

## **RADIATED AND CONDUCTED SUSCEPTIBILITY TESTING**

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### **INTRODUCTION**

This paper describes a test procedure used by CCL to evaluate the susceptibility of telephone equipment to radiated and conducted electromagnetic interference. The procedures have been specifically devised for single line telephone sets, but may be adapted as needed for other types of equipment. The criteria used in this test method for determining susceptibility is audio detection of the interfering signal.

Radiated electromagnetic interference occurs when the dimensions of the equipment being examined are of the same magnitude as the wavelength of the interfering signal. Conducted electromagnetic interference occurs when the dimensions of the equipment being examined are much less than the wavelength of the interfering signal. In this case, the interference is conducted to the device via an external cable.

When equipment is susceptible to electromagnetic interference, it can cause the equipment to operate in an undesirable manner. The most typical problem for a single line telephone set is caused when a modulated RF signal is detected by the equipment and amplified so that the interference is heard as audio interference. Other problems may also occur, including unwanted changes of state and data errors. The degree of susceptibility for a particular device can be evaluated by monitoring the performance of the equipment in a radiated electromagnetic field of known field strength and frequency, and by monitoring the performance of the equipment in the presence of conducted interference signals of known amplitude and frequency.

## TEST CRITERIA

In order to evaluate the immunity of a particular device to electromagnetic interference, it is necessary to define the desired levels of performance. In making this evaluation, the interfering signal must also be described. In particular, the signal amplitude, frequency and modulation must be described.

For a single line telephone, the ideal level of performance would be no audio interference for all types of interfering signals. A maximum acceptable level of audio interference must be chosen for practical purposes. Generally this is a value just slightly above the ambient noise level. The test procedure described here uses a level approximately 5 dB above the ambient level, which is about 50 dBspl. Therefore the maximum acceptable level of audio interference is 55 dBspl.

Susceptibility due to radiated signals is found to be the more dominant type of interference at high frequencies (frequencies above 10 MHz). Susceptibility due to conducted signals is found to be the more dominant type of interference at low frequencies (frequencies below 10 MHz). Both types of interference are important at the middle frequencies (frequencies from 5 to 30 MHz). A low frequency limit of 100 kHz and a high frequency limit of 150 MHz are considered adequate for the evaluation of a single line telephone set.

For the radiated susceptibility measurements, a frequency range of 100 kHz to 150 MHz is used. The detected audio level from the handset shall not exceed 55 dBspl while subjected to a 5 V/m RF signal, modulated with a 1 kHz tone at 80% amplitude modulation, over this frequency range. Five V/m was chosen as being representative of a typical worst case field condition.

For the conducted susceptibility measurements, a frequency range of 100 kHz to 30 MHz is used. The detected audio level from the handset shall not exceed 55 dBspl while subjected to a common mode RF signal of 3 V on the line cord, modulated with a 1 kHz tone at 80% amplitude modulation, over this frequency range. Three V was chosen as being representative of a typical worst case field condition.

## TEST PROCEDURES

### **RADIATED SUSCEPTIBILITY**

A block diagram of the radiated susceptibility test setup is included as Figure 1. The EUT is placed in a TEM cell to provide an accurate and uniform field. An RF signal that is modulated by a 1 kHz tone with 80% amplitude modulation is induced into the input of the TEM cell. The output is monitored using a power meter and the electric field is calculated from an equation based on the cell dimensions. The EUT is radiated from 100 kHz to 150 MHz.

The handset is mounted to an acoustic coupler that provides an artificial ear to measure the sound level at the receiver portion of the handset. The artificial ear is connected to a B&K sound level measuring amplifier which is then connected to an HP FFT analyzer to monitor the sound level of the 1 kHz tone. The field strength within the TEM cell is maintained at 5 V/m over the frequency range of 100 kHz to 150 MHz. The sound level in dBspl from the receiver of the handset is measured and recorded between 100 kHz to 150 MHz.

### **CONDUCTED SUSCEPTIBILITY**

A block diagram of the conducted susceptibility test setup is included as Figure 2. The set under test is placed on a conductive table in a screened room. An RF signal that is modulated by a 1 kHz tone with 80% amplitude modulation is induced onto the line cord via a current injection probe. A high impedance voltage probe and spectrum analyzer are used to measure the common mode voltage between the line cord and the ground plane. The EUT is injected with a common mode signal from 100 kHz to 30 MHz.

