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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Edition 1 of ETR 027 [5] was adopted in the early days of ETSI with the aim of highlighting the commonalties between the methods of measurement in a variety of ETSI standards.

Edition 2 of the present document is an updated document which includes a number of enhancements, as a result of work done in the preparation of ETR 273 [6] (which covers radiated measurements).

However, in the mean time, a considerable effort has been devoted to the drafting of methods of measurement to be included in a variety of ETSI standards (e.g. ETS 300 296 [9], ETS 300 113 [8], ETS 300 390 [10]) which have a scope similar to that of the ETR.

These methods of measurement, based on material initially found in the ETR, take into account the specific particularities of each standard, together with refinements or new ideas gathered as experience was increasing.

Feed back into ETR 027 [5] of such drafting and technical work has not been performed. Therefore care should be taken when using the ETR for writing other standards:

there may be more recent material available in other ETSI publications, on the same area.

The present document has been written in a way to cover a larger spread of equipment than what is actually stated in the scope (in order to help as much as possible) the particular aspects needed regarding some technologies such as TDMA may have been left out.

Hence, the present document is applicable to measurement methodology in a broad sense but care should be taken when using it to draft new standards or when applying it to a particular technology such as TDMA.

1 Scope

The test methods contained within the present document are intended for use in determining the electrical characteristics of radio equipment in the mobile radio services. A further aim is to give guidance to both manufacturers and type testing authorities so that common test methods can be adopted leading, potentially, to mutual acceptance of test results.

Parameter limits specific to a particular equipment can be found in the relevant ETS (European Telecommunication Standard) or EN (European Standard, Telecommunications series). In the drive towards uniformity, the measurement of a specific equipment parameter has, basically, only one test method although, procedurally, minor differences may exist due to the type of test site used e.g. a ground reflection test site (Anechoic Chamber with a ground plane or Open Area Test Site) requires a vertical height scan to achieve maximum coupling between transmitter and receiver whereas a "non-reflecting" environment (Anechoic Chamber) does not.

The methods apply to constant envelope frequency-modulated or phase-modulated systems as chosen by each administration operating on radio frequencies between 30 MHz and 1 000 MHz and with channel separations of 12,5 kHz, 20 kHz and 25 kHz. Test methods are given which are applicable to radio equipment capable of transmission and/or reception of analogue speech, bit stream and messages.

Included in the present document are test method for radio equipment fitted with external 50 Ω RF connectors (for antennas), temporary external 50 Ω RF connectors and integral antennas. Wherever possible, if the electrical characteristics are not expected to be changed, test measurements should be performed by use of a direct connection (via either the permanent or temporary external 50 Ω RF connector) to the radio equipment as stated in each ETS or EN in order to attempt to minimize measurement uncertainties.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] IEC 60489 (1988): "Methods of measurement for radio equipment used in the mobile services".

[2] Void.

[3] Void.

[4] Void.

[5] ETR 027: "Radio Equipment and Systems (RES); Methods of measurement for private mobile radio equipment".

[6] ETR 273: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement of radiated methods of measurement (using test sites) and evaluation of the corresponding measurement uncertainties".

[7] TR 100 028: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[8] ETS 300 113: "Radio Equipment and Systems (RES); Land mobile service; Technical characteristics and test conditions for radio equipment intended for the transmission of data (and speech) and having an antenna connector".

[9] ETS 300 296: "Radio Equipment and Systems (RES); Land mobile service; Technical characteristics and test conditions for radio equipment using integral antennas intended primarily for analogue speech".

[10] ETS 300 390: "Radio Equipment and Systems (RES); Land mobile service; Technical characteristics and test conditions for radio equipment intended for the transmission of data (and speech) and using an integral antenna".

[11] ANSI C63.5 (1988): "Electromagnetic Compatibility - Radiated Emission; Measurements in Electromagnetic Interference (EMI) Control - Calibration of Antennas".

[12] EN 55020 (1994): "Electromagnetic immunity of broadcast receivers and associated equipment".

[13] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".

[14] CCITT Recommendation O.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

antenna: that part of a transmitting or receiver system that is designed to radiate or to receive electromagnetic waves

audio frequency load: normally a resistor of sufficient power rating to accept the maximum audio output power from the equipment under test. The value of the resistor should be that stated by the manufacturer and should be the impedance of the audio transducer at 1 000 Hz. In some cases it may be necessary to place an isolating transformer between the output terminals of the receiver under test and the load

audio frequency termination: any connection other than the audio frequency load which may be required for the purpose of testing the receiver. (i.e. in a case where it is required that the bit stream be measured, the connection may be made, via a suitable interface, to the discriminator of the receiver under test)

The termination device should be agreed between the manufacturer and the testing authority and details should be included in the test report. If special equipment is required then it should be provided by the manufacturer.

band-stop filter (for the SINAD meter): the characteristics of the **band-stop filter** used in the audio distortion factor meter and SINAD meter should be such that at the output the 1 000 Hz tone will be attenuated by at least 40 dB and at 2 000 Hz the attenuation will not exceed 0,6 dB. The filter characteristic should be flat within 0,6 dB over the ranges 20 Hz to 500 Hz and 2 000 Hz to 4 000 Hz. In the absence of modulation the filter should not cause more than 1 dB attenuation of the total noise power of the audio frequency output of the receiver under test

combining network: a multipole network allowing the addition of two or more test signals produced by different sources for connection to a receiver input. Sources of test signals should be connected in such a way that the impedance presented to the receiver should be 5O Ω. The effects of any intermodulation products and noise produced in the signal generators should be negligible

correction: value which, added algebraically to the uncorrected result of a measurement, compensates for assumed systematic error

correction factor: numerical factor by which the uncorrected result of a measurement is multiplied to compensate for an assumed systematic error

duplex filter: a device fitted internally or externally to a transmitter/receiver combination to allow simultaneous transmission and reception with a single antenna connection

extreme test conditions: test conditions defined in terms of temperature and supply voltage. Tests should be made with the extremes of temperature and voltage applied simultaneously. The upper and lower temperature limits are specified in the relevant ETS. The test report should state the actual temperatures measured

When extreme temperatures are applied to the equipment, provisions have to be made so that thermal balance has been reached and that condensation does not occur. Further details will be specified in the relevant ETS or EN.

The extreme test voltage for equipment to be connected to an AC supply should be the *nominal mains voltage* ±10 %.

The extreme test voltages for equipment intended for use with lead acid batteries fitted on vehicles and charged from a regulator should be 0,9 and 1,3 times the nominal voltage of the battery.

The lower extreme test voltages for equipment with power sources using other types of batteries should be as follows:

1) For the Leclanché or lithium type of cell, 0,85 times the nominal voltage of the battery.

2) For the mercury or nickel-cadmium type of cell, 0,9 times the nominal voltage of the battery.

3) For other types of batteries, the end point voltage declared by the equipment manufacturer.

The upper extreme test voltage should be the nominal voltage of the battery.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages should be those agreed between the equipment manufacturer and the type testing authority and should be recorded with the results.

intermittent operation: the manufacturer should state the maximum time that the equipment is intended to transmit and the necessary standby period before repeating a transmit period

limited Frequency Range: a specified smaller frequency range within the full frequency range over which the measurement is made

The details of the calculation of the *limited frequency range* should be given in the relevant ETS or EN.

The *limited frequency range* should be used in the measurement of receiver spurious response immunity to enable a detailed search for responses close to the wanted frequency.

