AN INTRINSICALLY SAFE WIDE-BAND ANTENNA SYSTEM

A specialized antenna system can be used to perform electric field measurements near high voltage power lines.

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The Intrinsically Safe Wide-band Antenna System (ISWAS) is a unique system designed to significantly reduce the hazards of making electric field measurements in the presence of high voltage power lines and their associated fields. Performing electric field measurements in the vicinity of power distribution lines can result in significant danger to equipment and personnel. The ISWAS reduces this hazard by removing highly conductive paths between the measurement point and the operator.

The ISWAS is composed of four major components:

- an antenna/converter;
- a fiber-optic cable;
- an optical receiver;
- a fiberglass positioning pole.

A system diagram is shown in Figure 1. The antenna system operates over the frequency range of 50 kHz to 220 MHz, with sensitivities shown in Figure 2, and has an average dynamic range of 50 dB. The ISWAS has an antenna/converter module which consists of a shortened, balanced, fat dipole antenna with an RF amplifier, an electrical-to-optical signal converter, and a battery supply built into the antenna elements themselves. The only connection to the antenna module is a fiber-optic cable which carries the optical signal to the optical receiver unit.

The antenna module is mounted on an extendible fiberglass pole which is a modified "hot stick" used by electrical linemen while working near high voltage lines. As such, it is designed and tested to operate around high voltage power lines. Since high voltages are potentially lethal to humans and destructive to equipment, the ISWAS design specifically protects the operator and equipment. Obviously these safety features can be negated by operation during moist conditions, e.g., rain, snow, and heavy dew.

The optical receiver unit consists of an optical receiver/demodulator, an RF output line driver, and a rechargeable battery supply with built-in recharger. This subsystem can be operated from the battery or from a 50/60 Hz input, as dictated by measurement conditions. The output of the optical receiver unit is an accurate representation, in both frequencies and amplitudes, of the signals received by the antenna/converter unit. This output can be routed to a spectrum analyzer for display and measurement of the received signals, as shown in Figure 3. The operation of the ISWAS is simple and straightforward; little training is needed to accurately monitor and/or measure signals. Enhanced signal analysis would require advanced skills, as would be required

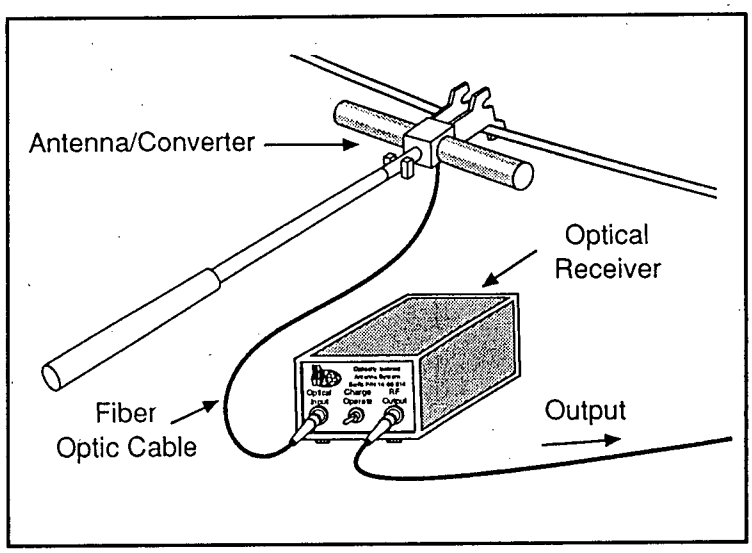

Figure 1. An Intrinsically Safe Wideband Antenna System.

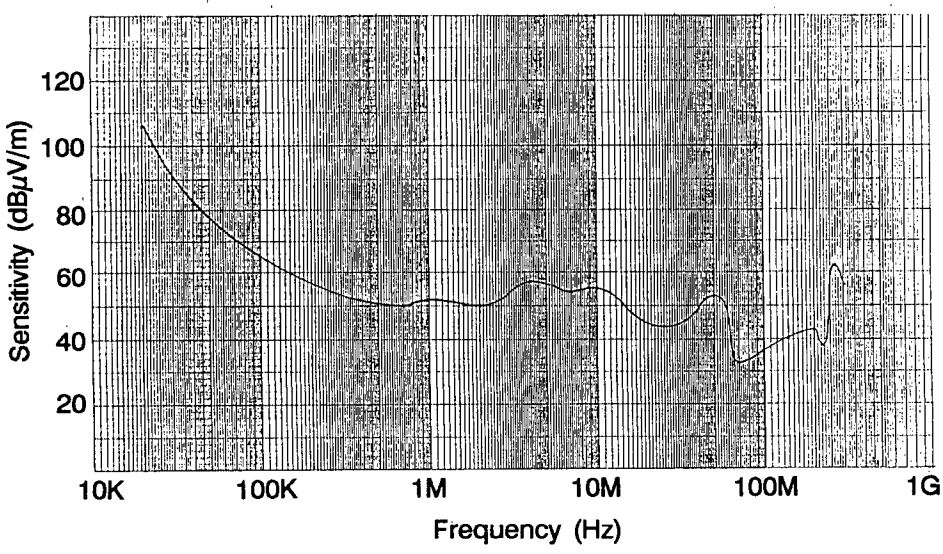

Figure 2. Typical System Sensitivity.

