PLASTIC STRUCTURE PROVIDES AN ENCLOSED, RF TRANSPARENT TEST FACILITY TO MEET FCC REQUIREMENTS FOR RADIATED EMI TESTING

Electromagnetic waves find transparency through composite materials.

TOM TOLER, COMPOSITE TECHNOLOGY INC., FORT WORTH, TX and
RALPH TREFNEY, APPLE COMPUTER, CUPERTINO, CA

The FCC requires that all computer manufacturers meet the emanations standards laid out in Part 15, Subpart J of the FCC Rules and Regulations. According to the document, the radiated, electromagnetic wave energy is to be measured in the open field to ensure repeatability by eliminating any reflecting objects near the measurement field. Only one plane of reflection is used for a known reference, a metallic ground plane extending from the equipment under test to the antenna used to measure the field strength of the emanation. This ground plane is to be flat to within one-tenth of a wavelength at the highest measured frequency to prevent the wave from being reflected. The ground plane also must extend behind the equipment under test and the measurement antenna so that both establish a uniform wave current distribution and impedance relationship to the ground plane without causing uneven current gradients due to "bunching."

DESIGN OF THE TEST FACILITY

A major computer company is testing electronic components in a recently constructed facility near its main engineering and corporate location in California. During the design process of the facility, the company had to consider the FCC's open field requirement, which presents the problems of exposing expensive test equipment to the elements and scheduling testing due to extremes in the weather. For this reason, management wanted an enclosed facility that would, in accordance with FCC specifications, offer no reflections of the measured wave energy. The facility also had to be designed to withstand the weathering elements of the Pacific coastal environment and to satisfy the Coastal Commission's demands that it not affect the ecological systems in the agricultural community where it was located.

SELECTION OF MATERIALS AND MANUFACTURER

The architectural engineering firm hired to design the building was given a specification as to the electrical properties of the needed materials, then procured the materials and manufacturer that best suited the requirements. Fiberglass reinforced composites were selected as materials for constructing the open field test facility because the materials provide transparency to electromagnetic waves. In addition to being nonmagnetic and electrically non-conductive, advanced composites of structural plastic are more durable in harsh, corrosive environments than more conventional materials such as steel, wood, and concrete. The dielectric properties combined with the structural strength and stiffness of a properly designed composite made fiber-reinforced plastic materials the optimum choice when compared to alternative materials.

The facility's components are constructed entirely from composite materials including all structural members, cladding, and fasteners. Metal sections, even fasteners, would interfere with the testing.

The composite components utilize straight, continuous glass fibers for structural reinforcement. The reinforcing fibers, which have a tensile strength of 500,000 psi, are advantageously placed within a plastic binder of premium grade resins that offer corrosion resistance, heat stability, and fire and flame retardance. Structural sections are closed and shaped to develop maximum structural quality. The efficient design of the composites provide strength and stiffness essential for building construction.

EFFECTIVENESS OF THE FACILITY

The building covers a 10-meter portion of a 30-meter facility. The building dimensions are 36 feet wide and 56 feet long (2016 sq. ft.) and one full story high. The reference ground plane is 36 feet wide and 122 feet long (4392 sq. ft.). For maximum cost effectiveness, only the 10-meter portion is covered; the 30-meter portion, required for European certification, is not frequently used. The reference ground screen is flat to within 1/4 of an inch. This flatness was achieved by grinding the high spots in the concrete to obtain this tolerance.

The building has, at one end, a pair of sliding doors which can be opened to the outside for 30-meter

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tests. In response to concern about the dielectric effects of the doors over the test frequency range from 30 to 1000 MHz, tests were conducted to establish what variation in field strength would be measured with the doors open and closed. The results showed a variation of no greater than 0.5dB over the entire frequency range.

The ground screen is constructed of 22 gauge wire, 1/4-inch by 1/4-inch square hardware cloth, electro-galvanized after weaving. It was provided in 48-inch wide and 100-foot long rolls. Seams were bound by underlayments of 3-inch wide galvanized steel strips, 8 feet long, over which the ground screen was laid and then soldered, using butt joint techniques. In the installation process, the building contractor was able to stretch the hardware cloth to remove mill distortion in the material and to ensure absolute flatness.

In the design of the building and the placement of the turntable and antenna measurement positions, consideration was given to symmetrical relationships. After careful consideration, a decision was reached not to allow symmetrical relationships to exist between the turntable, the building, or any of the antenna measurement points of 3, 10, or 30 meters. This was achieved by a slight skewing of the turntable position in relationship to the major axis of the centerline of the ground screen and building. This eliminated any sympathies that might develop into frequency dependent forms as a result of symmetrical relationships.

The site was calibrated over the frequency range of 30 to 1000 MHz, and did not vary more than ±1.6dB from the mathematical model in the site calibration procedure, OST-55, as published by the Federal Communications Commission. (The OST-55 document requires that the site calibration be within ±2.0dB.) This was demonstrated at both the 3-meter and 10-meter positions which are totally enclosed by the building structure.

The test site is equipped with a motorized turntable 8 feet in diameter, and supports a 2000-pound payload. The antenna mast is motorized and eqipped with auto-polarity means. The instrumentation and measurement procedures are fully automated and afford a repeatable and efficient test facility.

SUMMARY

The test facility, made entirely of properly designed fiberglass reinforced composites, has produced an RF transparent building that is enclosed to protect expensive test equipment, and allows year-round testing regardless of weather conditions, in keeping with FCC specifications for open-field testing. ■