IS 13986-1 (1994): Methods of measurement on receivers for satellite broadcast transmissions in the 12 GHz band, Part 1: Radio frequency measurements on outdoor units [LITD 7: Audio, Video and Multimedia Systems and Equipment]

BLANK PAGE

IS 13986 (Part 1) : 1994
IEC Pub 1079-1 : 1992
(Reaffirmed 2003)

भारतीय मानक

12 GHz बैंड में उपग्रह प्रसार प्रेषण के लिए रिसीवर की मापन-पद्धतियाँ

भाग 1 बाहरी यूनिटों में रेडियो आवृत्ति का मापन

Indian Standard

METHODS OF MEASUREMENT ON RECEIVERS FOR SATELLITE BROADCAST TRANSMISSIONS IN THE 12 GHz BAND

PART 1 RADIO-FREQUENCY MEASUREMENTS ON OUTDOOR UNITS

UDC 621·396·62:621·396·946:621·317·361·0295

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 1994

Price Group 12

Radio Communications Sectional Commitee, LTD 20

NATIONAL FOREWORD

This Indian Standard, which is identical with IEC Pub 1079 - 1 : 1992 'Mehods of measurement on receivers for satellite broadcast transmissions in the 12 GHz band, Part 1 : Radio frequency measurements on outdoor units' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of Radio Communications Sectional Committtee (LTD 20) and approval of the Electronics and Telecommunication Division Council.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

CROSS REFERENCES

In the adopted standard, reference appears to certain international Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC Pub 1079 - 2 : 1992 Methods of measurement on receivers for satellite broadcast transmission in the 12 GHz band, Part 2: Electrical measurements on DBS tuner units.	IS 13986 (Part 2) :1994 Methods of measurement on receivers for satellite broadcast transmission in the 12 GHz band : Part 2 Electrical measurements on DBS tuner units	Identical

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following standard and has decided that this is acceptable for use in conjunction with this standard:

IEC Pub 107 - 1 : 1977 Recommended method of measurement on receivers for television broadcast transmission : Part 1 : General considerations — Electrical measurements other than those at audio frequencies

Only the English language text in the IEC Publication has been retained while adopting it in this standard.

Indian Standard

METHODS OF MEASUREMENT ON RECEIVERS FOR SATELLITE BROADCAST TRANSMISSIONS IN THE 12 GHz BAND

PART 1 RADIO-FREQUENCY MEASUREMENTS ON OUTDOOR UNITS

SECTION 1 - GENERAL

1.1 Scope

This International Standard applies to the outdoor unit of a receiver for the direct reception of satellite broadcast transmissions in the 12 GHz band. The channels are those defined by WARC BS-77 and RARC SAT-83 and the systems are those defined in CCIR Recommendation 650.

The object of this standard is to define the conditions and methods of measurement to be applied. The standard does not specify performance requirements.

An outdoor unit normally comprises three main parts, the antenna, the depolarizer and optional orthomode transducer (OMT), and the SHF converter as defined in clause 1.3. The methods of measuring the electrical properties described in this part of the standard apply particularly to the outdoor unit or the SHF converter.

Methods of measurement on the associated DBS tuner unit are described in Part 2 of this standard.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication of this standard, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 107-1: 1977, *Recommended methods of measurement on receivers for television broadcast transmissions - Part 1: General considerations - Electrical measurements other than those at audio-frequencies.*

IEC 1079-2: 1992, *Methods of measurement on receivers for satellite broadcast transmissions in the 12 GHz band - Part 2: Electrical measurements on DBS tuner units.*

1.3 Definitions

For the purpose of this International Standard, the following definitions apply.

The outdoor unit is a part of the receiver for satellite broadcast transmissions in the 12 GHz band, and comprises three main parts:

a) the antenna including the feed horn which receives the signals broadcast by satellites;

b) the depolarizer that converts circular polarization to linear polarization and an optional orthomode transducer, OMT, which separates two incoming differently polarized signals into two independent SHF outputs;

c) the SHF converter (also called low noise converter (LNC) or low noise block converter (LNB)), which is a device to convert the received signals in the 12 GHz band to intermediate frequencies (often called the first i.f.) usually in the range of approximately 1 GHz to 2 GHz, for application to one or more DBS tuner units, where demodulation and decoding of the received signals are performed.

SECTION 2 - GENERAL NOTES ON MEASUREMENT

2.1 General conditions

2.1.1 *Introduction*

Measurements shall be made in accordance with the following conditions to ensure reproducible results. The methods described here assume the use of the following transmission systems: digital sub-carrier/NTSC, B-MAC, C-MAC/packet, D-MAC/packet and D2 MAC/packet. Information pertaining to these systems may be found in the references listed in the bibliography given in annex A.

2.1.2 *Test site*

Measurements shall be carried out at a location that is not subject to external interference from radio frequency energy. If interference cannot be avoided, the measurements shall be carried out in a screened room.

2.1.3 *Environmental conditions*

Sections Three, Four and Five of IEC 107-1 shall be applied.

2.1.4 *Power supply*

2.1.4.1 *Bias network*

When measuring the characteristics of an outdoor unit, it is necessary to supply d.c. or a.c. power to it without influencing the output signal. For this purpose, a bias network such as that shown in figure 1 can be used.

NOTE - Reverse connection of the bias network (see figure 2) is likely to cause damage.

2.1.4.2 *Nominal voltage*

The d.c. or a.c. voltage to be applied to the unit during the test shall be within ±2 % of the nominal operating voltage, unless otherwise specified.

Where only a range of voltages is specified, the nominal voltage shall be taken as the mean value of this range. Measurements shall be repeated at the limits of the specified range, as indicated in the following clauses.

2.1.5 *Other conditions*

2.1.5.1 *Accuracy of the measuring instruments*

The accuracy of the measuring instruments used, if known, shall either be stated as a percentage or in decibels as appropriate. Alternatively, the accuracy class may be quoted as laid down in the relevant publications (under consideration).

2.1.5.2 *Stabilization period*

The characteristics of an outdoor unit may change for some period after the application of supply voltage. Unless otherwise specified, measurements should be started after the stabilization of the characteristics is obtained.

2.2 Radio-frequency input signals

2.2.1 *Introduction*

The following input signals shall be used.

2.2.2 *Test signals*

Unless otherwise specified, continuous wave (c.w.) radio-frequency (r.f.) signals shall be used.

2.2.3 *Test frequencies*

Unless otherwise specified, test frequencies shall be selected near the nominal carrier frequency of each broadcast channel, as specified by the standards of the country or countries in which the equipment is intended for use.

2.2.4 *Radio-frequency input arrangement*

Depending on the input facilities of the equipment under test, the radio-frequency input signal can be applied in three different ways:

a) by means of a waveguide, having a flange and a cross-section compatible with the input of the unit;

b) by means of a coaxial cable and a connector compatible with the input of the unit;

c) by means of a transmitting antenna generating a field of wanted level at the receiving antenna which provides the electrical input signal for the unit.

When two or more signals are to be applied (two or multi-signal measuring methods), suitable combining networks, such as hybrid networks or directional couplers with the specified characteristic impedance shall be used to connect the various signal generators. All unused terminals shall be terminated with matched loads.

When input arrangement indicated in c) is used, the signals of the various generators are combined before application to the transmitting antenna.

NOTE - Any type of hybrid such as magic tee, rat-race or hybrid-ring can be used.

2.2.5 *Input signal level*

The input signal level to an outdoor unit shall be expressed according to the input arrangement used (see 2.2.4).

2.2.5.1 *Available power*

With the input arrangement a) or b) of 2.2.4, the input signal level is expressed in terms of available power at the output of the signal generator, including its associated network.

The available power is the power delivered by the signal generator to a matched load. It is expressed in milliwatts and can be calculated by the following formula:

$$P = \frac{E_g^{\ 2}}{4R_g} \text{ (mW)}$$

where

P = available power (mW);

E_g = electromotive force at the output terminal of the signal generator (V);

R_g = output resistance of the signal generator (Ω).

2.2.5.2 *Power flux density*

With input arrangement c) of 2.2.4, the input signal level is expressed in terms of power flux density (*PFD*) at the aperture plane of the receiving antenna, calculated as follows:

$$PFD = \frac{P_A G}{4\pi d^2} \text{ (W/m}^2\text{)}$$

where

P_A = power delivered by the signal generator to the input of the transmitting antenna (W);

G = gain of the transmitting antenna in the direction towards the receiving antenna;

d = distance between the transmitting antenna and the receiving antenna (m), measured between the electrical centres.

2.2.5.3 *Siting of the antennas*

The antennas shall be placed at least 4 m above ground level to lessen the interference by the reflected wave from the ground. When a slant antenna range* setting (see figure 3) is used, the transmitting antenna can be placed on the ground while the receiving antenna is placed at the top of a tower.

To avoid measurement errors caused by a non-uniform distribution of spherically propagated electromagnetic waves, the distance between the transmitting and the receiving antennas should be larger than $2\ D_1^2/\lambda$ and $D_1\ D_2\ /\ 0{,}32\ \lambda$, where D_1 and D_2 are the maximum diameters of the antenna under test and the transmitting antenna respectively, and λ is the free space wavelength at the test frequency. If the electric field strength at the receiving point deviates more than ±0,5 dB in the aperture plane, the height and the distance shall be rearranged to obtain a deviation smaller than ±0,5 dB. The method of measuring the electric field strength at the receiving point is mentioned in clause 3.8.

SECTION 3 - MEASURING METHODS

3.1 Polarization isolation

3.1.1 *Introduction*

This method of measurement determines the isolation between the two independent and differently polarized signals entering the outdoor unit measured at the output of the complete outdoor unit.

NOTE - According to CCIR recommendations, the polarization of the signals is right hand or left hand circular.

3.1.2 *Method of measurement*

A test signal is applied to the input terminal of the outdoor unit and the resulting output, from one of the SHF converters, is measured at specified frequencies. The polarization of the input signal is reversed by appropriate means and the resulting new output level is recorded. The polarization isolation is determined from the level difference between the two measurements. The arrangement of the test equipment is shown in figure 4. Only input arrangement c) (see 2.2.4) can be used to perform this measurement which should be made according to the following conditions and procedure.

3.1.2.1 *Measuring conditions*

a) Test frequency: the centre frequency of the lowest (L), the mid (M) and the highest (H) channels in the 12 GHz broadcasting band.

b) Test signal level at the input (12 GHz band): –94 dB(W/m^2).

---

* For a slant antenna range, the following paper can be referred to: P.W. Arnold, *The slant antenna range*, IEEE Trans. Antennas & Propag., AP-14, 5 pp. 658-659 (1966).

3.1.2.2 *Measurement procedure*

a) A c.w. signal at the specified test signal level is applied to the input terminal of the outdoor unit.

b) The output signal level of the outdoor unit (at the bias network output terminal) is measured: L_{P1} dB(mW).

c) The polarization of the input signal is reversed by appropriate means.

d) The new output signal level of the outdoor unit is measured: L_{P2} dB(mW).

e) Polarization isolation (L_{Pisol}) is:

$$L_{Pisol} = L_{P1} - L_{P2} \text{ (dB)}$$

f) The test signal frequency is changed and steps a) to e) are repeated.

g) The other output terminal is taken into consideration by connecting the bias network and spectrum analyzer to it while terminating the previous output terminal with a matched load.

h) Steps a) to f) are repeated with this new output terminal.

3.1.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically

3.2 Impedance matching at the input terminal

3.2.1 *Introduction*

This method of measurement determines the impedance matching at the input terminal of the SHF converter. It is applicable only to input arrangement a) or b) (see 2.2.4).

3.2.2 *Method of measurement*

A test signal is applied to the input terminal of the outdoor unit and the levels of the direct signal and reflected signal at the terminal are measured using a directional coupler. The return loss is the level difference between these two signals. The arrangement of the test equipment is shown in figure 5. The measurement should be made according to the following conditions and procedure.

3.2.2.1 *Measuring conditions*

a) Test frequency: the centre frequency of each channel in the reception band (12 GHz).

b) Test signal level: –70 dB(mW).

