Build a Magnetic Field Immunity Tester

Jim Ericson - June 01, 1999
The latest versions of European CE-Marking standards include magnetic-immunity requirements for residential, commercial, industrial and audiovisual electrical and electronic equipment. Your product may be required to meet these new requirements. Magnetic fields can produce character distortion on CRT displays, distortion in audio equipment, or false readings in equipment containingHall-effect devices or other electromagnetic field sensors. You can assemble a precompliance (or even full compliance) magnetic field immunity test system in a few hours using common laboratory instruments, a 100-W audio amplifier, some white PVC "Schedule-40" ¾-in. water pipe, some wood, and a copper or aluminum sheet.

European Standard EN 61000-4-8:1993 requires a 63 dB test field tolerance. That requirement results in a usable test volume of 0.6 x 0.6 x 0.5 m for a square loop 1 m on a side. Larger EUTs would require construction of a larger loop or a double "Helmholtz" coil as shown in the test standard. The Biot-Savart Law states that a single-turn circular loop with a diameter of 1 m will generate a magnetic field at its geometric center equal to the loop current. So, a round 1-m diameter loop carrying 1 A of current with two turns will produce a field of 2 A/m at its center. For a square loop, the correction factor is 4√2, or 90%. A 1 m square loop with two turns carrying 1 A of current will, therefore, generate a 1.8 A/m field at its center. Magnetic fields, however, are usually expressed in gauss, teslas, and oersteds. See "Handy Conversions," this page, for help in converting units.

**Build the Loop**

To construct a 1-m² multturn coil, you need straight PVC water pipe, elbows, and tees joined with liquid plastic-pipe cement. Figure 1 shows a 1-m³ PVC pipe frame that contains a two-turn, insulated 18-gauge solid copper wire loop inside. Solder banana jacks to the loop wires where they exit the pipe. Make a flexible twisted pair cable—not longer than 3 m—and connect it to the audio amplifier or other current source.

![Figure 1](image1.png)

Figure 1. Use PVC pipe to make a loop for magnetic field immunity testing.

Make all connections mechanically strong. Solder them well because the total loop resistance at 50 Hz will be about 200 mΩ. To complete the test setup, build a wood frame to support the loop. Place the frame and loop above a non-magnetic, aluminum or copper ground plane with minimum dimensions of 1 m x 1 m x 0.025 m.

Figure 2 shows how to connect the loop to the audio amplifier through an 8-W, 100-W power resistor with the loop. The resistor approximates the impedance of a speaker. The amplifier must be capable of handling the load connected to the test circuit and connected to the ground plane to safety earth. Connect the "low" side of the loop coil circuit to the ground plane; connect the "high" side of the loop circuit to the power resistor. Use PVC pipe to make a loop for magnetic field immunity testing. You can assemble a precompliance (or even full compliance) magnetic-field immunity test system in a few hours using common laboratory instruments, a 100-W audio amplifier, some white PVC "Schedule-40" ¾-in. water pipe, some wood, and a copper or aluminum sheet.

**Test Procedure**

To perform the magnetic immunity test, you’ll first need to define an appropriate test plan for your EUT. After verifying the EUT’s performance to its technical specifications, expose the EUT (and 1 m of any EUT cables) to the test field at different orientations by rotating the loop and shifting the EUT. Verify that the test field on the EUT is acceptable and the equipment is able to recover by itself when you remove the field. You can use the loop to perform full compliance testing if you calibrate the loop. To perform the calibration, you must measure the field strength with a calibrated instrument. Measure the field generated by the magnetic loop with either a Gauss meter or a small-calibrated loop antenna.2 If you use the loop antenna, you must connect it to either an EMI meter or a spectrum analyzer.

Depending upon the EUT’s application, the requirements of the "light" and "heavy" industrial standards EN 50082-1:1997 and EN 50082-2:1995 for magnetic immunity may range from 3 A/m to 30 A/m at the powerline frequency.2, 4

The product family standard for EMC immunity of professional audio/video equipment (EN 55103-2:1996) requires magnetic immunity testing from 50 Hz to 10 kHz at levels from 0.008 A/m to 10.0 A/m, depending upon the EUT’s classification.5 Requirements for other families (such as medical devices) are under consideration.

FOOTNOTES

1. EN 61000-4-8:1993, Electromagnetic compatibility (EMC) — Part 4—8: Testing and measurement techniques—Power frequency magnetic field immunity test. European Committee for Electrotechnical Standardization (CENELEC), Brussels, Belgium.


5. EN 55103-2:1996, Electromagnetic compatibility - Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use—Part 1. Immunity, European Committee for Electrotechnical Standardization (CENELEC), Brussels, Belgium. (This product family standard becomes mandatory on September 1, 1999.)

Jim Ericson is an EMC engineer at Acme Testing. armtest@acmetesting.com.