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Supplement 27
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SERIES G: DIGITAL NETWORKS
Transmission systems and multiplexing equipment

Interference from external sources

ITU-T G-series Recommendations – Supplement 27

Originally published in Red Book (1984) - Fascicle III.3

NOTES

1 Supplement 27 to the G-series Recommendations was approved in Málaga-Torremolinos (1984) and published in Fascicle III.3 of the *Red Book*. This file is an extract from the *Red Book.* While the presentation and layout of the text might be slightly different from the *Red Book* version, the contents of the file are identical to the *Red Book* version and copyright conditions remain unchanged (see below).

2 In this Supplement, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Supplement No. 27

INTERFERENCE FROM EXTERNAL SOURCES

(Malaga-Torremolinos, 1984)

(referred to in Recommendations G.221 and G.950)

This Supplement contains information which was collected during the study of Question 12/XV (1981-1984) and which seems of general interest. Two aspects are covered:

- measures to reduce effects from interference; and
- measuring methods.

a) *Measures to reduce effects from interferences*

There exists a great number of possible actions to reduce the effect of interference. Therefore, the following list is in fact incomplete and can only be used as a guide when looking for the optimum solution for a particular case of interference.

Only those measures are mentioned which can be applied when a case of interference is encountered in practice, i.e., when the equipment is already existing.

Possible measures to reduce interference are:

- additional screening of equipments or parts of it by metallic boxes, frames or plates;
- low impedance interconnection of all metallic parts of the equipment to form a Faraday Cage;
- suppression of out-of-band interference signals by using band limitation filters (bandpass, low pass);
- preventing earthing loops by using separation transformers or earth-free input or output transformers;[1]
- using twisted pairs of wires or coaxial pairs for interconnecting equipment units;
- using double-screened or cables with magnetic screens for the station cabling;
- using a clear star-formed earthing scheme for the equipment;[1]
- applying a low-pass filtering at the equipment input of the power distribution lines;
- reducing repeater sections in areas of high interference level;
- using metallic pipes as cable ducts.

b) *Measuring methods*

Administrations are using different methods for carrying out interference tests. The following two methods were described by two Administrations and are reproduced for information only.

The CCITT decided not to recommend a certain measuring method because of the great variety of situations encountered in practice.

Further measuring methods for the field strength can be found also in CISPR Publication 16, § 3.

[1] CCITT Manual *Earthing of Telecommunication Installations*, ITU, Geneva, 1976.

Interference from broadcast transmitters: test methods (Contribution from the Netherlands)

1 Introduction

This contribution deals mainly with measurements in repeater stations and with methods for testing the extent to which new equipment is affected by these interfering fields and currents.

2 Measurements made in repeater stations

2.1 *Field strength measurements*

The measuring equipment consists of a small ferrite antenna coupled to a selective measuring device.

An important conclusion that could be drawn from measurements is the difference in attenuation of the EM fields inside the building, depending on the type of building. In a repeater station in a concrete building, the field strength near the equipment racks is roughly 30 dB lower than outside the building. In a repeater station in a brick building, the field strength near the equipment racks is roughly 10 dB lower than outside the building.

2.2 *Current measurements*

The EM fields that penetrate into a repeater station will cause disturbing currents in the outer conductor or screening of the station cabling.

The measuring equipment consists of a current probe (clip-on current transformer) coupled to a selective measuring device.

If the transfer impedance of cables, connectors, etc. is not sufficiently low, these currents cause interference in telephone channels.

3 Test methods

3.1 *Influence of EM fields*

In the laboratories of the Netherlands PTT, the following measuring set-up is used: a very large-dimension transmission line arrangement consisting of two parallel metal plates is at one end connected to a signal generator and at the other end terminated with a matching load resistor. Between these two metal plates the required uniform EM field is propagated in a TEM mode (see Figure 1).