3.2.2.2 *Measurement procedure*

a) A c.w. signal is applied and the variable attenuator adjusted to obtain the recommended signal level at the output terminal of the directional coupler.

b) With a short-circuit termination placed at the output terminal of the directional coupler, the output signal level of the amplifier L_{P_o} [dB(mW)] is measured.

c) The SHF converter input terminal is connected to the directional coupler output terminal and the amplifier output signal level L_P [dB(mW)] is measured.

d) The return loss is expressed as the difference:

$$L_{P_o} - L_P \text{ (dB)}$$

e) The test signal frequency is changed and steps a), b), c) and d) are repeated.

NOTE - The amplifier shall be sufficiently linear not to influence the results within the range of the signal levels used.

3.2.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically.

3.3 Impedance matching at the output terminal

3.3.1 *Introduction*

This method of measurement determines the impedance matching at the output terminal of the outdoor unit.

3.3.2 *Method of measurement*

A test signal is applied to the output terminal of the outdoor unit and the levels of the direct signal and reflected signal at the terminal are measured using a SWR bridge. The return loss is the level difference between these two signals. The arrangement of the test equipment is shown in figure 6. The measurement shall be made according to the following conditions and procedure.

3.3.2.1 *Measuring conditions*

a) Test frequency: the centre frequency of each channel in the i.f. band.

b) Test signal level: –30 dB(mW).

3.3.2.2 *Measurement procedure*

a) The input terminal is terminated with a matched load when input arrangement a) or b) (see 2.2.4) is used. Otherwise, when input arrangement c) (see 2.2.4) is used, the outdoor unit antenna shall be oriented towards the sky, avoiding any satellite reception.

b) A c.w. signal is applied and the variable attenuator is adjusted to obtain the recommended signal level at the output terminal of the SWR bridge.

c) A short-circuit termination is placed at the test terminal of the SWR bridge and the output signal level of the SWR bridge L_{P_0} [dB(mW)] is measured.

d) The output terminal of the outdoor unit is connected to the SWR bridge test terminal and the output signal level of the SWR bridge L_P [dB(mW)] is measured.

e) The return loss is expressed as the difference: $L_{P_0} - L_P$ (dB).

The insertion loss and SWR of the bias network shall be known and taken into account in the measurement result.

f) The test signal frequency is changed and steps b), c), d) and e) are repeated.

3.3.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically.

3.4 Gain frequency characteristics

3.4.1 *Introduction*

This method of measurement determines the gain variation within a channel and between channels in the reception band.

3.4.2 *Method of measurement*

A constant level of test signal is applied to the input terminal and the corresponding output signal level is measured at specified frequencies. The arrangement of the test equipment is shown in figure 7 when input arrangement a) or b) (see 2.2.4) is used, and in figure 8 when input arrangement c) (see 2.2.4) is used. The measurement shall be made according to the following conditions and procedure.

3.4.2.1 *Measuring conditions*

a) Test frequency: the centre frequency of each allocated channel in the 12 GHz broadcasting band.

b) Test signal level: –70 dB(mW) when input arrangement a) or b) is used, or –94 dB(W/m^2) when input arrangement c) is used.

c) Seven points are measured every 5 MHz within ±15 MHz of the centre frequency in each channel.

3.4.2.2 *Measurement procedure*

a) A c.w. signal at the specified test signal level is applied to the input terminal of the outdoor unit.

b) The signal level L_{P_0} [dB(mW)] at the branch port of the directional coupler, and the signal level L_P [dB(mW)] at the bias network output terminal are measured.

c) When input arrangement a) or b) is used, the gain (G) is calculated using the following equation:

$$G = L_P - L_{Po} + L_r - L_s + L_b \text{ (dB)}$$

where

L_r = attenuation of the second variable attenuator (dB);

L_s = coupling factor of the directional coupler (dB);

L_b = insertion loss of the bias network (dB).

When input arrangement c) is used, the gain (G') is calculated using the following equation:

$$G' = L_P - PFD - 30 \text{ (dB(m}^2\text{))}$$

where

PFD (see 2.2.5.2) is measured according to the procedure mentioned in clause 3.8. The factor 30 is included because L_P is expressed in dB(mW) and *PFD* in dB(W/m^2).

d) The test frequency is changed and steps a), b) and c) are repeated.

NOTE - The attenuation of the second variable attenuator should be such as to minimize the difference between the signal level at the coupling terminal of the directional coupler and the output signal level of the SHF converter.

3.4.3 *Presentation of the results*

The results shall be presented graphically, using plotted curves showing the gain frequency characteristic, with the channel tested (or the frequency variation with respect to the nominal centre frequency of the channel) as the abscissa and the gain as the ordinate. Examples are shown in figures 9 and 10.

3.5 Output signal level versus input signal level

3.5.1 *Introduction*

This method of measurement determines the amplitude linearity of an outdoor unit.

3.5.2 *Method of measurement*

To obtain the linearity curve, the output signal level is measured at several input signal levels. The arrangement of the test equipment is shown in figure 7 when input arrangement a) or b) (see 2.2.4) is used and in figure 8 when input arrangement c) (see 2.2.4) is used. The measurement shall be made according to the following conditions and procedure.

3.5.2.1 *Measuring conditions*

a) Test frequency: the centre frequencies of the lowest (L), the mid (M) and the highest (H) channels in the frequency band specified to be covered by the outdoor unit (12 GHz band at the input and i.f. band at the output).

b) Test signal level at the input (12 GHz band): from −80 dB(mW) to −40 dB(mW) (5 dB steps), when input arrangement a) or b) is used; from −104 dB(W/m^2) to −64 dB(W/m^2) (5 dB steps), when input arrangement c) is used.

3.5.2.2 *Measurement procedure*

a) A c.w. signal is applied and the first variable attenuator is adjusted to obtain a convenient signal level [e.g. -35 dB(mW)] at the directional coupler output terminal.

b) The second variable attenuator is adjusted to obtain the minimum test signal level specified in 3.5.2.1, according to the input arrangement used.

c) The output signal level of the outdoor unit is measured.

d) The test signal level is increased by adjusting the second variable attenuator and the output signal level of the outdoor unit is measured.

e) The test signal frequency is changed and steps a), b), c) and d) are repeated.

NOTE - The output signal level of the outdoor unit may exceed the maximum power specified for the spectrum analyzer input terminal.

3.5.3 *Presentation of the results*

The results are presented graphically, using a plotted curve with the input signal level as the abscissa and the output signal level as the ordinate. An example is shown in figure 11.

3.6 Intermodulation

3.6.1 *Introduction*

This method of measurement determines the level of the interference components caused by the intermodulation of two signals received outside the desired channel.

3.6.2 *Method of measurement*

Two test signals are applied to the input of the outdoor unit and the intermodulation product level is measured at the output in the desired channel. The arrangement of the test equipment is shown in figure 12 when input arrangement a) or b) (see 2.2.4) is used, and in figure 13 when input arrangement c) (see 2.2.4) is used. The measurement shall be made according to the following conditions and procedure.

3.6.2.1 *Measuring conditions*

a) Desired signal frequency: the centre frequencies of the lowest (L), the mid (M) and the highest (H) channels in the reception band.

b) Desired signal level: from -80 dB(mW) to -40 dB(mW) (5 dB steps) when input arrangement a) or b) is used, from -104 dB(W/m^2) to -64 dB(W/m^2) (5 dB steps) when input arrangement c) is used.

c) Interference signal frequencies; for systems now planned or in service, suitable frequencies are:

- centre frequencies of channels (L+2) and (L+4) for the L channel;
- centre frequencies of channels (M-2) and (M-4), or (M+2) and (M+4) for the M channel;
- centre frequencies of channels (H-2) and (H-4) for the H channel.

(See ITU Radio Regulations, appendix 30*.)

d) Interference signal level: same as the desired signal level.

* See also CCIR Reports 473-4 and 811-2 (annex A).

3.6.2.2 *Measurement procedure*

a) A c.w. signal at the desired frequency at the test signal level is applied.

b) The variable band-pass filter is adjusted to obtain the maximum i.f. signal level. The i.f. signal level L_{Po} [dB(mW)] is measured at the output terminal.

c) The two c.w. interference signals are applied simultaneously, as indicated for each case, with the same level as a). The i.f. signal level L_P [dB(mW)] is measured at the output terminal. The intermodulation interference ratio is given by the value $(L_{Po} - L_P)$ (dB).

d) The desired signal level is changed and steps a), b) and c) are repeated.

e) The desired signal frequency is changed and steps a), b), c) and d) are repeated.

NOTE - The variable band-pass filter is used to prevent the spectrum analyzer from generating intermodulation. Although it may be unnecessary to use the band-pass filter for a spectrum analyzer having a large dynamic range, confirmation shall be made that intermodulation does not occur within it.

3.6.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically. Curves showing the intermodulation interference ratio are plotted with the input signal level as the abscissa and the intermodulation ratio as the ordinate. A graphical example is shown in figure 14.

3.7 Noise figure and noise temperature

3.7.1 *Introduction*

This method of measurement determines the noise generated in the SHF converter. It is applicable only if input arrangement a) or b) (see 2.2.4) is possible. The test site should comply with the conditions indicated in 2.1.2.

3.7.2 *Method of measurement*

A noise source is connected to the input terminal of the SHF converter and the noise level appearing at the output terminal is measured with and without the input noise. The noise figure and noise temperature are obtained from these data by calculation. The arrangement of the test equipment is shown in figure 15. The measurement shall be made according to the following conditions and procedure.

NOTE - An isolator or an attenuator should be inserted between the noise source and the outdoor unit to reduce the VSWR of the noise source.

3.7.2.1 *Measuring conditions*

a) Test frequency: the centre frequency of each channel (12 GHz band).

b) Environmental temperature: room temperature.

3.7.2.2 *Measurement procedure*

a) The variable band-pass filter is tuned to the intermediate frequency that corresponds to the test frequency. The noise power level L_{Po} [dB(mW)] that appears at the amplifier output terminal is then measured with the noise source power supply inoperative.

b) The noise source is activated and the noise power level L_P [dB(mW)] that appears at the amplifier output terminal is measured.

c) The noise figure is calculated using the following equation:

$$NF = (E_N - L) - 10 \log (Y - 1) \text{ (dB)}$$

where

NF = noise figure;

E_N = excess noise ratio (ENR) of the noise source (dB);

L = insertion loss of the isolator or attenuator (dB);

Y = $10^{0,1(P-Po)}$

NOTES

1 The isolator shall have a VSWR of less than 1,05. The attenuator shall have a VSWR of less than 1,05 and an attenuation of 6 dB to 10 dB.

2 The variable band-pass filter shall be tunable over the i.f. band of the SHF converter and have a pass band of approximately 20 MHz.

3 The noise source shall have an ENR of about 15 dB.

4 The value of E_N (dB) is expressed by the following equation:

$$E_N = 10 \log \left(\frac{P_H}{P_L} - 1\right) \text{ (dB)}$$

where

P_H = the noise power generated by the noise source in operation;

P_L = the noise power generated by a resistance equal to the noise source nominal impedance, at a temperature of 290 K.

5 If the noise figure measurement is carried out at a temperature different from 290 K (17 °C), the following equation shall be considered:

$$NF = 10 \log \left[F - (T_r / 290-1)(10^{0,1L} - 1)\right] - L \text{ (dB)}$$

Where the environmental temperature for the measurement is T_r (K), and F is given by the formula:

$$F = \frac{10^{0,1\,E_N} - Y(T_r / 290-1)}{Y-1}$$

6 The effective noise temperature T_e is expressed by the following equation:

$$T_e = 290\,(10^{0,1\,NF} - 1) \text{ (K)}$$

7 If the SHF converter under test does not include an image band rejection filter, the measurement of the noise figure and the noise temperature shall be corrected according to the following equation:

$$NF = E_N - L - 10 \log (Y-1) + 10 \log (1 + 10^{-0,1\,R_m}) \text{ (dB)}$$

where

R_m (dB) is the image suppression ratio of the SHF converter (see 3.10).

3.7.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically. A graphical example is shown in figure 16.

3.8 G/T

3.8.1 *Introduction*

This method of measurement determines the figure of merit of an outdoor unit. Therefore this method of measurement applies only when input arrangement c) (see 2.2.4) is possible (see appendix A).