The handset is mounted to an acoustic coupler that provides an artificial ear to measure the sound level at the receiver portion of the handset. The artificial ear is connected to a B&K sound level measuring amplifier which is then connected to an HP FFT analyzer to monitor the sound level of the 1 kHz tone. The common mode voltage is maintained at 3 V over the frequency range of 100 kHz to 30 MHz. The sound level in dBspl from the receiver of the handset is measured and recorded between 100 kHz to 30 MHz.

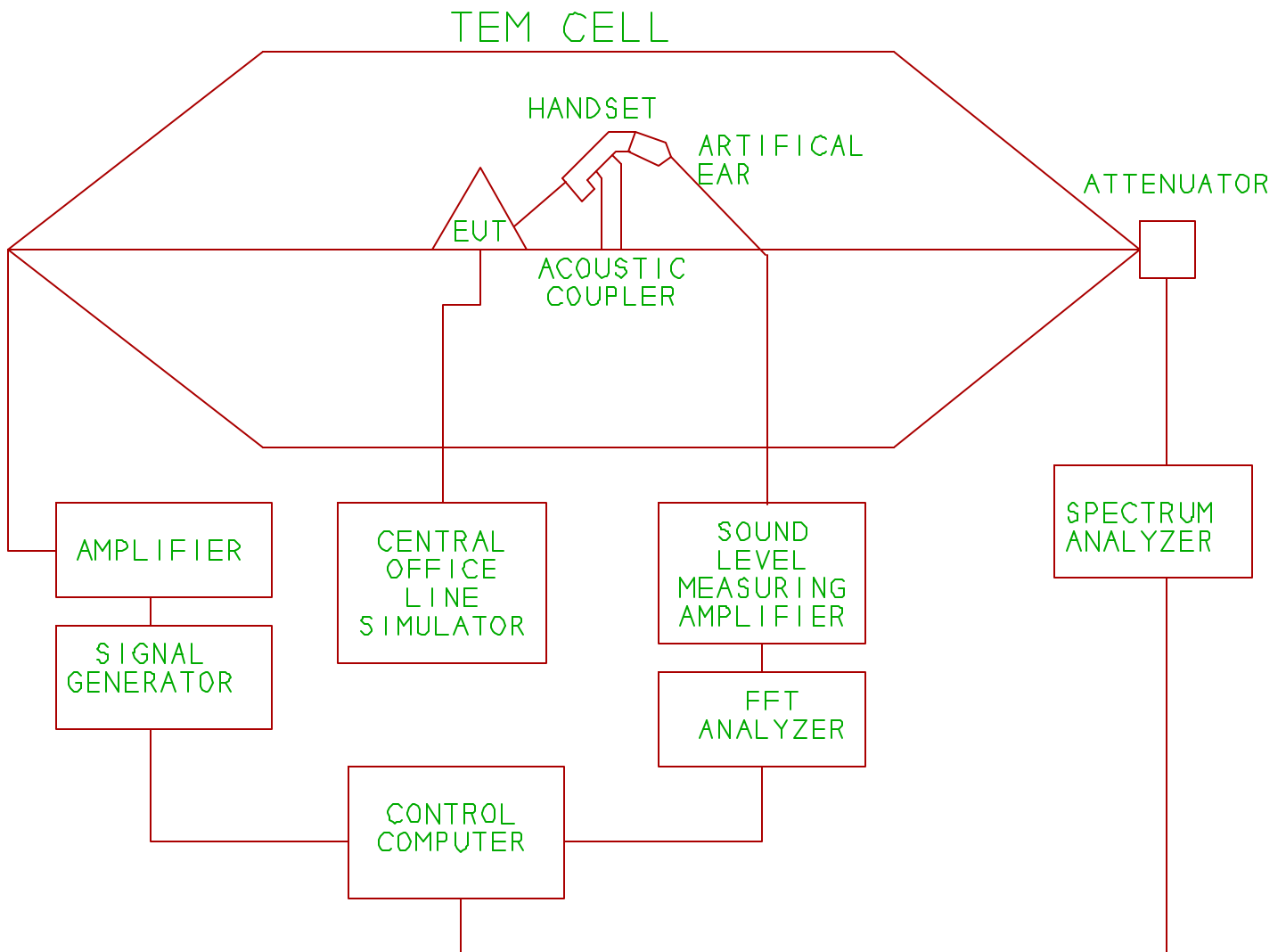
## RESULTS

Once the measurement data has been obtained, it is plotted in graph form. Figure 3 shows a plot of radiated susceptibility measurements. Figure 4 shows a plot of conducted susceptibility measurements.

