerns until the very day they take their boxes to an EMI test facility for radiated emissions testing, and then are terribly shocked when the products emissions are above the limit. At frequencies below about 200 MHz, a significant portion of the radiated energy originates from uncontrolled common mode currents on cables connected to the unit. The product development engineer may perform an early assessment of radiated emissions by directly measuring these currents. In this demonstration, a controlled current is applied to a wire above a ground plane, and the resulting electric field is measured. The transfer function of electric field per unit current (E/I) is determined and presented as a tool for predicting radiated electric fields from a simple measurement with a clamp-on current probe before the product ever leaves the development laboratory. Product development engineers are encouraged to perform these measurements in order to facilitate diagnosis of potential problems as early as possible in the product's development cycle.

9) Troubleshooting Conducted Emissions When the Noise Path Isn’t Conducted  
*Lee Hill, SILENT Solutions LLC, Amherst, New Hampshire, USA*

Most system-level and many component-level EMC test programs require the evaluation conducted emissions, which are noise currents or noise voltages that are produced the EUT at its input and/or output power terminals. In many cases conducted emissions test failures result from common-mode
noise currents that are NOT conducted coupled from the EUT to the measurement device. This demonstration will illustrate how to identify the path of the noise current in such cases.