NOTE - Although the G/T can be calculated from the antenna gain, the antenna noise temperature and the noise figure of the SHF converter, it is more practical and accurate to measure the G/T directly, because the noise figure of an SHF converter depends on the impedance matching between the antenna and the SHF converter.

3.8.2 *Method of measurement*

The arrangement of the test equipment is shown in figure 17. After the position of the outdoor unit under test (OU) is determined, the standard horn shall be set near the aperture plane of the OU. This is called the specified position. The measurement shall be made according to the following conditions and procedure.

3.8.2.1 *Measuring conditions*

a) Testing site: a location that does not give rise to radio wave reflections due to surrounding objects.

b) Test frequency: the centre frequencies of the lowest (L), the mid (M) and the highest (H) channels in the reception band (12 GHz band).

c) Test signal level: the test signal level shall be high enough to provide a good signal-to-noise ratio as far as the amplitude linearity of the SHF converter is maintained. The linearity can be checked as indicated in clause 3.5.

d) Siting of the antennas: see 2.2.5.3.

e) Sky conditions: when the sky is used to measure the antenna effective temperature, the antenna should be directed to the area which minimizes the output noise level of the outdoor unit after confirming that there is no noise source such as clouds, the sun, satellites, buildings and trees within 10° from the main beam of the antenna.

3.8.2.2 *Measurement procedure*

The procedure is composed of several measurements including the gain of the OU (procedures a), b) and c)), the noise temperature of the OU (procedure d)), the power flux density at the OU aperture plane (procedures e) and f)) and calibration factors (procedures g), h) and i)).

a) Switch A is set to radiate a signal from the transmitting antenna. The polarization direction of the signal shall coincide with that of the receiving antenna.

b) The OU is placed at the specified position and switch C is adjusted to position "2", and the output power P_1 (W) of the OU is measured.

c) Switch A is set to the "off" position and the output level P_2 (W) of the OU is measured.

d) The OU is directed to the sky and the output power P_3 (W) of the OU is measured.

e) Switch A is set to "on" again. Switch B and switch C are adjusted to position "1". The output level of the reference SHF converter is measured, moving the standard horn in the plane where the OU is located to get the spatial power flux density distribution of the wave coming from the transmitting antenna. The mean output power P_m (W) is calculated.

f) The standard horn is placed at the specified position near the aperture plane of the OU. The output power of the reference outdoor unit P_4 (W) is measured. The ratio $\beta = P_m / P_4$ is calculated.

g) Switch A is set to the "off" position and the output power P_5 (W) is measured.

h) Switch B is set to position "2" and switch D to the "on" position, and the output power P_6 (W) is measured.

i) Switch D is set to the "off" position and the output power P_7 (W) is measured.

j) The G/T for a circular polarization is calculated according to the following formula:

$$\frac{G}{T} = 10 \log \frac{G_s (P_1-P_2)(P_6-P_7)}{2\, T_o E_N \beta P_3 (P_4-P_5)} \quad \text{(dB/K)}$$

where

G_s = the gain of the linearly polarized standard horn with respect to an isotropic antenna, expressed as a ratio (not in dB);

E_N = the excess noise ratio of the noise source, expressed as a ratio (not in dB);

T_o = 290 K.

k) The G/T for a linear polarization is obtained by deleting the factor "2" of the denominator in the above formula.

l) The noise power measurements shall be corrected taking into account the bandwidth of the spectrum analyzer.

3.8.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically. A graphical example is shown in figure 18.

3.9 Alternative method for G/T

3.9.1 *Introduction*

The normal method of measurement for the gain of an antenna and the figure of merit (G/T) of a DBS receiver outdoor unit, requires a large test site that is substantially reflection free. These stringent requirements can be avoided by using a satellite broadcast signal as the signal source. However, the modulation will disturb the measurement unless it is cancelled.

The method described uses a second receiver, in addition to the unit under test. The second receiver provides a local oscillator signal, for mixing with the i.f. output of the test unit. Since both signals carry the same modulation, the modulation will cancel and the resulting output will be a line spectra, suitable for measurement purposes. The second receiver is also used to provide a reference signal. As both receivers are looking at the same satellite, any level fluctuation of the incoming signal will affect each unit similarly, and such level changes can now be compensated.

NOTES

1 G/T is defined as the ratio of the antenna gain to the antenna-SHF converter noise temperature referred to the antenna terminal.

2 The following paper is recommended as a reference: *H. Isono & K. Ohmaru, "A new method for measuring satellite broadcast field intensity and a measurement method for antenna gain and G/T using a satellite broadcast signal", NHK LABORATORIES NOTE, No. 361, pp 1-9 (1988).*

3.9.2 *Method of measurement*

A circular polarized satellite broadcast signal may be utilized as a test signal if the signal is converted to an unmodulated single spectral line and the carrier to noise ratio (C/N) is improved. The method described makes it possible to realize these conditions. The arrangements of test equipments for measuring G/T are shown in figure 19. The measurements shall be made under the following conditions and procedure.

3.9.2.1 *Measuring conditions*

a) Testing site: a location where signals from satellites are not reflected into the receiving antennas.

b) Test frequency: broadcast frequencies.

c) Measuring time: measurements should be performed when antennas do not receive noise from the sun.

d) Sky conditions: when the sky is used to measure the antenna effective noise temperature, the antenna should be directed to the area which minimizes the output noise level of the outdoor unit after confirming that there is no noise source like clouds, the sun, satellites, buildings and trees within 10 degrees from the main beam of the antenna.

3.9.2.2 *Measurement procedure*

a) The standard antenna, the outdoor unit under test and the reference outdoor unit are installed on their own supporting apparatus which is adjustable for azimuth and elevation angles.

A satellite broadcast signal is received after arranging the measurement equipments as shown in figure 19 and setting both SW1 and SW2 to "1" position.

LO2 is adjusted in accordance with the broadcast channel to be measured in order to produce a fixed i.f. ATT1 and ATT2 should be set to 0 dB and 40 dB (or more), respectively.

Each antenna direction is adjusted to maximize the received power, observing the spectrum analyzer connected at port 1 or port 2. An example of the spectrum is shown in figure 20.

NOTE - In this measuring system, the output of SHF converter or the first i.f. is converted again to the 2nd i.f. which can be arbitrarily chosen. It is convenient to choose the same 2nd i.f. as the indoor unit since the frequency converter and BPF can be procured easily. An example of the parameter of each component in figure 19 is listed in table 1.

b) The spectrum analyzer is connected at port 3 and the line spectrum is observed at a frequency of $f_3 + \Delta f_1 + \Delta f_2$. If the power level difference between the main spectrum and a sideband is smaller than 20 dB, an adjustable delay line should be inserted before the combiner. The sideband levels can be reduced by adjusting the electrical length. An example of the line spectrum is shown in figure 25.

c) The direction of the standard antenna is readjusted so that the received power is maximized.

d) The attenuation of ATT2 is decreased to observe the line spectrum at f_3 at port 3 which is created by introducing the reference antenna output signal only, and then it is adjusted so that the power level becomes the same level as the spectrum observed in procedure c). This level is called the reference level. An example of the spectra is shown in figure 22. Also in this case, an adjustable delay line should be inserted before ATT2 if the sideband levels exceed the level explained in b).

e) SW2 is set to "2" position. Spectrum analyzer is connected to port 1. The direction of the outdoor unit under test (OU) is adjusted in order to obtain a maximum signal level at port 1. LO2 is readjusted to produce the same i.f. as procedure a).

f) The spectrum analyzer is connected to port 3. Attenuation of ATT1 is increased until the level of line spectrum observed at the same frequency as procedure b) coincides with the reference level. The attenuation of ATT1 is recorded as L_1 (dB).

g) OU is directed to the sky for the condition described in 3.9.2.1. ATT1 is set to 0 dB. The noise level at the centre frequency of the 2nd i.f. is measured by means of the spectrum analyzer connected to the port 1. This noise level will be recorded.

h) SW1 is set to "2" position,
SW2 is set to "1" position and
SW3 is set to "on" position.

The noise level observed at port 1 is set to the same level measured in procedure g) by adjusting ATT1. The attenuation value is recorded as L_2 (dB).

i) SW3 is set to "off" position. The noise level observed at port 1 is set to the same level measured in procedure g) by adjusting ATT1. The attenuation value is recorded as L_3 (dB). G/T is calculated as follows:

$$\frac{G}{T} = 10 \log \frac{G_s\, 10^{L_1/10} \left(10^{L_2/10} - 10^{L_3/10}\right)}{2\, T_0 E_N} \quad \text{(dB/K)}$$

where

G_s = the gain of the linearly polarized standard horn with respect to an isotropic antenna, expressed as a ratio (not in dB).

E_N = the excess noise ratio of the noise source, expressed as a ratio (not in dB).

T_0 = 290 K.

j) The G/T for a linearly polarized antenna is obtained by adding 3 dB to the above equation.

3.9.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically, specifying the utilized satellite and the elevation angle.

Table 1 – Example of parameters of components in figure 19

DBS signal frequency	11,99600 GHz
LO1 nominal frequency	10,67800 GHz
1st i.f.	1318,00 MHz
LO2	1720,78 MHz
2nd i.f.	402,78 MHz
LO3	805,56 MHz
BPF:	
– centre frequency	402,78 MHz
– bandwidth (3 dB)	27 MHz
i.f. amplifier 1	G = 15 dB
i.f. amplifier 2	G = 30 dB
Limiter amplifier	Output power = 7 dBm
ATT1 (SHF attenuator)	0 dB – 20 dB variable
ATT2 (UHF attenuator)	0 dB – 40 dB variable

3.10 Image suppression ratio

3.10.1 *Introduction*

This method of measurement determines the capability of the outdoor unit to reject signals appearing in the image band.

3.10.2 *Method of measurement*

The arrangement of the test equipment is shown in figure 7 when input arrangement a) or b) (see 2.2.4) is used, and in figure 8 when input arrangement c) (see 2.2.4) is used. The measurement shall be made under the following conditions and procedure.

3.10.2.1 *Measuring conditions*

a) Desired signal frequency: the centre frequencies of the lowest (L), the mid (M) and the highest (H) channels in the reception band (12 GHz band).

b) Interference signal frequency: the image frequency corresponding to each desired signal frequency.

c) Desired signal level: −70 dB(mW) when input arrangement a) or b) is used, or −94 dB(W/m²) when input arrangement c) is used.

d) Interference signal level −40 dB(mW) when input arrangement a) or b) is used, or −64 dB(W/m²) when input arrangement c) is used.

NOTE - The image frequency can be calculated by the following expression:

$$f_i = 2\,f_l - f_s$$

where

f_i = image frequency;

f_l = local oscillator frequency;

f_s = desired signal frequency.

3.10.2.2 *Measurement procedure*

a) The desired c.w. signal is applied and set to the test signal level. The signal level L_{Po} [dB(mW)] that appears at the output terminal is measured.

b) A c.w. interference signal corresponding to the image frequency of the desired signal in a) is applied. The signal level L_P [dB(mW)] that appears at the output terminal is measured.

c) The image interference ratio is given by the value $L_{Po} - L_P$+30) (dB), where 30 dB is a value that provides the correction due to the difference between the desired and the interference signal level at the input.

d) The desired and corresponding interference signal frequencies are changed and steps a), b) and c) are repeated.

NOTE - The directional coupler and transmitting antenna should be checked for satisfactory operation at the image frequency.

3.10.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically. A graphical example is shown in figure 23.

3.11 Spurious responses

3.11.1 *Introduction*

This method of measurement determines the capability of the outdoor unit to suppress spurious responses caused by a signal other than the image frequency signal.

3.11.2 *Method of measurement*

The arrangement of the test equipment is shown in figure 7 when input arrangement a) or b) (see 2.2.4) is used, and in figure 8 when input arrangement c) (see 2.2.4) is used. The measurement shall be made according to the following conditions and procedure.