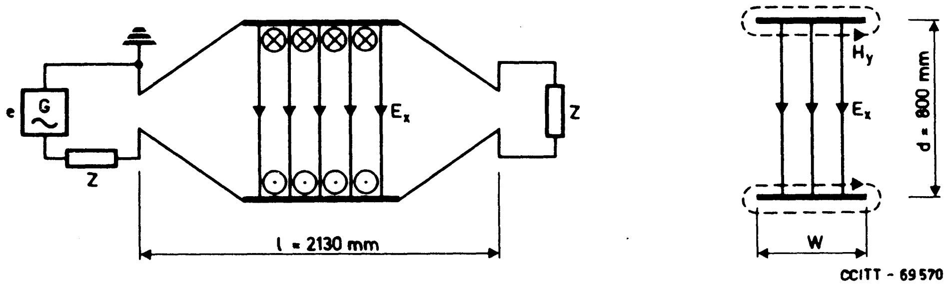


FIGURE 1

Electric field (full lines) and magnetic field (dashed lines) in the measuring arrangement

The relation between the field strength E_x, the input voltage (e) and the distance (d) between the plates is given by:

$$E_x = c \frac{e}{d} \text{ (V/m)}$$

For 1 MHz and no obstacles between the plates c = 0.5 (Figure 1). The actual field strength at any frequency can be determined by a short rod aerial mounted on the upper plate.

Between these plates, a complete subrack with equipment can be placed. More information on the placing of the equipment to be tested and on the connection of the measuring equipment is given in Figure 2.

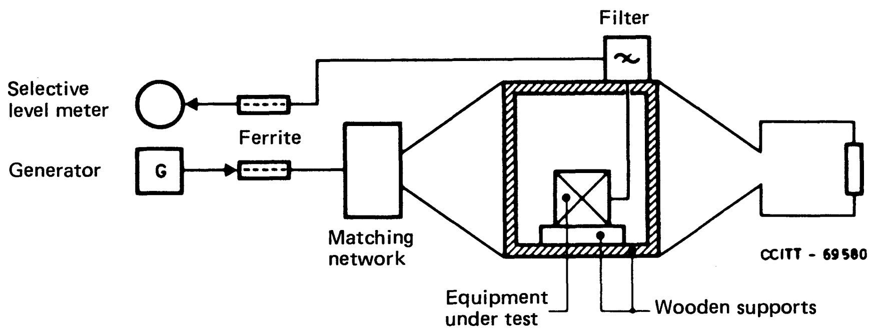


FIGURE 2

Measuring set-up

In Appendix 1 some construction details are given.

More information can be found in [1].

3.2 *Influence of current*

The influence of current can be expressed in terms of transfer impedance.

3.2.1 *Cables and connectors*

In IEC Publication 96-1 (Radio frequency cables), the transfer impedance (Z_T) per unit length of cable is defined as the ratio between the voltage measured along the screening of the disturbed system and the current through the disturbing system (see Figure 3).

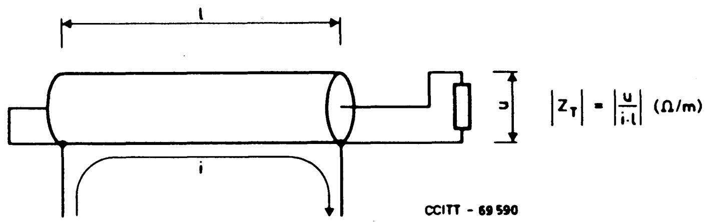


FIGURE 3

Definition of transfer impedance

The same IEC publication contains a description of a test method.

The same test method can be used for connectors.

3.2.2 *Equipment*

The transfer impedance of equipment is not defined by IEC; however, the same approach as described in the previous section can be used.

Two categories of equipment have to be distinguished:

1) equipment with a linear relation between the amplitude of the input voltage and the amplitude of the output voltage without frequency translation;

2) other equipment.

For the first category of equipment, the transfer impedance ($Z_{T_{eqI}}$) can be found as shown in Figure 4.

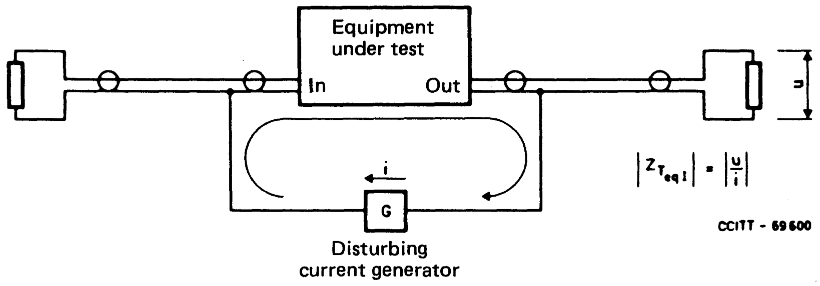


FIGURE 4

Measuring set-up for Z_T measurements of Category I equipment

In the case of category II equipment, matters are somewhat more complicated.