Outside the *limited frequency range* the receiver spurious response immunity should be measured at frequencies where it is calculated that a spurious response could occur.

maximum permissible frequency deviation: the maximum value of frequency deviation stated for the relevant channel separation and is shown in table 1:

Table 1

Channel separation (kHz)	Maximum permissible frequency deviation (kHz)
12,5	±2,5
20,0	±4,0
25,0	±5,0

NOTE: The above values of deviation are equal to 20 % of the channel separation.

measurement uncertainty: an estimate characterizing the range of values within which the true value of a measurand lies

nominal frequency: one of the channel frequencies on which the equipment is designed to operate

nominal mains voltage: the declared voltage or any of the declared voltages for which the equipment was designed

normal test conditions: test conditions defined in terms of temperature, humidity and supply voltage

The normal temperature and humidity conditions for tests should be any convenient combination of temperature and humidity within the following ranges:

- Temperature: +15°C to +35°C;
- Relative humidity: 20 % to 75 %.

The actual temperature and humidity should be recorded in the test report for each measurement.

If it is impractical to carry out the tests under the foregoing conditions, a note stating that the actual temperature and humidity were outside normal test conditions should be added to the report.

The normal test voltage for equipment connected to the mains should be the *nominal mains voltage*.

The frequency of the *nominal mains voltage* should be between 49 Hz and 51 Hz.

The normal test voltage for equipment intended for use with lead acid batteries fitted on vehicles and charged from a regulator should be 1,1 times the nominal voltage of the battery. The nominal voltage of a lead acid cell should be taken to be 2 V.

If other power sources or types of battery (primary or secondary) are required for operation then the normal test voltage should be that declared by the equipment manufacturer.

normal deviation: the frequency deviation for analogue signals which is equal to 12 % of the channel separation

psophometric weighting network: as described in ITU-T Recommendation O.41 [13]

rated audio output power: the maximum output power under normal test conditions, and at standard test modulations (A-M1, see subclause 2.2.18), as declared by the manufacturer

rated radio frequency output power: the maximum carrier power under normal test conditions, as declared by the manufacturer

SINAD: acronym for "signal plus noise plus distortion to noise plus distortion ratio" expressed in decibels

test load: a 50 Ω substantially non-reactive, non-radiating power attenuator which is capable of safely dissipating the power from the transmitter

test modulation: a baseband signal which modulates a carrier and is dependent upon the type of equipment under test and also the measurement to be performed

- Signals for analogue speech:

  A-M1**:** A 1 000 Hz tone at a level which produces a deviation of 12 % of the channel separation.

  A-M2**:** A 1 250 Hz tone at a level which produces a deviation of 12 % of the channel separation.

  A-M3**:** A 400 Hz tone at a level which produces a deviation of 12 % of the channel separation. This signal is used as an unwanted signal for analogue and digital measurements.

- Signals for data (bit stream):

  The level of deviation used in digital measurements is system and method dependent (sub-carrier or direct modulation) and should be agreed between the testing authority and the supplier. At no time will it exceed 20 % of the channel separation.

  D-M0**:** A signal representing an infinite series of '0' bits.

  D-M1**:** A signal representing an infinite series of '1' bits.

  D-M2**:** A signal representing a pseudorandom bit sequence of at least 511 bits in accordance with CCITT Recommendation O.153 [14]. This sequence should be continuously repeated. This signal is used as a wanted signal. In the case of digital duplex measurements it is also used to modulate the transmitter but the sequence should start at a different time from the signal modulating the receiver.

- Signals for data (messages):

D-M3**:** A test signal should be agreed between the testing authority and the manufacturer in the cases where it is not possible to measure a bit stream or if selective messages are used and are generated or decoded within an equipment. The agreed test signal may be formatted and may contain error detection and correction.

For test purposes if special equipment is required to generate or indicate correct acceptance of the messages then it should be supplied by the manufacturer.

Details of the test signal should be supplied in the test report.

trigger device: a circuit or mechanism to trigger the oscilloscope timebase at the required instant. It may control the transmit function or inversely receive an appropriate command from the transmitter

upper specified audio frequency limit: the maximum audio frequency of the audio pass-band and is dependent on the channel separation

- For 20 kHz and 25 kHz channel separated systems the limit is 3 000 Hz;
- for 12,5 kHz channel separated systems the limit is 2 550 Hz.

wanted signal level: for conducted measurements the ***wanted signal level*** is defined as a level of +6 dB/μV emf referred to the receiver input under *normal test conditions*. Under *extreme test conditions* the value is +12 dB/μV emf

For radiated measurements the *wanted signal* is defined as a field strength given in table 2:

Table 2

Frequency Band (MHz)	Field strength in dB relative to 1 μV/m	
	Normal test conditions	Extreme test conditions
25 to < 100	14	20
100 to < 230	20	26
230 to < 470	26	32
470 to 1 000	32	38

For analogue measurements the wanted signal level has been chosen to be equal to the limit value of the measured usable sensitivity.

For bit stream and message measurements the wanted signal has been chosen to be +3 dB above the limit value of measured usable sensitivity.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
AF	Audio Frequency
D	Distance in metres from equipment under test to the point at which measurements are made
DC	Direct Current
emf	electromotive force
EUT	Equipment Under Test
IF	Intermediate Frequency
LPDA	Log Periodic Directional Antenna
NaCl	Sodium chloride
RF	Radio Frequency
rms	root mean square
Rx	Receiver
SINAD	SIgnal plus Noise And Distortion divided by noise plus distortion
TDMA	Time Division Multiple Access
TEM	Transverse Electromagnetic wave

Tx	Transmitter
VSWR	Voltage Standing Wave Ratio

4 General arrangements

4.1 Power measuring receiver

A power measuring receiver is used for the measurement of the adjacent channel power of a transmitter. There are three different types of receiver that come under the general heading of power measuring receiver. They are:

- a Spectrum Analyser;
- a Measuring receiver with digital filters;
- an Adjacent Channel Power Meter with mechanical filters.

4.1.1 Spectrum analyser

To use a spectrum analyser in the measurement of adjacent channel power, the transmitter under test is connected via a matching and attenuating network and the level of the carrier recorded as reference. The adjacent channel power is then calculated from 9 spectrum analyser sample readings by means of Simpson's Rule. This method is usually employed for channel spacings outside the land mobile range, such as 50 kHz or 100 kHz.

The uncertainty of this measurement is of the order of ±2 dB to ±3 dB.

4.1.2 Measuring receiver with digital filters

The transmitter under test is connected to a measuring receiver with digital filters through a matching and attenuating network as in the adjacent channel power meter method above.

This method involves the measurement of the transmitter adjacent channel power by sampling the power in the adjacent channels. The measuring receiver with digital filters is normally for 10 kHz 12,5 kHz 20 kHz and 25 kHz channel spacings.

The uncertainty of this measurement is of the order of ±0,5 dB to ±1 dB.

4.1.3 Adjacent channel power meter

The transmitter under test is connected to an adjacent channel power meter through a matching and attenuating network. The meter consists of a mixer, an IF filter, an amplifier, a variable attenuator and a level indicator, as shown in figure 1. The local oscillator signal for the adjacent channel power meter is usually a low noise signal generator.