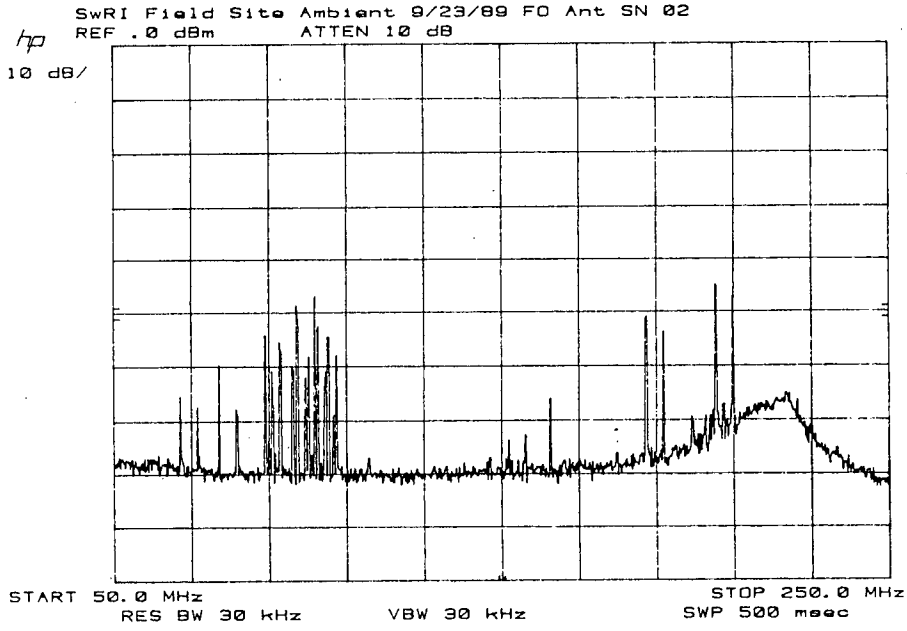

Figure 3. Typical System Output, Using Spectrum Analyzer.

for other measurement techniques.

The antenna/modulator unit is mounted on the extendible fiberglass pole and the fiber-optic cable is connected to the optical receiver. The antenna/modulator unit is designed with an unique bracket that allows the ISWAS to be positioned at a fixed distance from the high voltage cable with one of three orthogonal polarizations.

There are two options in the placement of the antenna near the high voltage line. The first option is a search mode where the unit is positioned against the line and manipulated by the operator while the spectrum analyzer is monitored. The second option is the monitor mode, where the unit is hooked onto the high voltage cable and remains in a stable position without operator assistance. This mode of operation is very useful for longer periods of monitoring a particular power line for narrow-band and/or broadband signals which are irregular in nature or timing.

While the ISWAS was designed to solve unique problems posed by the operation of RF measurement systems in the vicinity of high voltage power lines, it is also very useful for other measurement applications in its operational range. One example is operation around other lower voltage cables such as motor controllers, data lines, and coaxial cables. The use of the ISWAS allows the identification of particular cables which may be radiating narrow-band and/or broadband interference signals.

Another application is the probing of large computing systems to determine the escape point of various internally generated signals. For this application, the extendible fiberglass pole is replaced by a shorter nonconductive handle or tripod. The size of the antenna allows better positive resolution of exit points than is possible with other larger measurement antennas. Also, since the ISWAS has an amplified balanced antenna, it can detect signals which are undetectable by unamplified passive probe systems. A third application supports analysis of the shielding effectiveness of enclosures, rooms, and entries.

While the ISWAS does not cover the entire frequency range as specified in NSA 65-6 and other similar documents, it does provide rapid wideband capabilities for initial investigations of newly constructed shielded areas by using signals of convenience, such as those of the various broadcast services. The ISWAS can also be used in measurements performed in accordance with various specifications, such as MIL-STD 285. ■

FOR FURTHER READING

"An Isolated Antenna System for Shielded Enclosure Measurements, 20-200 MHz," G. N. Van Steenberg, E. L. Bronaugh, and W. C. Dolle, *1971 EMC International Symposium*, Philadelphia, PA, July 1971.

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"A Small, Accurate, Optically Isolated Electric Field Probe," R. J. Spiegel, D. R. Sterns, E. H. Cooper, and E. L. Bronaugh, *1979 IEEE Power Systems and Apparatus (PES) Summer Meeting*, Paper A79 507-3, Vancouver, B.C., July 1979.