In the case of amplitude modulation equipment, for example, the interfering signal at the output will have another frequency than the disturbing current.

In the case of frequency modulation equipment, the disturbing current will cause frequency modulation of the output signal.

The transfer impedance of category II equipment ($Z_{T_{eqII}}$) is formulated as the equivalent voltage at the input causing the same magnitude of the output variable as the disturbing current, divided by the disturbing current (see Figure 5).

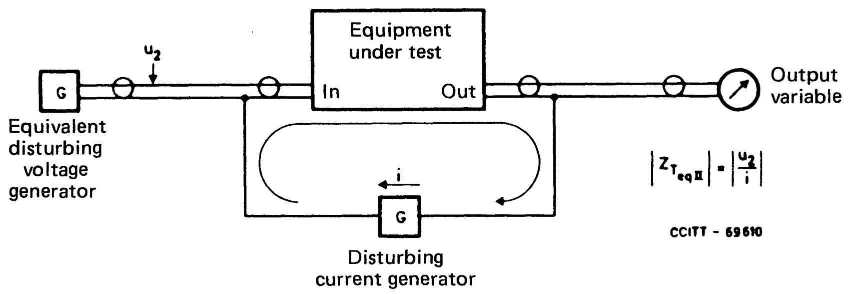


FIGURE 5

Measuring set-up for Z_T measure of Category II equipment

Reference

[1] GROENVELD (P.), DE JONG (A.): A simple R.F. immunity test set-up. *Symposium on Electromagnetic Compatibility*, pp. 233-239, Montreux 1977.

APPENDIX I

(to Supplement No. 27)