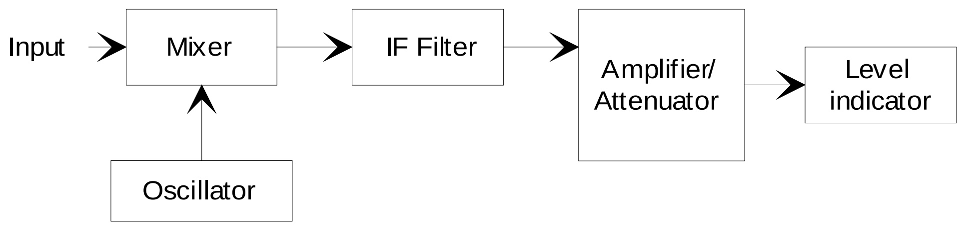


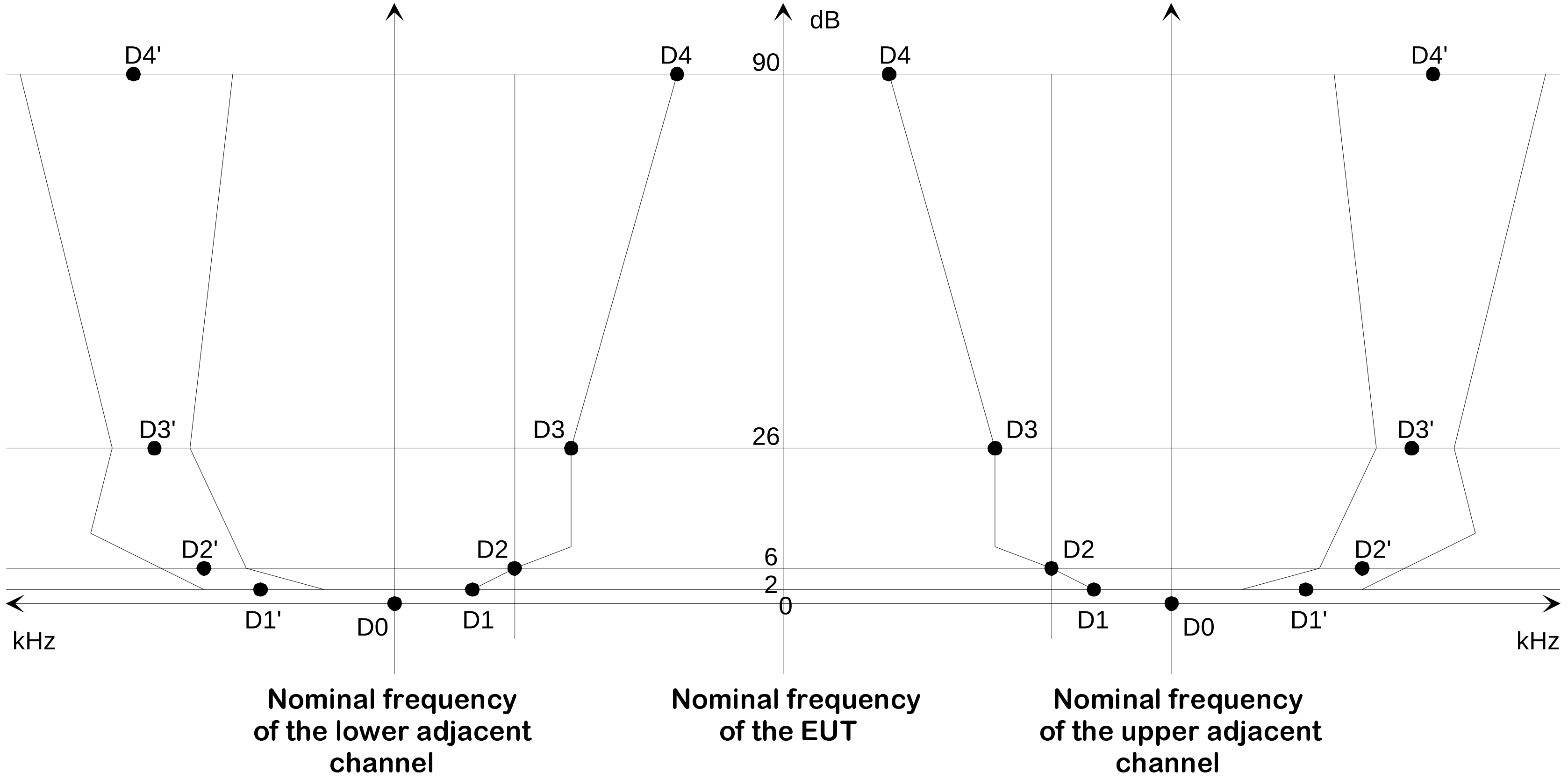
Figure 1: Schematic of an adjacent channel power meter

The test method involves the measurement of the transmitter adjacent channel power by off-setting the IF filter which has a very well defined shape.

4.1.3.1 IF filter

The IF filter should be within the limits of the selectivity characteristics given in figure 2. Depending on the channel separation, the selectivity characteristics should keep the frequency separations and tolerances given in table 2A. The minimum attenuation of the filter outside the 90 dB attenuation points should be equal to or greater than 90 dB.

NOTE 1: A symmetrical filter can be used provided that each side meets the tighter tolerances and the D0 points have been calibrated relative to the -6 dB response. When a non-symmetrical filter is used the receiver should be designed such that the tighter tolerance is used close to the carrier.



NOTE: This lower adjacent filter shape is a mirror image of the upper adjacent channel.

Figure 2: Power measuring receiver filter shape

Table 2A: Power measuring filter shape

Point	Attenuation relative to passband (dB)	Distance in kHz from D2 (-6 dB ref.) for channel separations of:			
		10 kHz	12,5 kHz	20 kHz	25 kHz
D4	90		-5,25 *	-5,25 *	-5,25 *
D3	26		-1,25 *	-1,25 *	-1,25 *
D2	6		0	0	0
D1	2		1,25 *	3,00 *	3,00 *
D0	0, +2		4,25 ± 0,1	7,00 ± 0,1	8,00 ± 0,1
D1'	2		7,25 ± 2,0	11,00 ± 3,0	13,00 ± 3,5
D2'	6		8,50 ± 2,0	14,00 ± 3,0	16,00 ± 3,5
D3'	26		9,75 ± 2,0	15,25 ± 3,0	17,25 ± 3,5
D4'	90		13,75 + 2,0 - 6,0	19,25 + 3,0 - 7,0	21,25 + 3,5 - 7,5

NOTE 2: The values with an asterisk appended are maximum distances from the D2 reference.
NOTE 3: D0 is the nominal centre of the template of the filter and may be used as the reference with respect to the nominal frequency of the adjacent channel.

Caution should be exercised when a non-symmetrical filter is used. In these cases the meter should have been designed such that the tighter tolerance filter slope is used close to the carrier. This type of equipment is used to measure adjacent channel power in systems employing channel spacings of 10 kHz, 12,5 kHz, 20 kHz and 25 kHz.

The uncertainty of this measurement is of the order of ±3 dB to ±4 dB.

4.1.3.2 Oscillator and amplifier

The measurement of the reference frequencies and the setting of the local oscillator frequency should be within ±50 Hz.

The mixer, oscillator and the amplifier should be designed in such a way that the measurement of the adjacent channel power of an unmodulated test signal source, whose noise has a negligible influence on the measurement result, yields a measured value of ≤ -90 dB for channel separation of 20 kHz and 25 kHz and of ≤ -80 dB for a channel separation of 12,5 kHz referred to the level of the test signal source.

The linearity of the amplifier should be such that an error in the reading of no more than 1,5 dB will be obtained over an input level variation of 100 dB.

4.1.3.3 Attenuation indicator

The attenuation indicator should have a minimum range of 80 dB and a resolution of 1 dB.

4.1.3.4 Level indicators

Two level indicators are required to cover the rms and the peak transient measurement.