3.11.2.1 *Measuring conditions*

a) Desired signal frequency: the centre frequencies of the lowest (L), the mid (M) and the highest (H) channels in the reception band (12 GHz band).

b) Desired signal level: −70 dB(mW) when input arrangement a) or b) is used, or −94 dB(W/m²) when input arrangement c) is used.

c) Interference signal frequency: from 7,8 GHz to 15 GHz.

d) Interference signal level: −40 dB(mW) when input arrangement a) or b) is used, or −64 dB(W/m²) when input arrangement c) is used.

NOTES

1 An example of a frequency f [GHz] at which spurious response tends to occur is expressed by the formula:

$$f = (f_s + f_l) / 2$$

where

f_s = desired signal frequency;

f_l = local oscillation frequency;

2 When input arrangement c) is used, appropriate transmitting antennas should be prepared considering the wide frequency range of the interference signal.

3.11.2.2 *Measurement procedure*

a) A desired c.w. signal is applied and set to the test signal level. The signal level L_{Po} [dB(mW)] that appears at the output terminal is measured.

b) A c.w. interfering signal is applied alone. When any output appears at the output terminal around the frequency of the desired output signal, a fine frequency adjustment is made so that the output level becomes maximum. The input frequency f (GHz) and output signal level L_P [dB(mW)] are measured.

c) The spurious response suppression ratio is given by the value ($L_{Po} - L_P + 30$) (dB), where 30 dB takes into account the difference between the desired and the interference signal levels applied at the input.

d) The interference signal frequency is changed and steps a), b) and c) are repeated.

e) The desired and the corresponding interference signal frequencies are changed and steps a), b), c) and d) are repeated.

NOTES

1 A c.w. signal generator with sufficiently low spurious frequency components should be used.

2 Since a frequency lower than 10 GHz can be outside the directional coupler frequency range, the coupling coefficient of the directional coupler should be checked and calibrated.

3.11.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically. The graph showing the suppression ratio is plotted with the input signal frequency as the abscissa and the ratio as the ordinate. Suppression ratios greater than 60 dB may be omitted in the graph. A graphical example is shown in figure 24.

3.12 Intermediate frequency beat suppression ratio

3.12.1 *Introduction*

This method of measurement determines the capability of the outdoor unit to suppress the beat interference caused by signals at a frequency equivalent to the sum or difference of the desired signal frequency and the intermediate frequency.

3.12.2 *Method of measurement*

The desired and the interfering signals are applied simultaneously at the input terminal and the beat signal level appearing at the output terminal is measured. The arrangement of the test equipment is shown in figure 12 when input arrangement a) or b) (see 2.2.4) is used, and in figure 13 when input arrangement c) (see 2.2.4) is used. The measurement shall be made according to the following conditions and procedure.

3.12.2.1 *Measuring conditions*

a) Desired signal frequency (f_s): the centre frequencies of the lowest (L), the mid (M) and the highest (H) channels in the reception band (12 GHz band).

b) Interference signal frequency: $f_s \pm f_i + 5$ (MHz), where f_i is the first intermediate frequency.

c) Desired signal level: −70 dB(mW) when input arrangement a) or b) is used, or −94 dB(W/m^2) when input arrangement c) is used.

d) Interference signal level: −40 dB(mW) when input arrangement a) or b) is used, or −64 dB(W/m^2) when input arrangement c) is used.

NOTE - The interference signal frequency has a +5 MHz offset to separate the interference signal output from the desired signal output.

3.12.2.2 *Measurement procedure*

a) The desired c.w. signal is applied and set to the test signal level. The signal level L_{Po} [dB(mW)] that appears at the output terminal is measured.

b) The desired and undesired c.w. signals are applied simultaneously. The beat interference signal level L_P [dB(mW)] that appears at the output terminal is measured.

c) The intermediate frequency beat interference ratio is given by the value ($L_{Po} - L_P + 30$) (dB), where 30 dB is a value that provides the correction due to the difference between the desired and the interference signal levels at the input.

d) The desired signal frequency is changed and steps a), b) and c) are repeated.

3.12.3 *Presentation of the results*

The results shall be listed in a table and/or presented graphically. A graphical example is shown in figure 25.

3.13 Local oscillator frequency stability

3.13.1 *Introduction*

This method of measurement determines the variations of the local oscillator frequency of the outdoor unit due to:

- warm-up of the SHF converter;
- environmental temperature variations;
- power supply voltage variations.

3.13.2 *Method of measurement*

A constant frequency test signal is applied to the input terminal of the outdoor unit and the changes of the output signal frequency are measured at the output terminal. The local oscillator frequency is obtained from the difference between the frequencies of the input signal and the output signal. The arrangement of the test equipment is shown in figure 26 if input arrangement a) or b) (see 2.2.4) is used, and in figure 27 if input arrangement c) (see 2.2.4) is used. The measurement shall be made according to the following conditions and procedure.

3.13.2.1 *Measuring conditions*

a) Test frequency: the centre frequency of the mid channel in the reception band (12 GHz band).

b) Test signal level: –60 dB(mW) when input arrangement a) or b) is used, and –84 dB(W/m^2) when input arrangement c) is used.

c) Environmental temperatures: –30 °C, 0 °C, 25 °C and 50 °C.

d) Power supply range: from –12 % to +10 % of the rated voltage.

3.13.2.2 *Measurement procedure*

a) A c.w. test signal is applied at the test signal level, and the frequency f_o (GHz) is measured.

b) Switch SW is set to position "2" and the frequency f_{if} (GHz) of the intermediate frequency signal is measured at the output terminal.

c) The local oscillation frequency is given by the value ($f_o - f_{if}$) (GHz).

d) Steps a), b) and c) are repeated under the following conditions:

i) from 1 min after the power supply (at its rated value) is switched on to the time when the local oscillator frequency stabilizes at room temperature;

ii) at the environmental temperatures given above, after the local oscillator has stabilized, following a change in temperature;

iii) at the minimum and maximum values of the power supply.

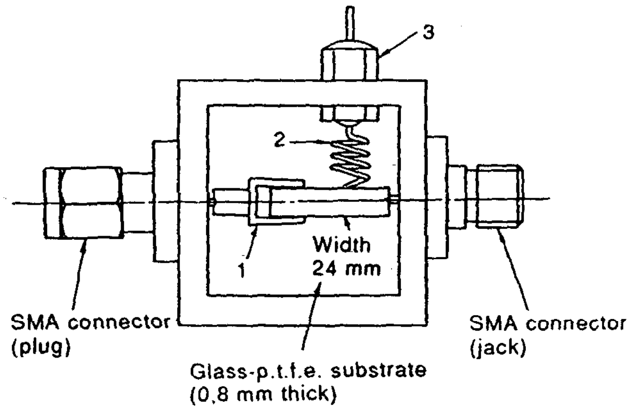
NOTES

1 The local oscillator frequency component that leaks at the input terminal or the output terminal can be directly measured using a highly sensitive frequency counter or a spectrum analyzer as a simplified method.

2 Erroneous counting may occur if the frequency counter input level is inappropriate.

3.13.3 *Presentation of the results*

The results shall be listed in tables and/or presented graphically. Graphical examples are shown in figures 28 and 29.

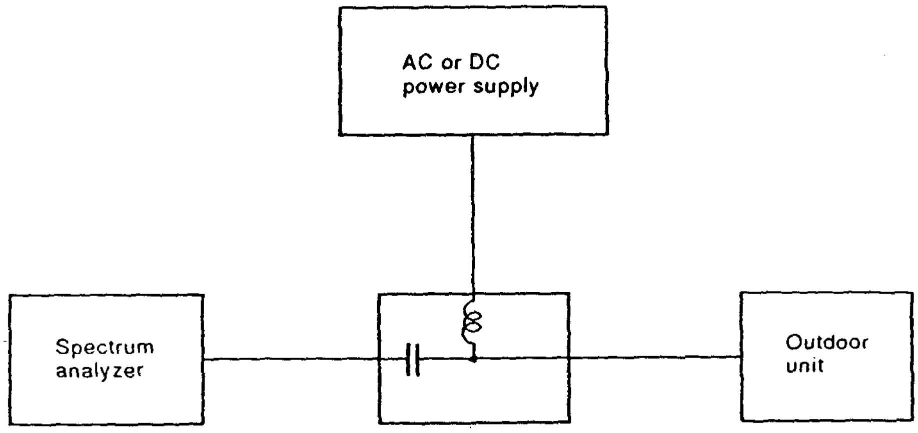


(1) Wedge type capacitance 1 000 pF

(2) Choke coil, around 30 nH

(3) Feed through capacitance 1 000 pF

Figure 1 – Example of a bias network



NOTE - Reverse connection of the bias network is likely to cause damage to the spectrum analyzer.

Figure 2 – Connection of a bias network

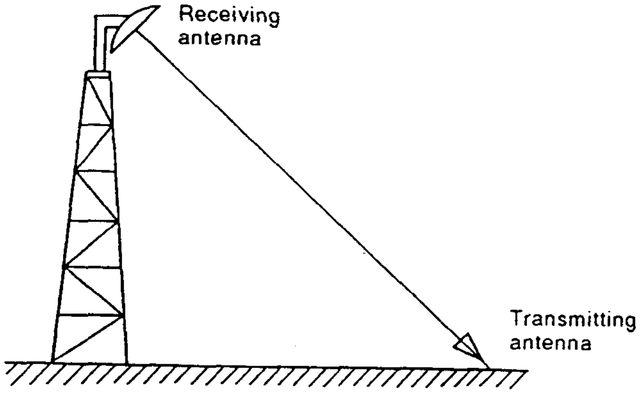
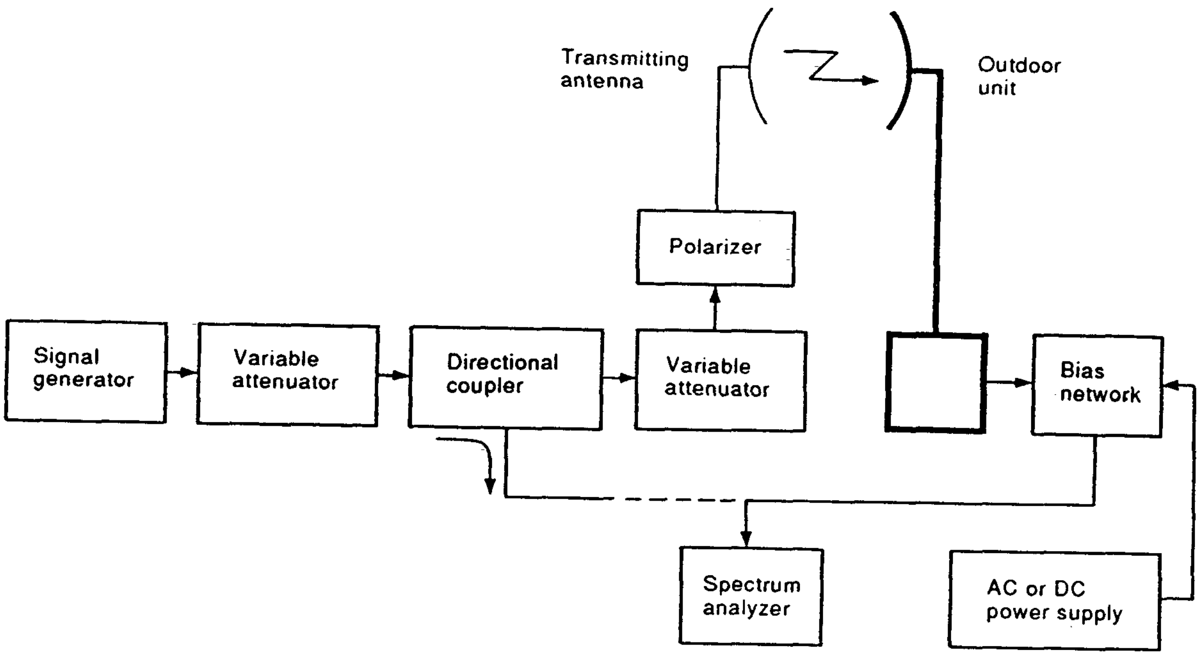
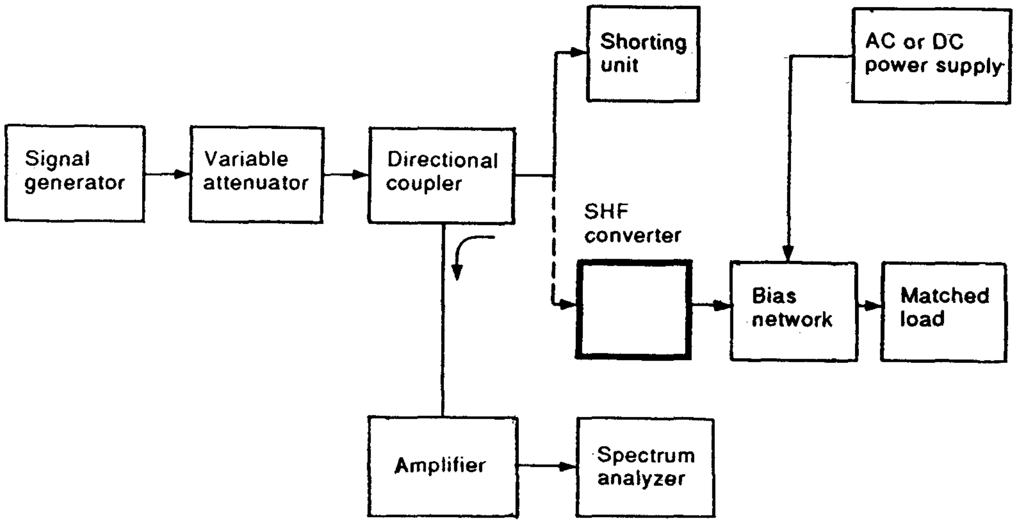


Figure 3 – An example of a slant antenna range setting



NOTE - The directional coupler employed shall satisfy the characteristics of directivity larger than 20 dB and a coupling factor of around 10 dB.