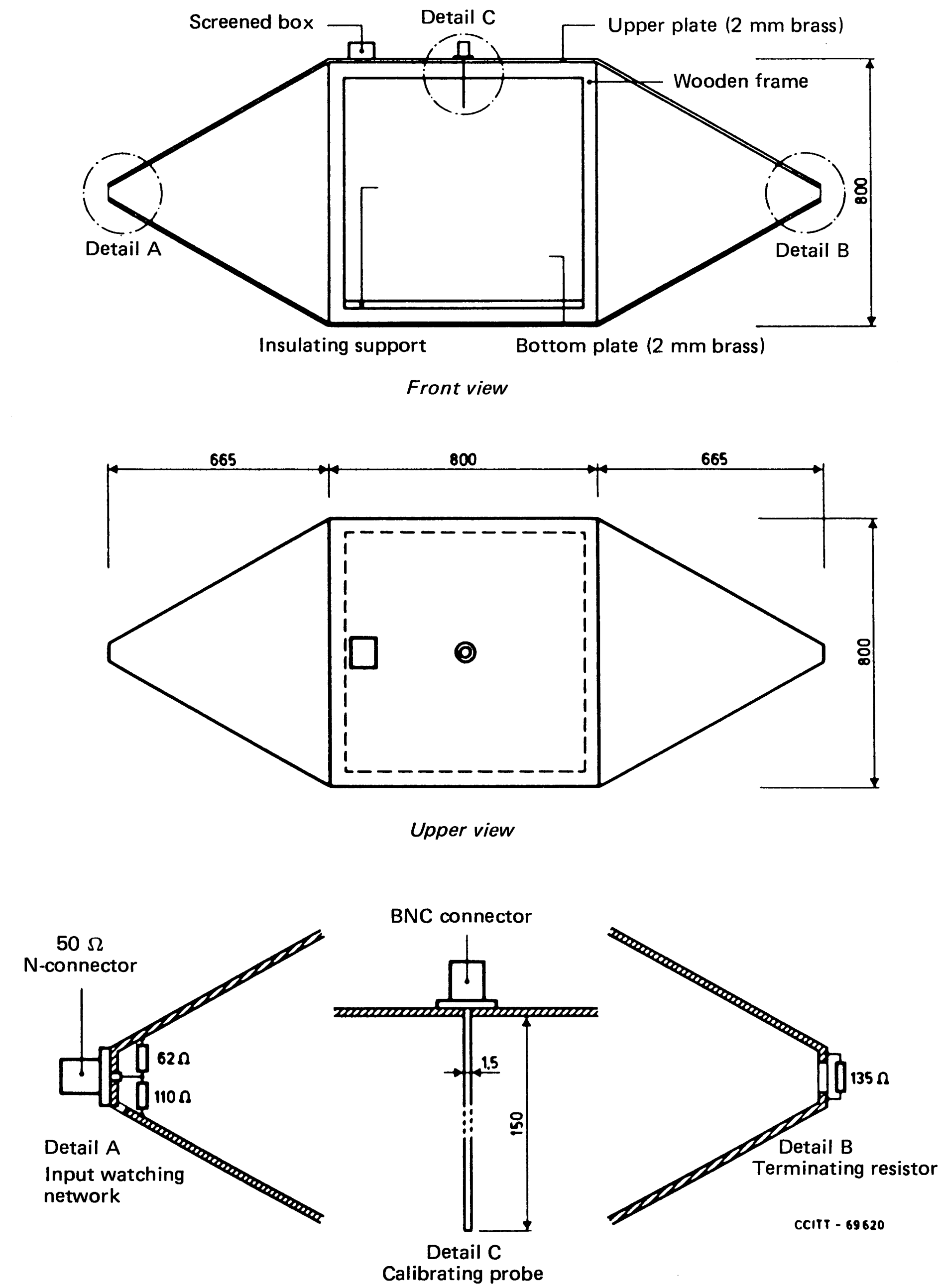


FIGURE I-1

Construction details of E.M. field test set-up

Measuring technique of electromagnetic radiations

(Contribution by Telecom Australia)

I.1 *Test coil*

The method adopted by this Administration uses a flat spiral search or origin coil, which is achieved by printed circuit technique. This technique provides a small, low cost, highly reproducible, convenient rugged device, details of which are shown in Figure I-1. Provision is made for reducing electrostatic pick-up, which can be a severe limitation on other methods.

I.2 *Measurements of radiated fields*

The card is connected to a selective level meter, wideband oscilloscope or spectrum analyzer by a coaxial cord terminated in 75 ohm at the instrument end. The preferred method is as follows:

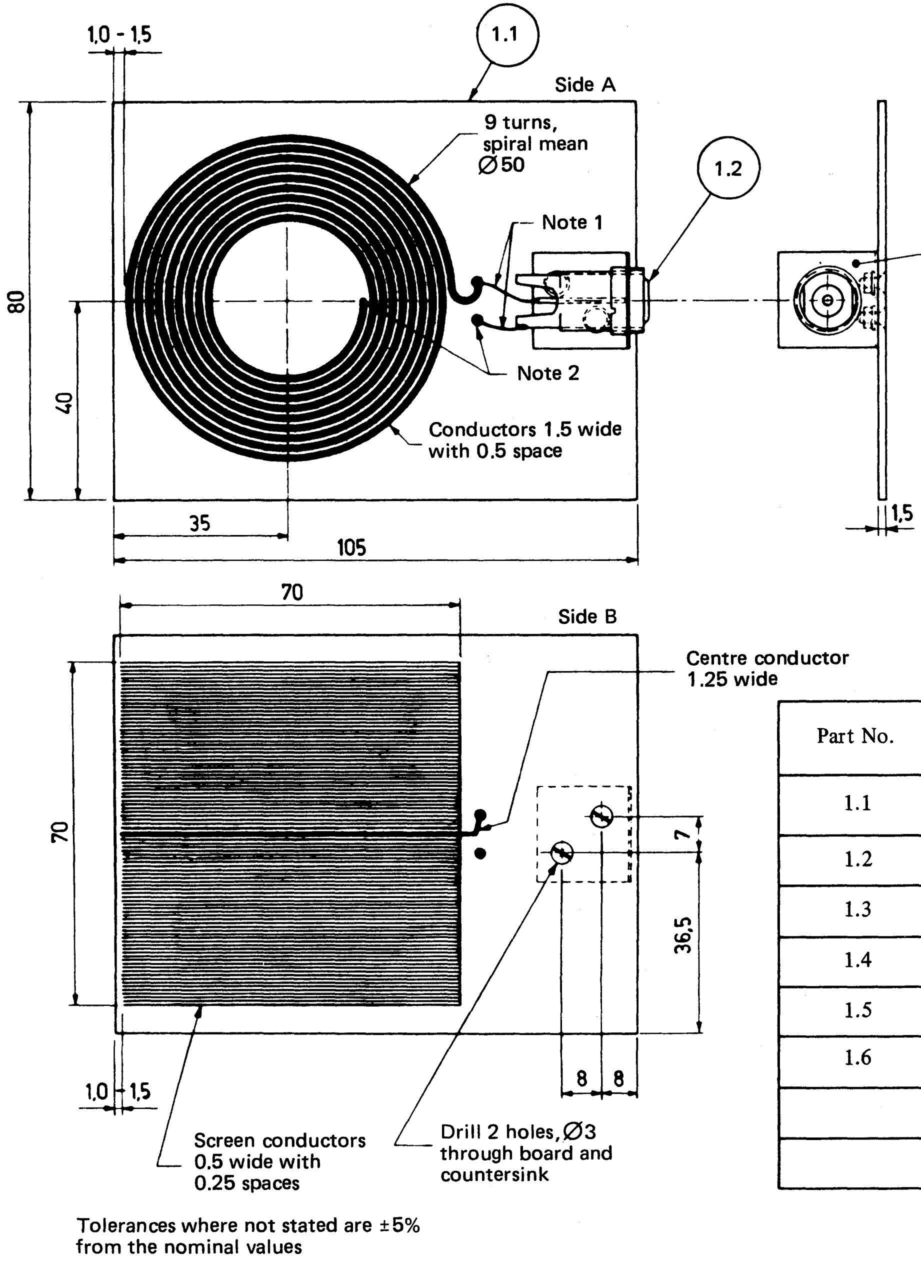
The "B" side of the card is placed directly on the exterior surface of of the item under test, and moved over all exterior faces to find maxima. Leakage points can be identified readily, and the test may be carried out with equipment mounted in a rack, or in isolation.