4.1.3.4.1 Rms level indicator

The rms level indicator should indicate non-sinusoidal signals accurately within a ratio of 10:1 between peak value and rms value.

4.1.3.4.2 Peak level indicator

The peak level indicator should indicate accurately and store the peak power level. For the transient power measurement the indicator bandwidth should be greater than twice the channel separation.

A storage oscilloscope or a spectrum analyser may be used as a peak level indicator.

4.2 Test discriminator

The test discriminator consists of a mixer and local oscillator (auxiliary frequency) to convert the transmitter frequency to be measured into the frequency of a broadband limiter amplifier and of a broadband discriminator with the following characteristics:

- The discriminator should be sensitive and accurate enough to cope with transmitter carrier powers as low as 1 mW.
- The discriminator should be fast enough to display the frequency deviation (approximately 100 kHz/100 ms).
- The discriminator output should be DC coupled.

4.3 Test sites

There are four test sites which may be used for determining absolute values during radiated tests. These are the Anechoic Chamber, an Anechoic Chamber with a ground plane, an Open Area Test Site and a Stripline. These test sites are generally referred to as free field test sites. An additional type of test site is the Test Fixture. However, this can only be used for relative measurements since the coupling mechanism between the coupling probe and an EUT is generally too complex to model theoretically. All five test sites are discussed below.

4.3.1 Description of an Anechoic Chamber

An Anechoic Chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical Anechoic Chamber is shown in figure 3.

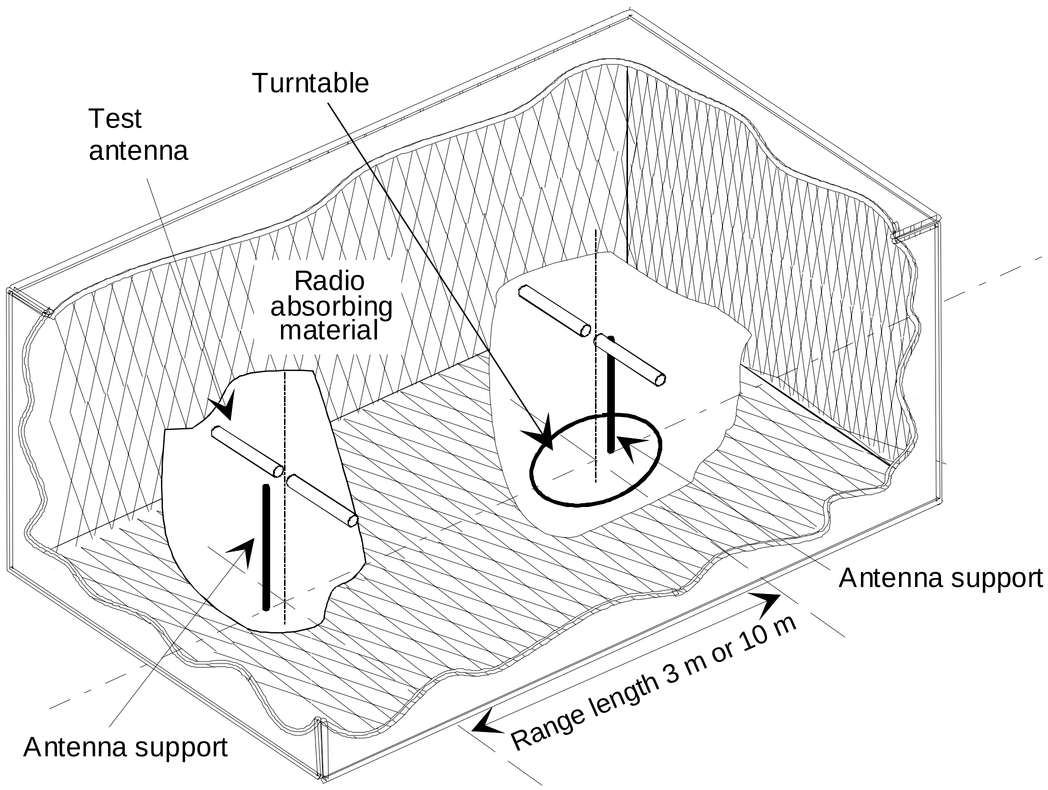


Figure 3: A typical Anechoic Chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

No design of radio absorbing material, however, satisfies the requirement of complete absorption of all the incident power (it cannot be perfectly manufactured and installed) and its return loss (a measure of its efficiency) varies with frequency, angle of incidence and in some cases, is influenced by high power levels of incident radio energy. To improve the return loss over a broader frequency range, ferrite tiles, ferrite grids and hybrids of urethane foam and ferrite tiles are used with varying degrees of success.

The Anechoic Chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers.

Both absolute and relative measurements can be performed in an Anechoic Chamber. Where absolute measurements are to be carried out, or where the test facility is to be used for accredited measurements, the chamber should be verified.

The verification procedure involves the transmission of a known signal level from one calibrated antenna (usually a dipole) at a specified fixed height on the turntable and the measurement of the received signal level in a second calibrated antenna (also usually a dipole). By comparison of the transmitted and received signal levels, an "insertion loss" can be deduced. After inclusion of any correction factors to the measurement, the figure of loss which results from the verification procedure, is known as "Site Attenuation". A comparison is then made of the measured performance to that of an ideal theoretical chamber, with acceptability being decided on the basis of the differences not exceeding some pre-determined limits.

A fully detailed procedure for verifying the performance of an Anechoic Chamber is given in ETR 273 [6].

Field uniformity in an Anechoic Chamber resulting from constructive and destructive interference of the direct and any residual reflected fields can be minimal, but will still vary, depending on the quality of the absorber, in amplitude, phase, impedance and polarization from one measurement point to another and from one frequency to another within the test volume or test area.

All types of emission, sensitivity and immunity testing can be carried out within an Anechoic Chamber without limitation although it is more usual for adjacent channel power and most immunity testing to be performed in a Test Fixture.

4.3.2 Description of an Anechoic Chamber with a ground plane

An Anechoic Chamber with a ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical Anechoic Chamber with a ground plane is shown in figure 4.

This type of test chamber attempts to simulate an ideal Open Area Test Site (historically, the reference site upon which the majority, if not all, of the specification limits have been set) whose primary characteristic is a perfectly conducting ground plane of infinite extent.

The chamber shielding and radio absorbing material work together (in the same manner as described in subclause 4.3.1) to provide a controlled environment for testing purposes.

Both absolute and relative measurements can be performed in an Anechoic Chamber with a ground plane. Where absolute measurements are to be carried out, or where the test facility is to be used for accredited measurements, the chamber should be verified.

The verification procedure involves the transmission of a known signal level from one calibrated antenna (usually a dipole) at a specified fixed height on the turntable and the measurement of the received signal level in a second calibrated antenna (also usually a dipole) which has been "peaked" by raising and lowering the antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals from the transmitting antenna. By comparison of the transmitted and received signal levels, an "insertion loss" can be deduced. After inclusion of any correction factors to the measurement, the figure of loss which results from the verification procedure, is known as "Site Attenuation". A comparison is then made of the measured performance to that of an ideal theoretical chamber, with acceptability being decided on the basis of the differences not exceeding some pre-determined limits.

A fully detailed procedure for verifying the performance of an Anechoic Chamber with a ground plane is given in ETR 273 [6].