Figure 4 – Circuit arrangement for the measurement of polarization isolation. Input arrangement c) (see 2.2.4) is used



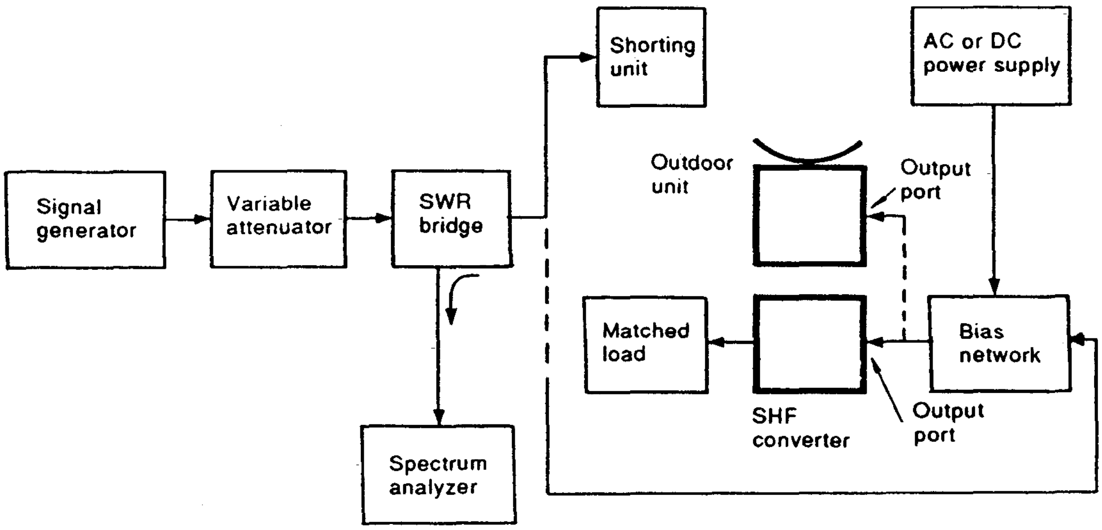
NOTES

1 The directional coupler employed shall satisfy the following characteristics:

- VSWR less than 1,05;
- directivity larger than 35 dB;
- coupling factor around 10 dB.

2 The amplifier employed shall cover the frequency range of the satellite broadcast band and have a gain larger than 40 dB. Another SHF converter can be utilized instead of the amplifier.

Figure 5 – Circuit arrangement for the measurement of the impedance matching at the input terminal

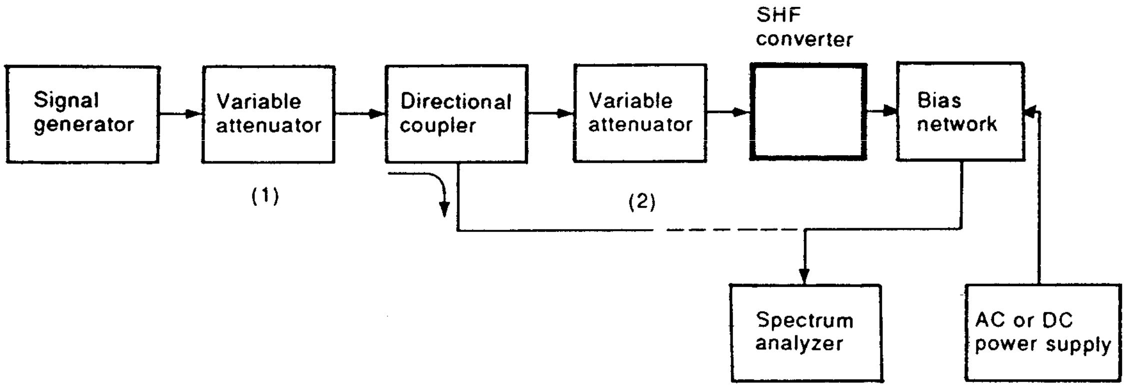


NOTES

1 The SWR bridge shall have a residual VSWR of less than 1,05.

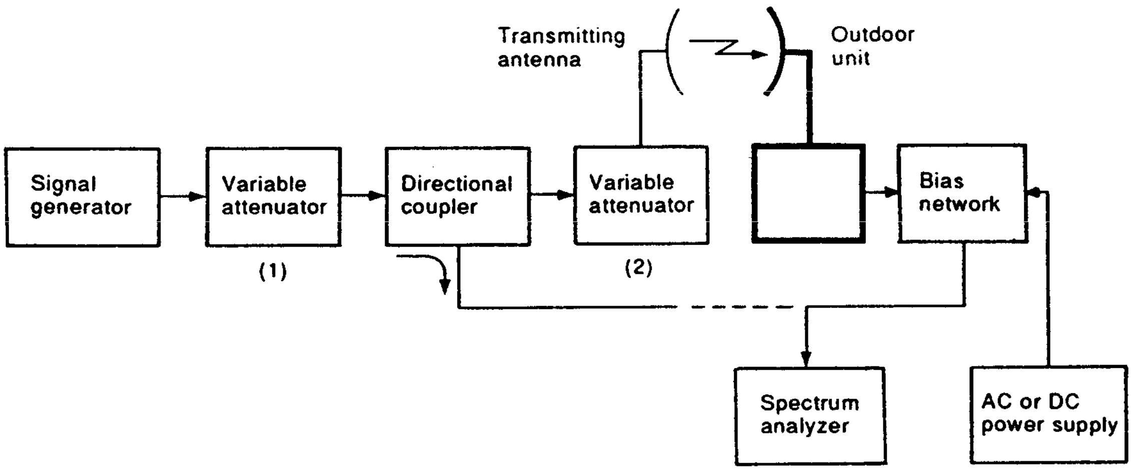
2 The bias network shall have a residual VSWR of less than 1,1.

Figure 6 – Circuit arrangement for the measurement of the impedance matching at the output terminal. The input terminal of the SHF converter shall be terminated with a matched load when input arrangement a) or b) (see 2.2.4) is used, or the outdoor unit antenna shall be oriented towards the sky, avoiding any satellite reception, when input arrangement c) (see 2.2.4) is used



NOTE - The second variable attenuator shall be able to change the attenuation from 0 dB to 50 dB continuously with direct reading.

Figure 7 – Circuit arrangement for the measurement of the gain versus frequency characteristics, the output signal level versus the input signal level, the image suppression ratio, and the spurious response suppression ratio when input arrangement a) or b) (see 2.2.4) is used



NOTE - The second variable attenuator shall be able to change the attenuation from 0 dB to 50 dB continuously with direct reading.

Figure 8 – Circuit arrangement for the measurement of the gain versus frequency characteristics, the output signal level versus the input signal level, the image suppression ratio, and the spurious response suppression ratio when input arrangement c) (see 2.2.4) is used

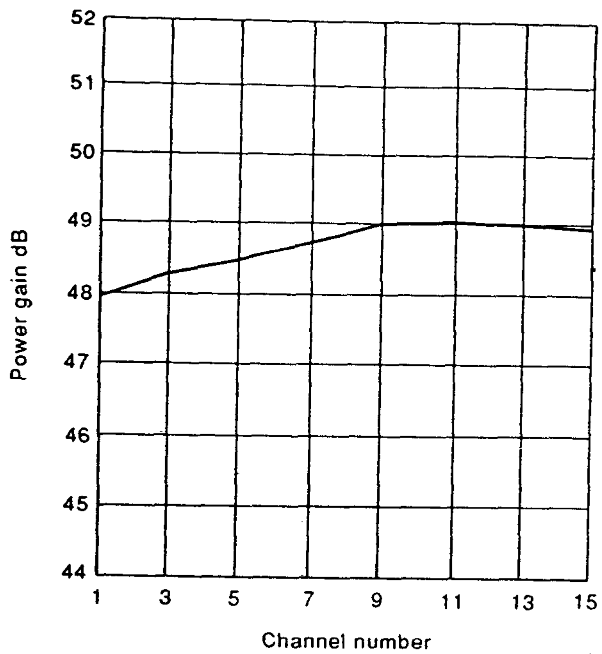


Figure 9 – Example of the gain variation as a function of the channel number

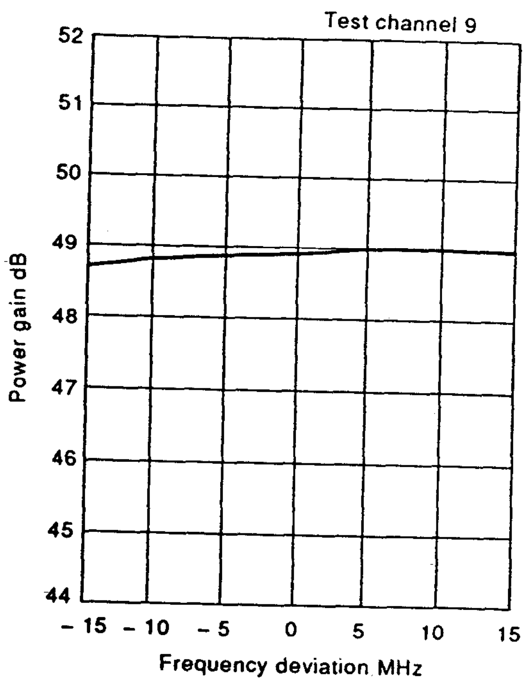


Figure 10 – Example of the gain variation in a channel as a function of the frequency difference from the channel centre