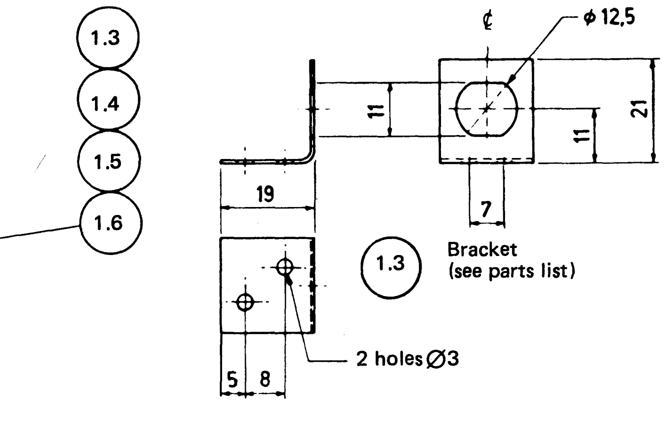
Using a spectrum analyzer, the largest amplitude frequency components are determined and the levels measured. Should any component(s) approach the specified maximum level, the exact level(s) can be measured by substituting a selective level meter for the spectrum analyzer.

I.3 *Effect of interfering fields*

For this test, two identical cards are used. One card, the transmit unit, is placed with the "B" side against the equipment face to be tested, as in the previous test. The card is driven by a 75-ohm swept frequency generator. A second card, the receive unit, is placed with the "B" side in parallel contact with the "A" side of the transmit unit, but with the coaxial connector end rotated by 90° to allow clearance between the two coaxial connectors. The receive unit is connected to a level meter synchronized with the generator.

The level in the transmit unit is increased until the level meter indicates a level 40 dB above the nominal level used in the previous test. Both units are moved over all surfaces of the equipment as in the previous test, while the output of the equipment under test is monitored for unwanted signals or performance defects caused by the interfering fields. Should such be detected, the level in the transmit unit is reduced until the level in the receive unit is the nominal level. If unwanted effects are still noticeable, they can be investigated and corrected. The reason for the initial high level is to expedite the initial detection of effects, the reduced "nominal" level is to check compliance with specified performance. Two of the most common tests are noise in analogue equipment, and error rate in digital devices.





Note 1 – 0.63 (22SWG) tinned copper wire.

Note 2 – Plated through holes to connect A side B side.

Note 3 – Both sides of the printed circuit board to be insulated in A/W MIL-I-46058.

Note 4 – Copper cladding 99.5% purity electrolytically deposited to a thickness of 0.035 mm.

PARTS LIST

Part No.	Description		No. off
1.1	Printed board, 80 × 105 ±1.0 copper thickness, see Note 4	Board material in A/W Type GE MIL-P-13949D	1
1.2	Female co-ax socket, 75 ohm, size 2.5/6.0		1
1.3	MS 0.5, Zn plate and passivate		1
1.4	Screw, countersunk head, M2.5 brass		2
1.5	Nut, hex. M2.5, brass		2
1.6	Washer, flat, M2.5 brass		2

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FIGURE I-2

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