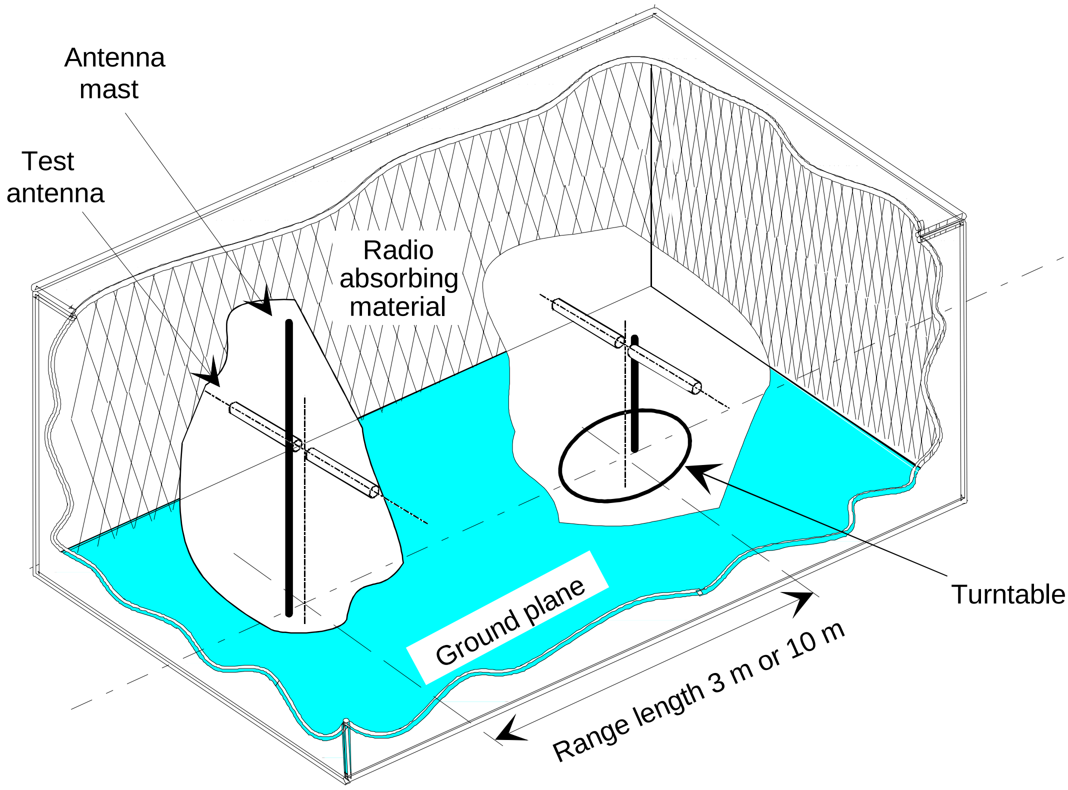


Figure 4: A typical Anechoic Chamber with a ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

In use, the antenna mast provides a variable height facility so that the elevation height of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

Under these conditions, emission testing involves firstly "peaking" the field strength from the EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

Receiver sensitivity tests over a ground plane also involve "peaking" the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the EUT will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the EUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the EUT.

The field uniformity due to constructive or destructive interference of the direct and reflected fields, may vary considerably in amplitude, phase, impedance and polarization from one measurement point to another and from one frequency to another within the test volume.

For this reason, immunity tests (involving two or more signals at different frequencies) should not be carried out in an Anechoic Chamber with a ground plane since the interference makes it difficult to sweep the frequency and maintain a constant field strength at the EUT.

4.3.3 Description of an Open Area Test Site

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other set above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical Open Area Test Site is shown in figure 5.

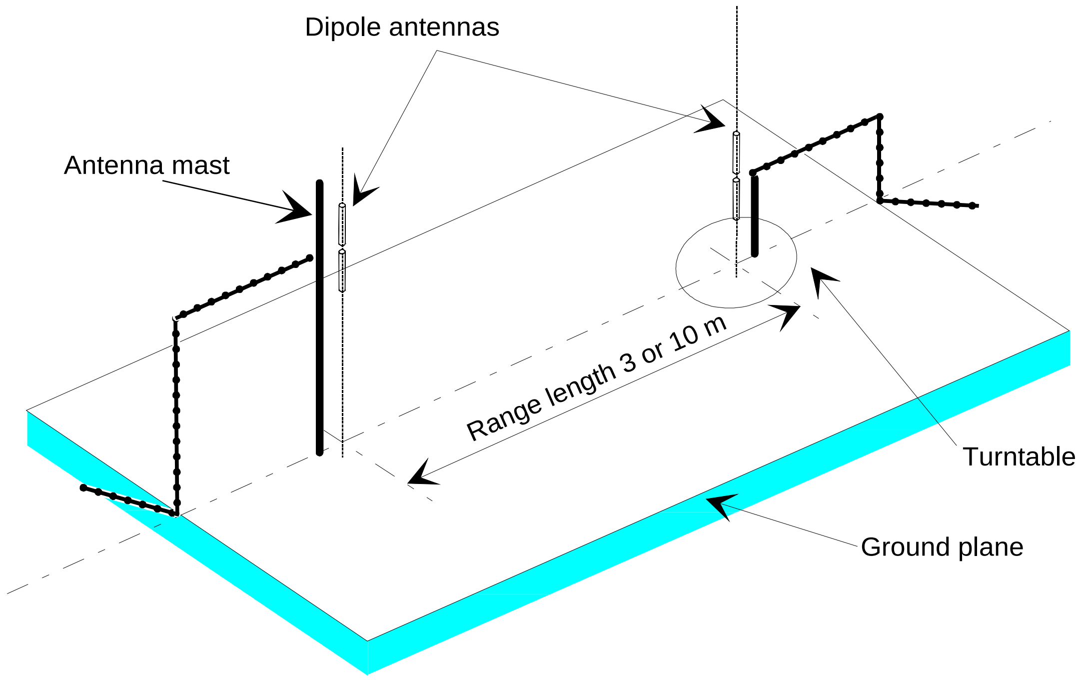


Figure 5: A typical Open Area Test Site

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

In practice, the antenna mast provides a variable height facility so that the position of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

Both absolute and relative measurements can be performed on an Open Area Test Site. Where absolute measurements are to be carried out, or where the test facility is to be used for accredited measurements, the Open Area Test Site should be verified.

The verification procedure involves the transmission of a known signal level from one calibrated antenna (usually a dipole) at a specified fixed height on the turntable and the measurement of the received signal level in a second calibrated antenna (also usually a dipole) which has been "peaked" by raising and lowering the antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals from the transmitting antenna. By comparison of the transmitted and received signal levels, an "insertion loss" can be deduced. After inclusion of any correction factors to the measurement, the figure of loss which results from the verification procedure, is known as "Site Attenuation". A comparison is then made of the measured performance to that of an ideal theoretical chamber, with acceptability being decided on the basis of the differences not exceeding some pre-determined limits.

A fully detailed procedure for verifying the performance of an Open Area Test Site is given in ETR 273 [6].

For a discussion of the practicalities of emission, sensitivity and immunity testing on an Open Area Test Site, reference should be made to subclause 4.3.2 since the considerations are the same as for an Anechoic Chamber with a ground plane.

The Open Area Test Site is, historically, the reference site upon which the majority, if not all, of the specification limits have been set. The ground plane was introduced for uniformity of ground conditions, between test sites, during testing.

4.3.4 Description of Striplines

A Stripline is essentially a transmission line in the same sense as a coaxial cable. It sets up an electromagnetic field between the plates in a similar way that a coaxial cable sets up fields between inner and outer conductors. In both cases, the basic mode of propagation is in the form of a transverse electromagnetic wave (TEM) i.e. a wave which possesses single electric and magnetic field components, transverse to the direction of propagation, as in the case of propagation in free-space. Stripline test facilities, therefore, are transmission lines constructed with their plates separated sufficiently for an EUT to be inserted between them.