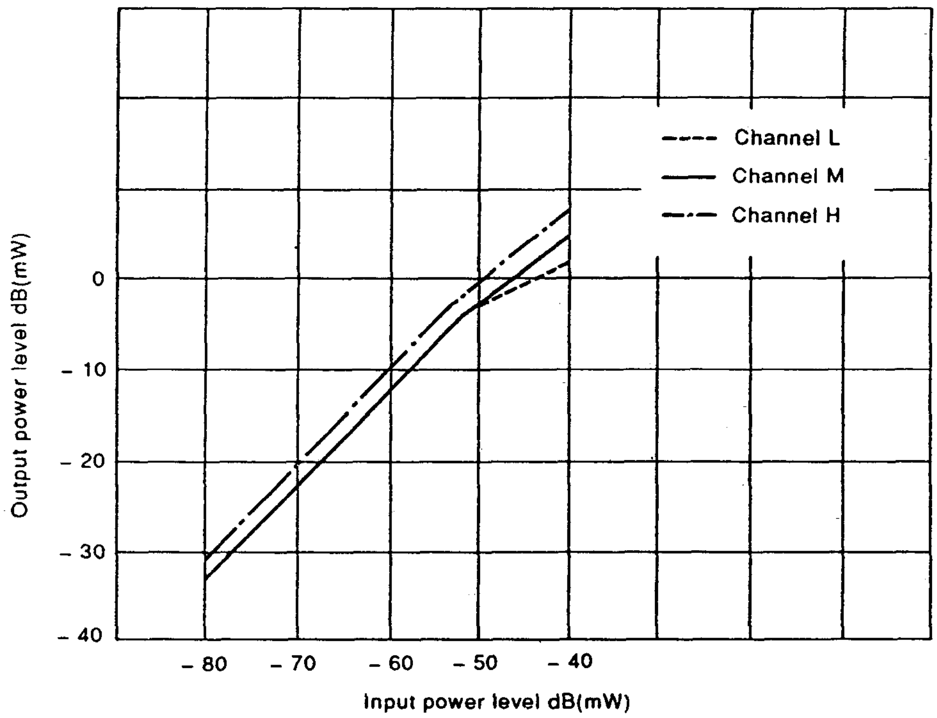
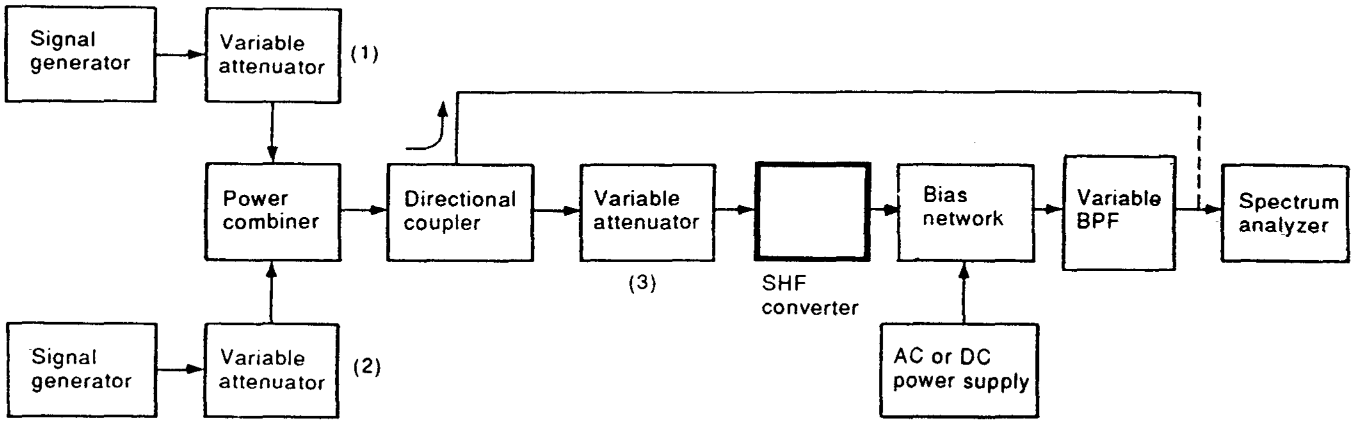


Figure 11 – Example of the output signal level as a function of the input signal level at three representative channels

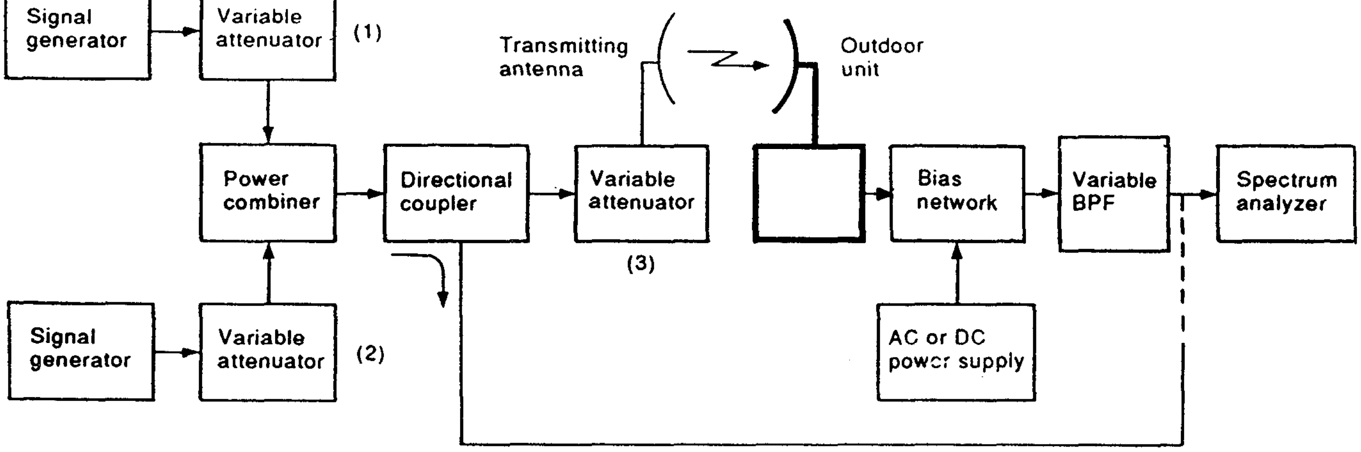


NOTES

1 The variable band-pass filter shall cover the i.f. band of the SHF converter and have a pass band width of about 20 MHz.

2 The variable attenuator (3) shall be able to change the attenuation from 0 dB to 50 dB continuously with direct reading.

Figure 12 – Circuit arrangement for the measurement of the intermodulation and the intermediate frequency beat suppression ratio when input arrangement a) or b) (see 2.2.4) is used



NOTES

1 The variable band-pass filter shall cover the i.f. band of the SHF converter and have a pass band width of about 20 MHz.

2 The variable attenuator (3) shall be able to change the attenuation from 0 dB to 50 dB continuously with direct reading.

Figure 13 – Circuit arrangement for the measurement of the intermodulation and the intermediate frequency beat suppression ratio when input arrangement c) (see 2.2.4) is used

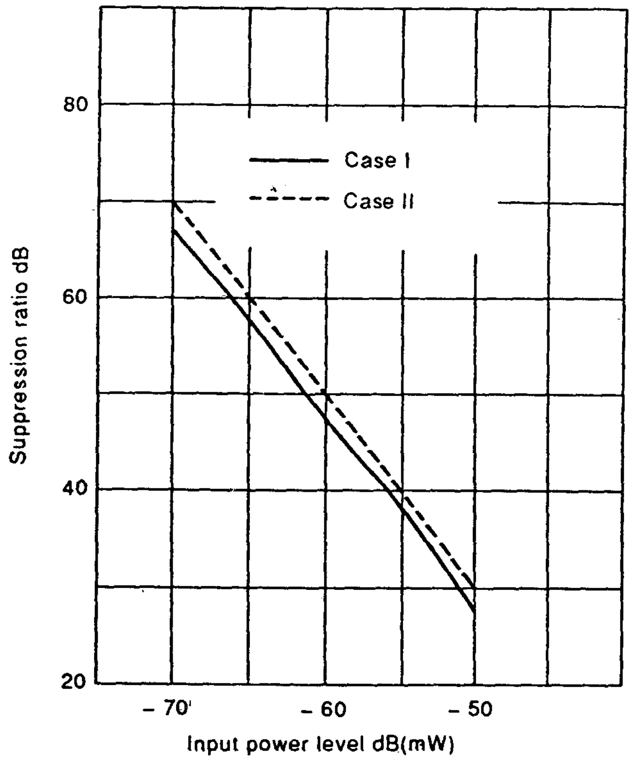


Figure 14 – Example of the intermodulation suppression ratio as a function of the input signal level for two kinds of interference signals

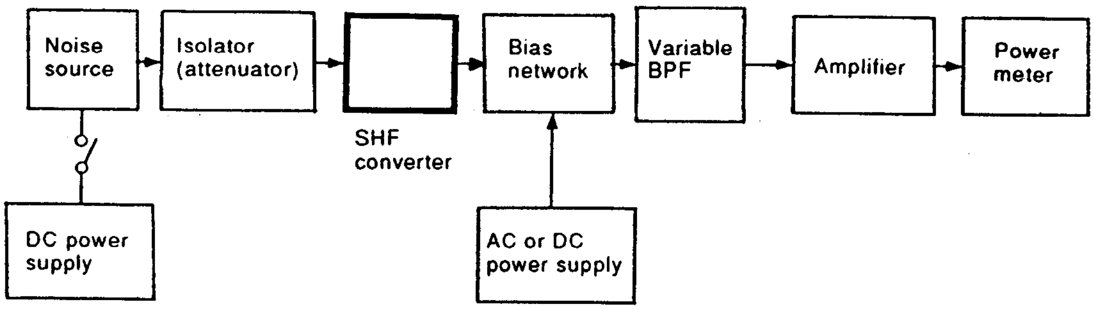


Figure 15 – Circuit arrangement for the measurement of noise figure and noise temperature

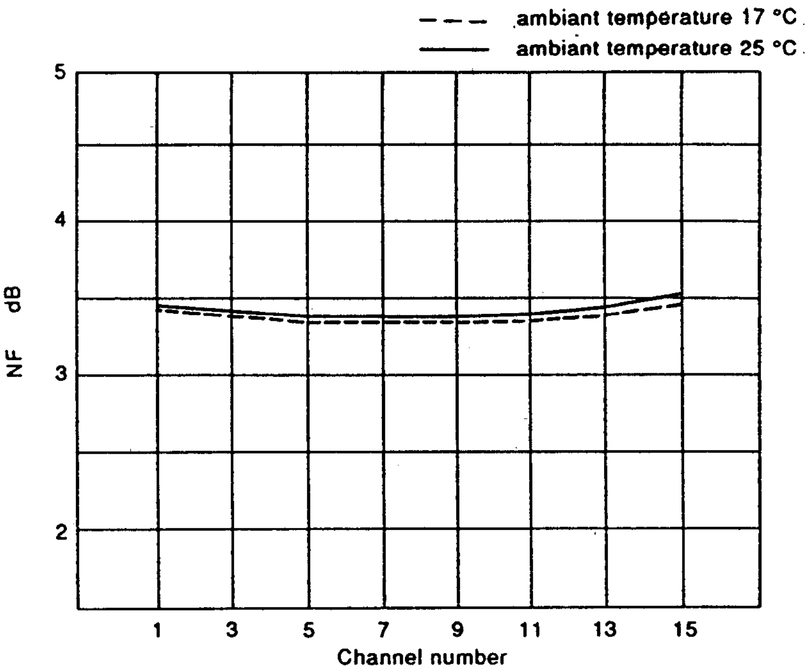
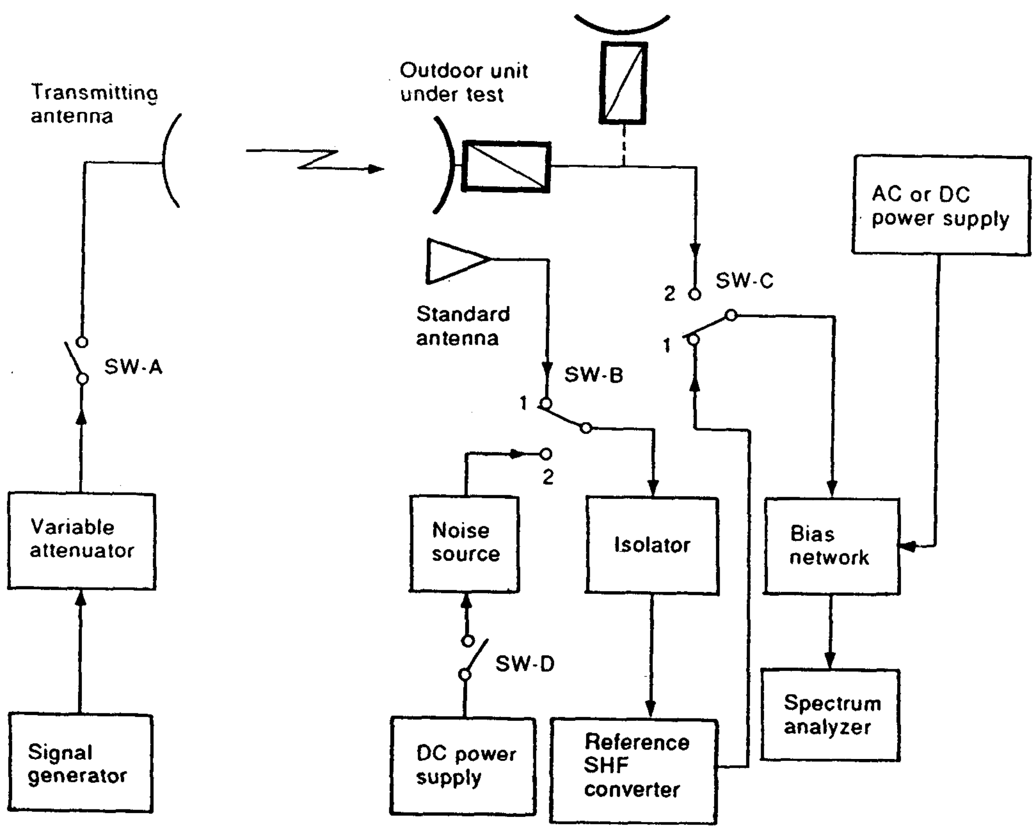


Figure 16 – Example of the noise figure as a function of the channel number at two ambient temperatures



NOTES

1 The isolator shall have a VSWR of less than 1,05.

2 The standard antenna shall be a horn antenna which transmits/receives linearly polarized waves and has a gain of more than 20 dB. It should be calibrated at the test frequencies.