## TEST EQUIPMENT

Description	Manufacturer	Model Number
Signal Generator	Fluke	6060A
Amplifier	Instruments for Industry, Inc.	M5300
TEM Cell	Instruments for Industry, Inc.	CC101.5S
Attenuator	Hewlett Packard	8493A
Spectrum Analyzer	Hewlett Packard	8568A
Acoustic Coupler	Brüel & Kjaer	4905
Artificial Ear	Brüel & Kjaer	4134
Sound Level Measuring Amplifier	Brüel & Kjaer	2636
FFT Analyzer	Hewlett Packard	35660A
Voltage Probe	Hewlett Packard	10017A 10:1
Current Injection Probe	Solar Electronics Co.	9108-1N

Figure 1  
Radiated Susceptibility Test Configuration



**Figure 2**  
**Conducted Susceptibility Test Configuration**

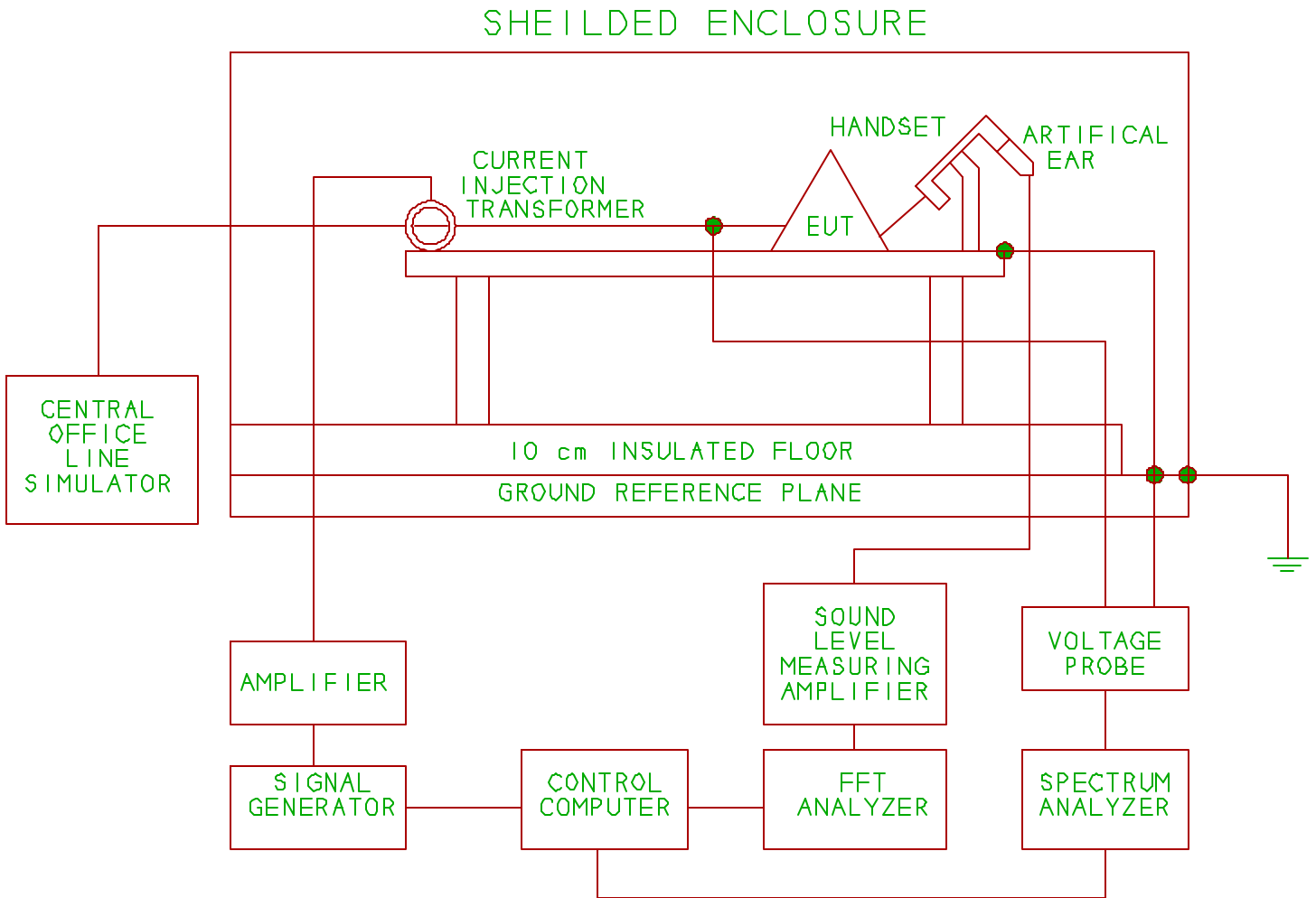


Figure 3  
Radiated Susceptibility Test Data Sheet

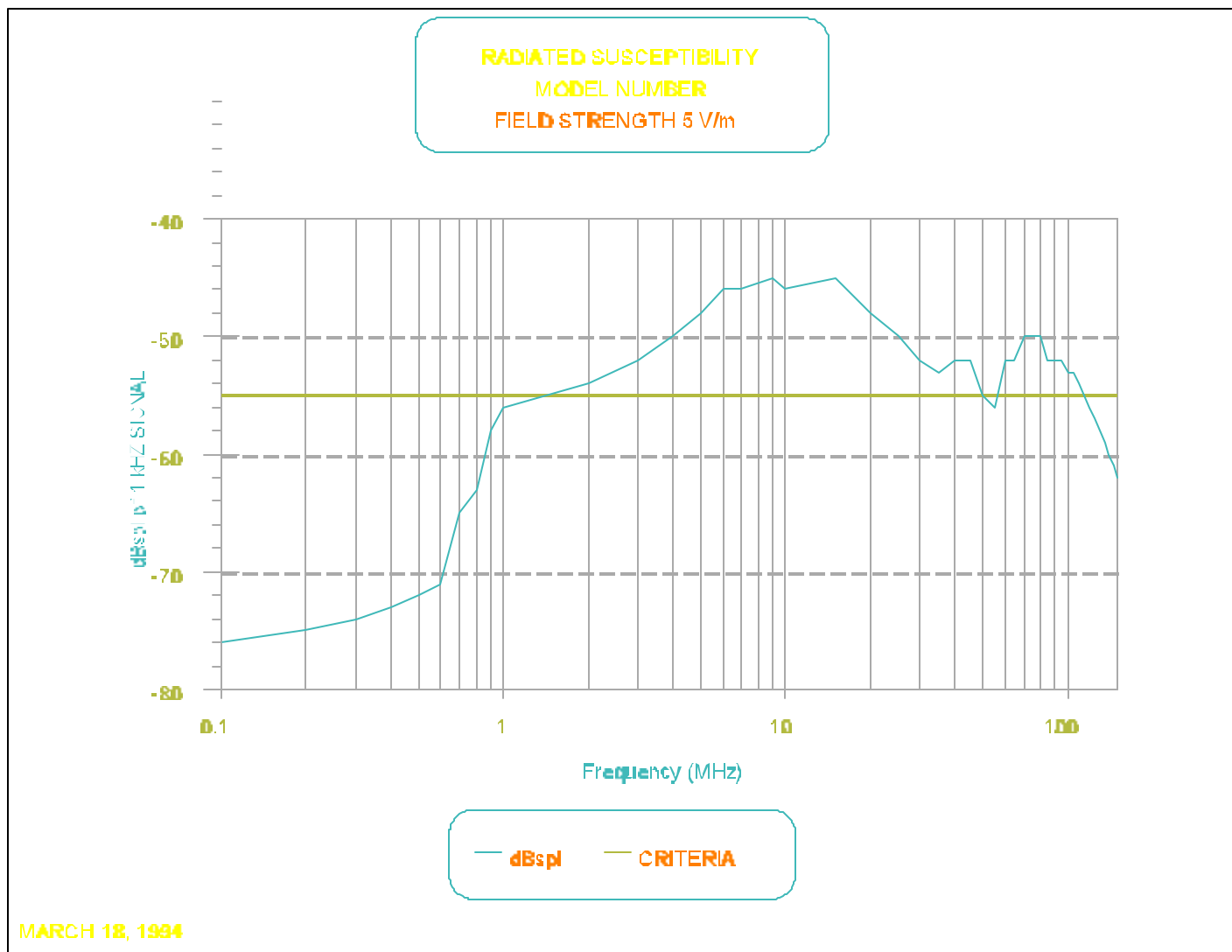


Figure 4  
Conducted Susceptibility Test Data Sheet