There are various types of Stripline test facilities, mainly comprising either 2 or 3 plates. The 3 plate designs are available as either open or closed i.e. the fields can either extend into the region surrounding the line or they can be totally enclosed by metal side plates.

Typical 2 and 3-plate open Striplines are shown in figure 6. For the 3-plate open cell, the middle plate can be either symmetrically spaced between the outer two (as shown in figure 6), or offset more towards the bottom or top plate.

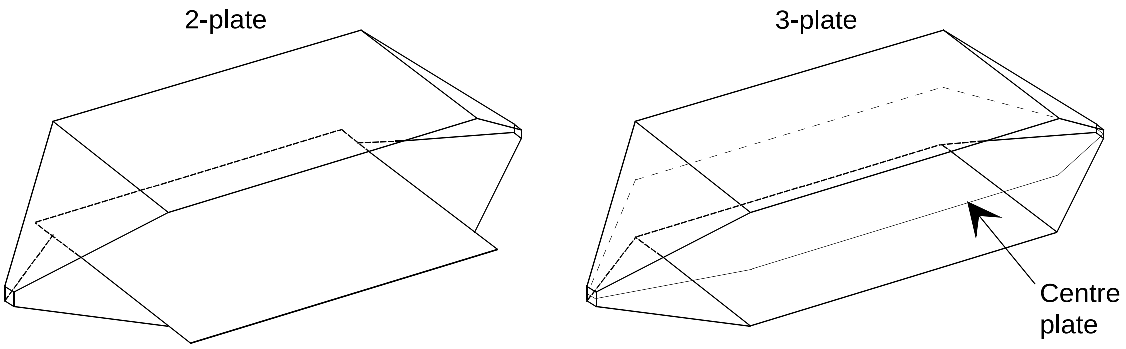


Figure 6: Typical open 2-plate and 3-plate Stripline test facilities

For all versions of the open Stripline, some portion of the electromagnetic field extends beyond the physical extent of the line since the sides are not enclosed by metal. As a direct consequence, the performance of an open cell is dependent not only on its construction but also on its immediate environment - the cell interacting with physical objects which may be present e.g. test equipment, people, etc., as well as suffering from the influences of external electrical effects such as local ambient signals and resonances of the room in which the cell is located. Shielding the room has the benefit of eliminating ambient signals but can seriously increase the magnitude of the room resonance effects (the room acting like a large resonant waveguide cavity). Where a shielded room is used to locate the open Stripline, strategic use of absorbing panels (for damping resonance effects and generally reducing other interactions) is regarded as essential. Use of an open Stripline in a non-shielded room may cause interference to others.

A typical closed Stripline (alternatively termed TEM cell) is shown in figure 7. The TEM cell is constructed using 5 plates, i.e. a central conductor in addition to four sides. Benefits, resulting from the enclosure on all four sides, include the elimination of effects due to external reflections, local ambient signals and room resonances suffered by the open Stripline. Drawbacks include internally generated resonances and a dramatic cost increase relative to the equivalent open version.

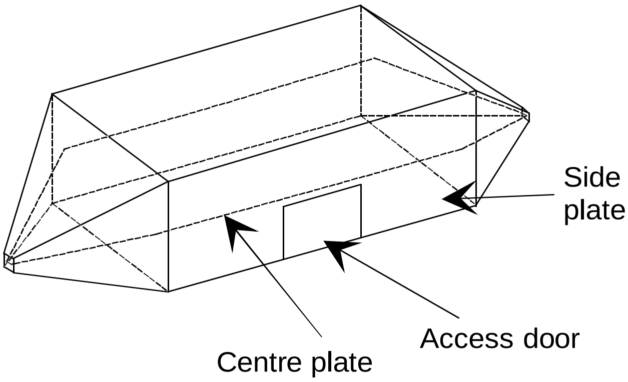


Figure 7: A typical closed Stripline test facility

A Stripline test facility needs a room much larger than itself in which to be installed. Room resonances can be encountered in rooms of rectangular cross-section at all frequencies satisfying the following formula:

$$f = 150\sqrt{\left(\frac{x}{l}\right)^2 + \left(\frac{y}{b}\right)^2 + \left(\frac{z}{h}\right)^2} \ MHz$$

Here *l*, *b* and *h* are the length, breadth and height of the room in metres and *x*, *y* and *z* are mode numbers. The only condition limiting the use of this formula is that only one of *x*, *y* or *z* can be zero at any one time.

For a room measuring 8 m × 8 m × 4 m, there are 25 resonant frequencies within the band 26,5 MHz to 120,1 MHz. This shows that, in principle, room resonances can pose major problems. Their effects are worse for rooms which are metal lined for shielding from ambient signals. In this condition, the room acts like a waveguide and will possess high Q-factors for some or all resonant frequencies. Their effects are to put sharp spikes into the field strength variation with frequency within the cells. In general, these can only be damped by the use of absorbing material placed around the cell.

Other factors which can contribute to disturbance of the field within the Stripline include cabling (in terms of reflections and its possible parasitic effect) and local ambient effects. In general, to keep cabling problems to a minimum, these should be as short as possible within the Stripline, gain access to the test area via small holes in the bottom plate and be heavily loaded with ferrite beads. To completely nullify ambient signals, a shielded room is required but the above discussion of resonances should be borne in mind.

4.3.5 Discussion of a Test Fixture

A Test Fixture is, in most cases, individually constructed for testing a specific equipment type. It consists of a 50 Ω RF connector and a device for electromagnetically coupling to the EUT. It should also incorporate a means for repeatable positioning of the EUT. Figure 8 illustrates a typical Test Fixture.

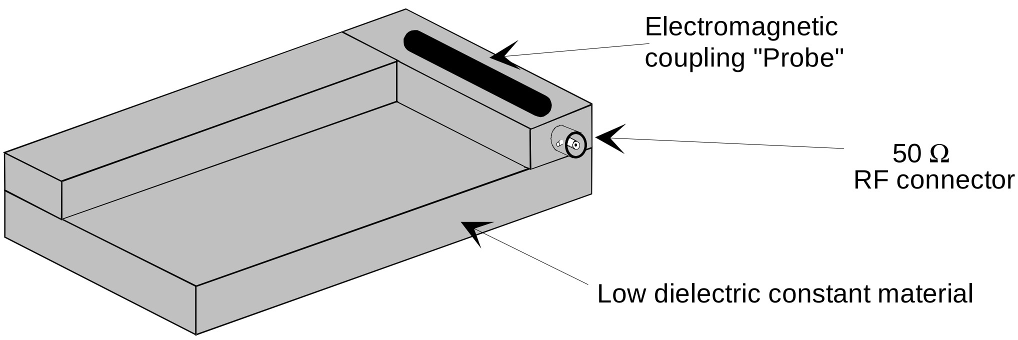


Figure 8: Basic, typical Test Fixture

The coupling device usually comprises a small antenna that is placed, physically and electrically, close to the EUT. This antenna/coupling device is used for sampling or generating the test fields when the EUT is undergoing testing at extreme conditions of temperature and/or voltage.

Test fixtures should be constructed in such a way that measurements are repeatable. This requires some specific mounting arrangements to be incorporated within the Test Fixture to secure the EUT in a fixed position. Such mounting arrangements would additionally help to maintain the relative polarization between the EUT and the coupling device. A typical scheme is shown in figure 9.