3 The transmitting antenna shall have the same polarization characteristics as the antenna under test.

Figure 17 – Circuit arrangement for the measurement of G/T

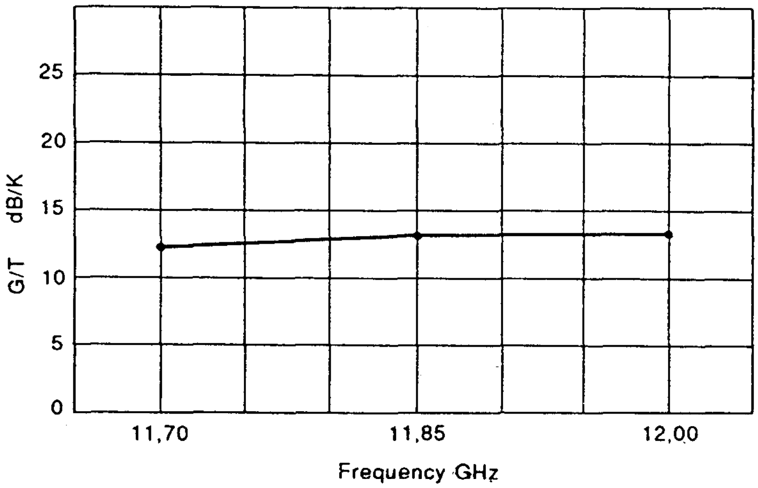


Figure 18 – Example of the G/T as a function of frequency

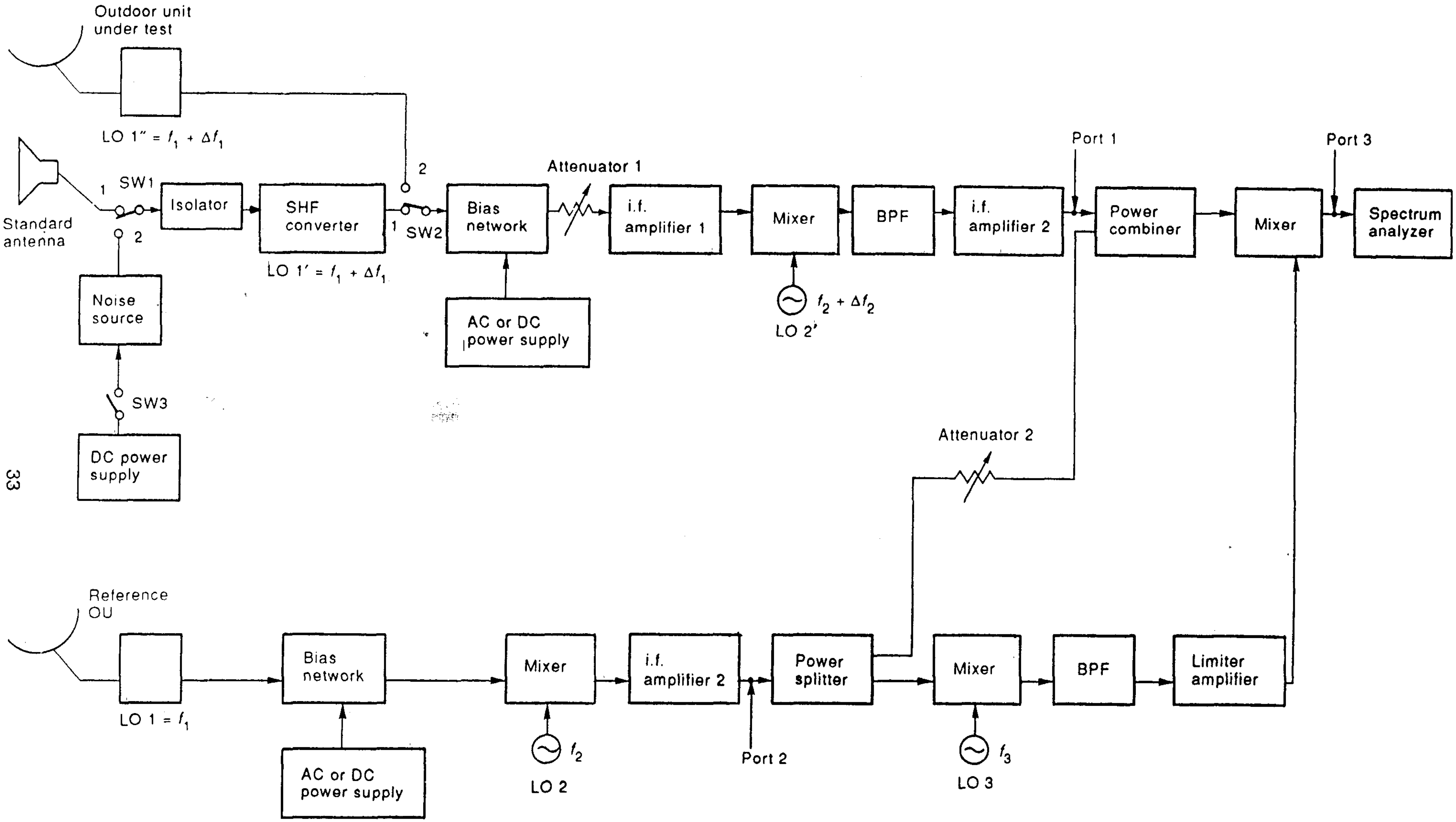
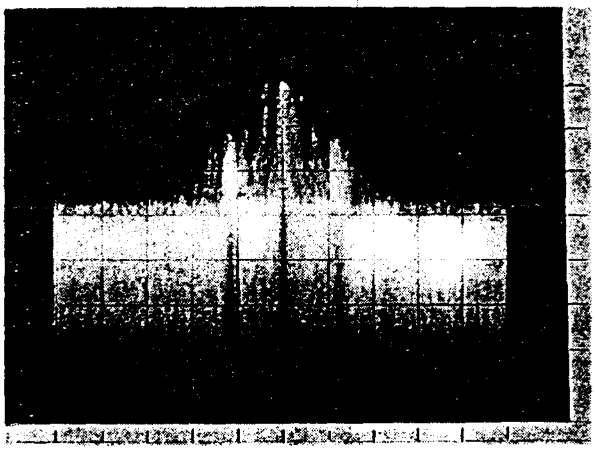
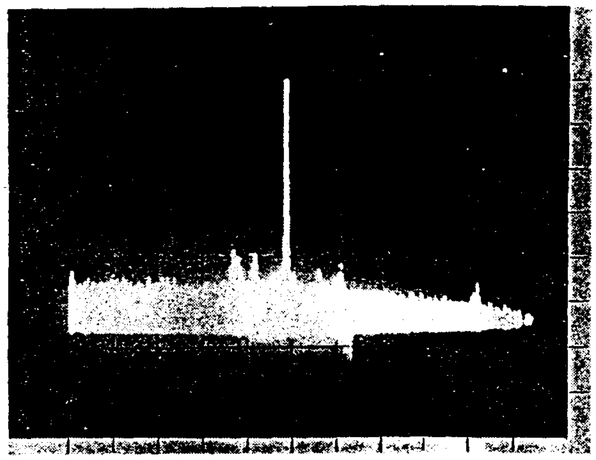


Figure 19 – Circuit arrangement for the measurement of G/T



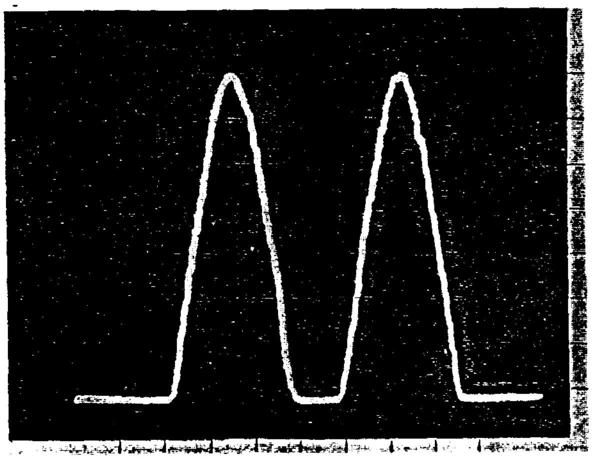
Band width 300 kHz
Scan width 5 MHz/div
Scale 10 dB/div

Figure 20 – Spectrum of satellite broadcasting wave



Band width 3 kHz
Scan width 5 MHz/div
Scale 10 dB/div

Figure 21 – Spectrum of satellite broadcasting wave converted into an unmodulated wave



Band width 10 kHz
Scan width 10 kHz/div
Scale 2 dB/div
Scan time 0,1 s/div
Video filter 10 Hz

Figure 22 – Spectrum in the reference signal simultaneous display system (reference signal is at left and measuring signal at right)

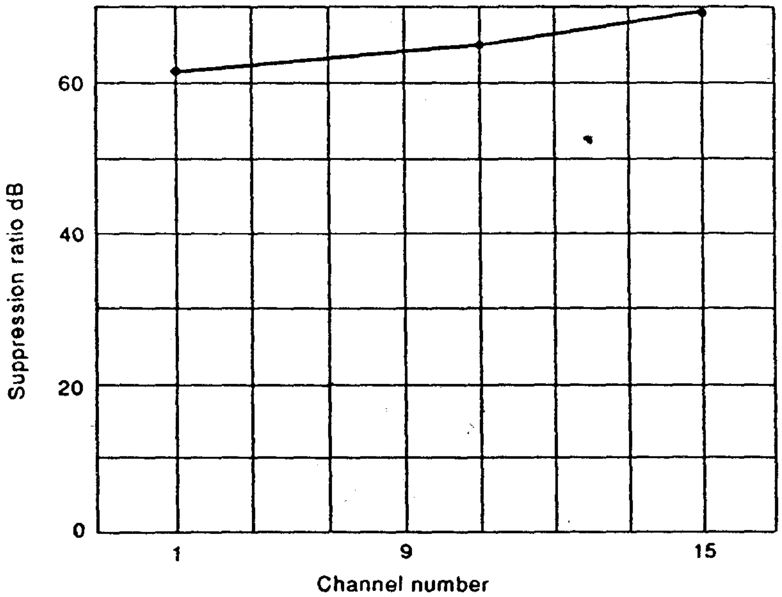


Figure 23 – Example of the image suppression ratio as a function of the channel number