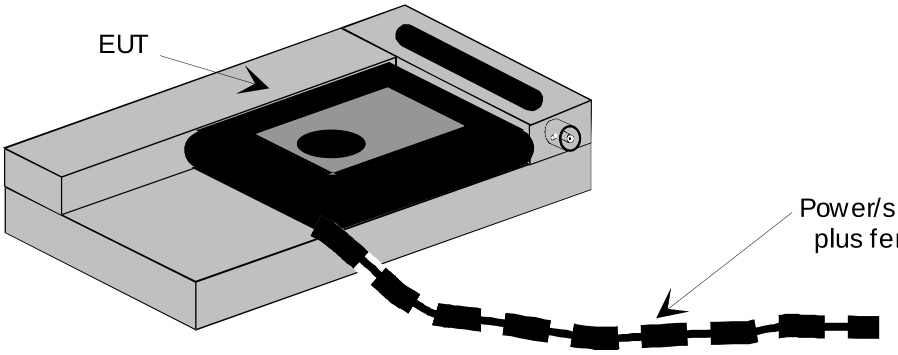


Figure 9: EUT mounted in a typical Test Fixture

A Test Fixture should enable adequate access to the EUT for interfacing with the test equipment. In particular, it should provide, where relevant, access to:

- the "press to talk" button for a transmitter;
- the modulator input for a transmitter;
- the audio output for a receiver;
- the power terminals for connection to an external power supply.

The entire assembly of Test Fixture plus EUT is generally extremely compact and it can be regarded as a miniature test site. Its compactness enables the whole assembly to be accommodated within a test chamber (usually a climatic facility) that completely encloses the extreme condition.

The circuitry associated with the RF coupling device should contain no active or non-linear components and should present a VSWR of better than 1,5:1 to a 50 Ω line.

4.3.5.1 Performance limitations

The coupling mechanism between the EUT and the Test Fixture is extremely complex since the two are placed physically and electrically very close together. This complexity makes any attempt at theoretically modelling a Test Fixture's performance not only very difficult but also time consuming and costly. In practise, therefore, modelling is seldom attempted. The direct consequence of this is that absolute measurements cannot be made in a Test Fixture and any measurement results have to be related, in some way, to baseline results taken on a Free-Field Test Site.

The usual way to relate the results is by a process, sometimes referred to as field equalization, in which the relevant parameter (effective radiated power, receiver sensitivity, etc.) is initially measured on a Free-Field Test Site under normal conditions and then subsequently re-measured using only the Test Fixture (with the EUT installed) also under normal conditions. The difference (in dB) of the two results (received signal level for an effective radiated power test, output power from a signal generator for a sensitivity test) is termed the coupling factor of the Test Fixture and provides the link between all the results of EUT tests carried out in the Test Fixture and its performance on a verified Free-Field Test Site. As a general rule, the coupling factor should not be greater than 20 dB.

To reiterate, this key limitation for a Test Fixture can be stated in two ways:

- only relative measurements can be made;
- absolute measurements cannot be made.

A further limitation to the use of a Test Fixture results from the unknown variation of the coupling factor with frequency. This variation cannot be relied upon to be linear over large bandwidths and this puts a limit on those tests which can be accurately carried out. As a result, emission tests are generally limited to the nominal frequencies (for which the performance of the Test Fixture has been verified) of low power devices for effective radiated power and frequency error tests. Occasionally, however, adjacent channel power is tested.

Similarly, receiver tests are normally limited to receiver sensitivity although, occasionally, co-channel rejection, adjacent channel selectivity, inter-modulation immunity and blocking are tested.

Ideally, all Test Fixtures should be verified and where EUT testing will be required over a frequency band, the verification procedure should be extended to include the frequencies at the band edges. In any case, routine verification, perhaps every 6 months, should be carried out as a means of detecting any deterioration/change in performance.

A fully detailed procedure for verifying the performance of a Test Fixture is given in ETR 273 [6].

Local ambient signals can potentially be problematic to measurements carried out in a Test Fixture, although very little uncertainty is introduced into transmitter tests, since EUT power levels will dominate. However, for receiver tests (i.e. sensitivity and various types of immunity testing) shielding may be required. Adequate shielding can be achieved by either using the Test Fixture within a metalized test chamber (e.g. climatic facility) or by enclosing it within a shielded room. In either case, one shall however be aware of the possible frequencies of resonance for these structures.

Only integral antenna devices are tested in a Test Fixture. For devices possessing either permanent or temporary external RF connectors, all testing is carried out using conducted methods.

4.4 Salty columns/artificial human beings

There are several forms of artificial human beings currently used in radiated testing. The three most commonly used types are the Saltwater column, the Salty man and Salty-lite. The Saltwater column has historically been used not only for testing body-worn devices e.g. paging receivers, but also for tests on maritime and other mobile equipment. It was the first in existence and is mainly used in measurements on body-worn equipment operating below 50 MHz. At higher frequencies, many tests are currently performed using two types of Salty man which are basically saltwater filled plastic cylinders of the height of an average adult.

4.4.1 Saltwater column

A Saltwater column comprises a plastic cylinder of side wall thickness 0,005 m, overall height 1,5 m and of inside diameter typically 0,01 m filled with a saline solution whose concentration of salt (NaCl) is 9,0 g per litre of distilled water (see figure 10). The Saltwater column has been used with the EUT either fixed to the side of the column (to simulate belt-worn or breast pocket-worn devices) or mounted on a hinged metal mounting bracket on the top metal mounting plate which enables an EUT to be oriented at various angles during measurements.

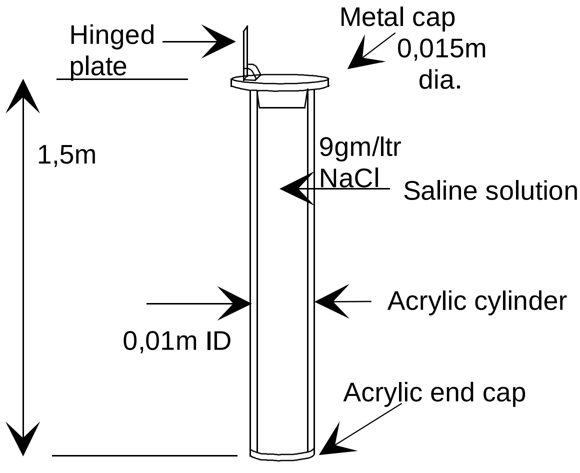


Figure 10: Typical saltwater column

No theoretical or experimental data concerning the Saltwater column has been found and due to its obvious dissimilarity with the human body, and the lack of data supporting its usage, it is recommended that the Saltwater column should not be used for body-worn equipment tests. The following discussions are therefore limited to the merits of Salty man and Salty-lite and the recommended frequency limitations of their use on Free-Field Test Sites.

4.4.2 Salty man

A "Salty man", illustrated in figure 11a), comprises a cast acrylic cylinder of 0,305 m outside diameter with acrylic caps at both ends. It is 1,7 m in length with side wall thickness of 4,8 mm and the whole is filled with a saline solution whose concentration is 1,49 g of salt per litre of distilled water. Figure 11a illustrates the original design of a Salty man as detailed in IEC 489-6, Appendix H [1].

4.4.3 Salty-lite

"Salty-lite" is shown in figure 11b) and is a much lighter version of the Salty man (approximately 61,5 kg against 125 kg) which therefore makes it easier to handle and transport.