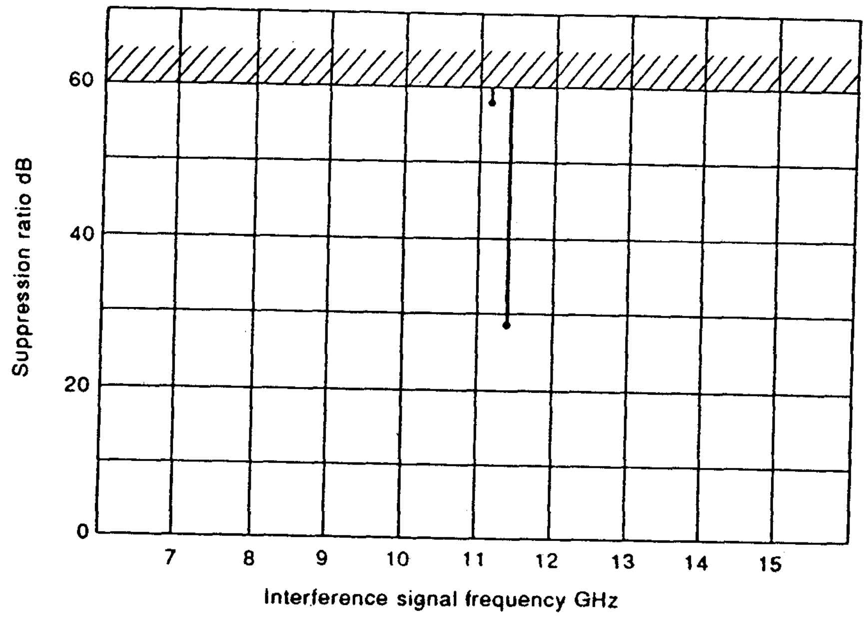


Figure 24 – Example of the spurious response suppression ratio as a function of the interference signal frequency

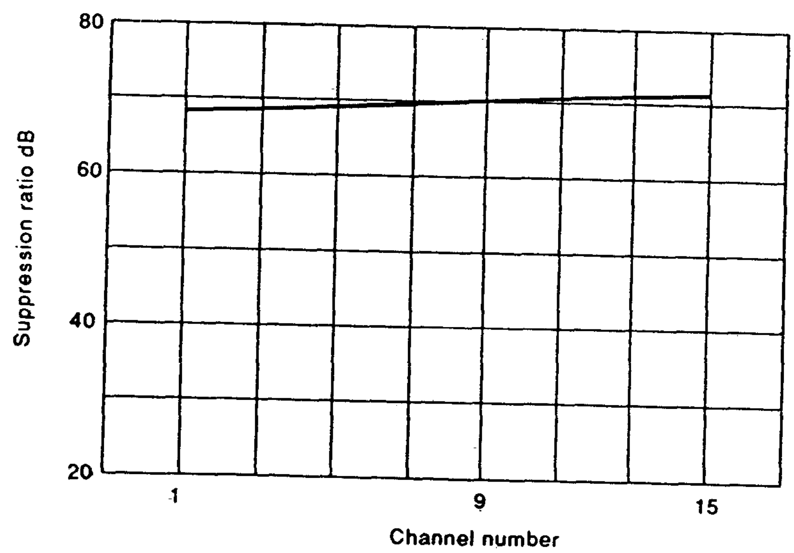


Figure 25 – Example of the intermediate frequency beat suppression ratio as a function of the channel number

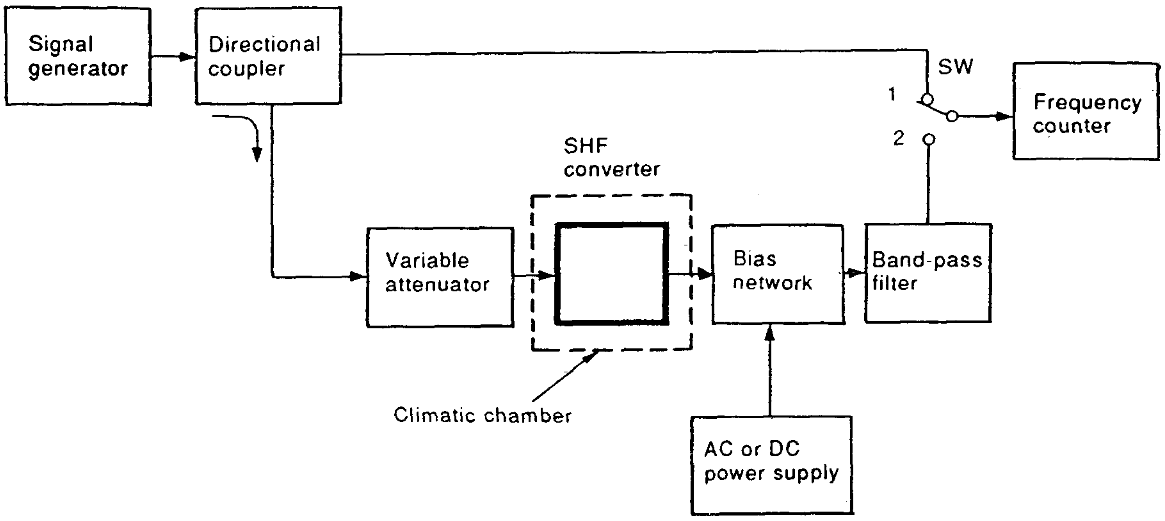
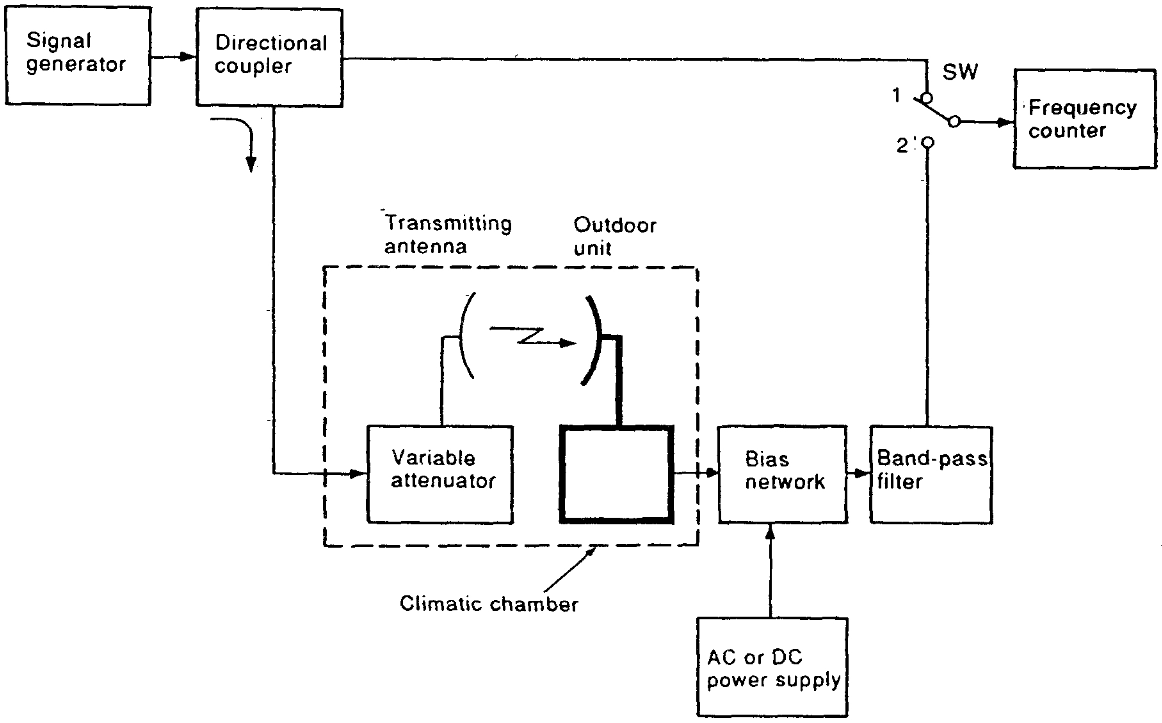


Figure 26 – Circuit arrangement for the measurement of the local oscillator frequency stability when input arrangement a) or b) (see 2.2.4) is used



NOTE - A climatic chamber of adequate size is required.

Figure 27 – Circuit arrangement for the measurement of the local oscillator frequency stability when input arrangement c) (see 2.2.4) is used

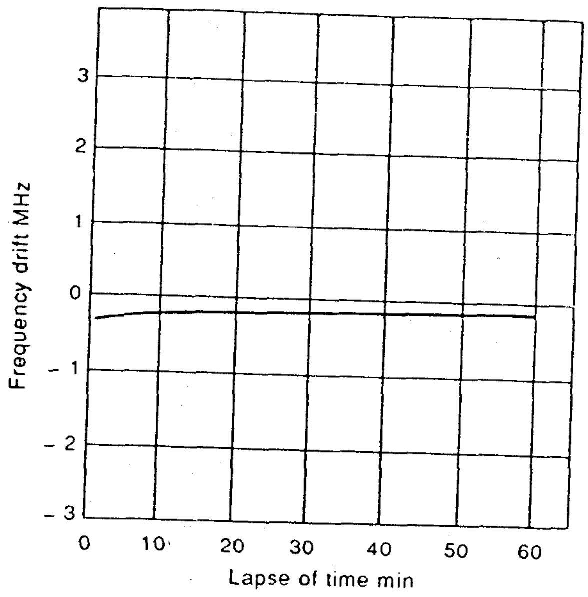


Figure 28 – Example of the initial variation of the local oscillator frequency as a function of time at room temperature

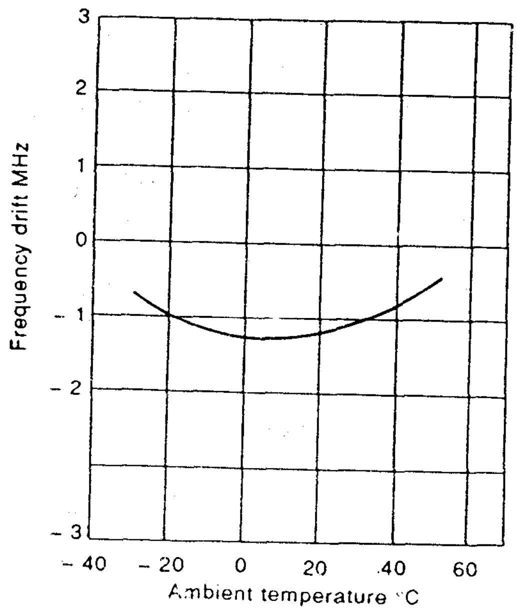


Figure 29 – Example of the local oscillator frequency drift as a function of the ambient temperature

Annex A
(informative)

Bibliography

The following publications contain contain useful information that is relevant to the subject of this standard.

At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of any publications indicated below.

NOTE - CCIR publications may be obtained from the International Telecommunications Union, Sales Office, Geneva, Switzerland.

CCIR Report 473-4: 1986, *Characteristics of ground receiving equipment for the broadcasting-satellite service.*

CCIR Report 634-3: 1986, Broadcasting-satellite service (sound and television). Measured interference protection ratios for planning television broadcasting systems.

CCIR Recommendation 650: 1986, Television standards for satellite broadcasting in the channels defined by WARC BS-77 and RARC SAT-83.

CCIR Report 811-2: 1986, Broadcasting satellite service. Planning elements including those used in the establishment of Plans of frequency assignments and orbital positions for the broadcasting-satellite service in the 12 GHz band.

CCIR Report 1073: 1986, Television standards for the broadcasting-satellite service.

CCIR Special publication: 1986, Specification of transmission systems for the broadcasting-satellite services.

IEEE TRANS. BROADCAST., K. Ohmaru and Y. Mikuni: 1984, Direct G/T measurement for satellite broadcasting receivers, BC-30, 2, pp. 38-43.

ITU Radio Regulations. Appendix 30.

Bureau of Indian Standards

BIS is a statutory institution established under the Bureau of Indian Standards Act, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Revision of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

This Indian standard has been developed from
Doc No. LTD 20 (1502)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
Common to all offices)

Regional Offices :		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	331 01 31 331 13 75
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola CALCUTTA 700054	37 84 99, 37 85 61 37 86 26, 37 86 62
Northern	: SCO 445-446, Sector 35-C, CHANDIGARH 160036	53 38 43, 53 16 40 53 23 84
Southern	: C.I.T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42 235 15 19, 235 23 15
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	632 92 95, 632 78 58 632 78 91, 632 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.

Printed at Dee Kay Printers, New Delhi-110015, India