Salty-lite comprises two concentric cast acrylic cylinders, the outer one having an outside diameter of 0,305 m whilst the inner cylinder has an outside diameter of 0,225 m. The outer cylinder is 1,32 m in length whilst the inner one measures 1,52 m. The difference in length is used to form an air-filled head. Only the space between the two cylinders is filled with saline solution which, in early versions, had a similar concentration of salt as the Salty man (1,49 g of salt per litre of distilled water). However, [2] revealed several resonances are evident at this concentration, and experimental and theoretical work [1] showed that these resonances could be damped out by using a concentration of 4g of salt per litre of distilled water. This is the currently recommended concentration and all discussion of Salty-lite's electrical performance given in clauses 4 and 5 assume this more concentrated salt solution.

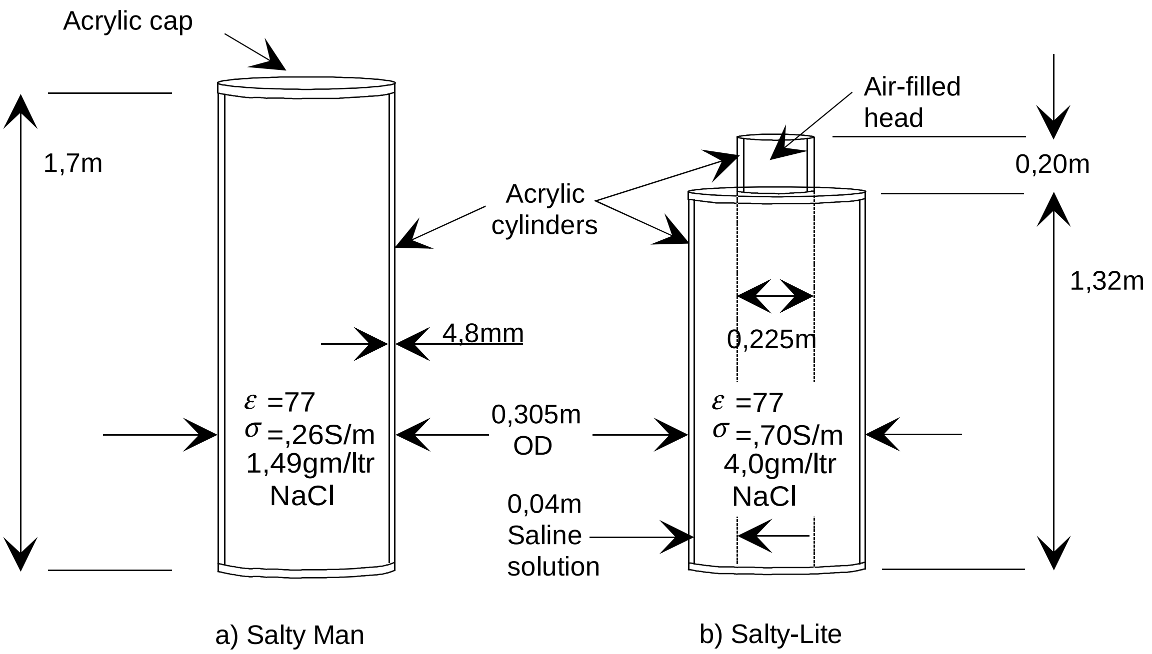


Figure 11: The two types of Salty man

4.4.4 Test conditions

The provision of realistic test conditions for Salty man/Salty-lite is extremely difficult. In everyday use of a body-worn equipment, a human being will operate the equipment over a variety of ground types, none of which influences performance in the same way as those provided during testing in either an Anechoic Chamber or on a perfectly reflecting ground plane site. Specifically, the distribution of the illuminating fields over the length of the Salty man/Salty-lite (when used in receiver tests) varies fundamentally with ground type. Whereas the ideal Anechoic Chamber provides a slowly varying amplitude distribution (consistent with the vertical plane radiation pattern of the transmitting antenna) and a phase distribution entirely dependent on the path length geometry (see figure 12), an Open Area Test Site/Anechoic Chamber with a ground plane can, in contrast, provide a wildly varying field distribution. By virtue of the phase of the reflected signal on this ground plane type of site, horizontally and vertically polarized signals are affected differently. Figure 13 shows the distribution of amplitude and phase for a vertically polarized electric field over the length of Salty man/Salty-lite for a typical testing range length of 3 metres over a ground plane. The height of the test antenna has been optimized for a chest worn equipment, assumed to be mounted 1,5 m above the base of the Salty man.

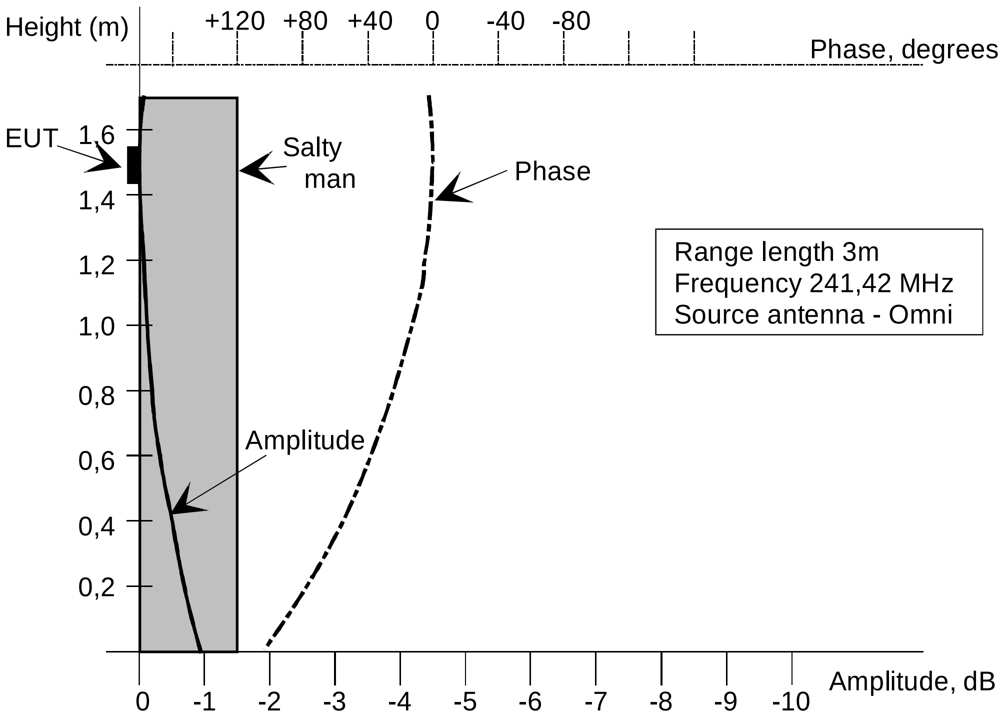


Figure 12: Amplitude and phase distribution along the Salty man over an absorptive ground

The figure shows that a deep null in the amplitude of the illuminating electric field occurs at a height of approximately 0,7 m above the base of the Salty man. Additionally, the phase of the illuminating field over the length of the Salty man is far from uniform. One has to question how representative of the real-life performance are the results from tests carried out on this type of facility. On the plus side, it can be seen from figure 5 that in the near vicinity of the EUT the amplitude and phase of the electric field can be seen to be reasonably constant but this may not be sufficient for test purposes.

The parameters for determining figure 13 have been selected as a typical example; a test antenna height of 1,5 m giving a field maximum at chest height (also 1,5 m) at a range length of 3 m. For the example frequency of 241,42 MHz, there is no other test antenna height (assuming 1 m to 4 m available height variation) which will produce a peak at chest height. Therefore only one null appears on the Salty man/Salty-lite. However, as the frequency increases more nulls appear.

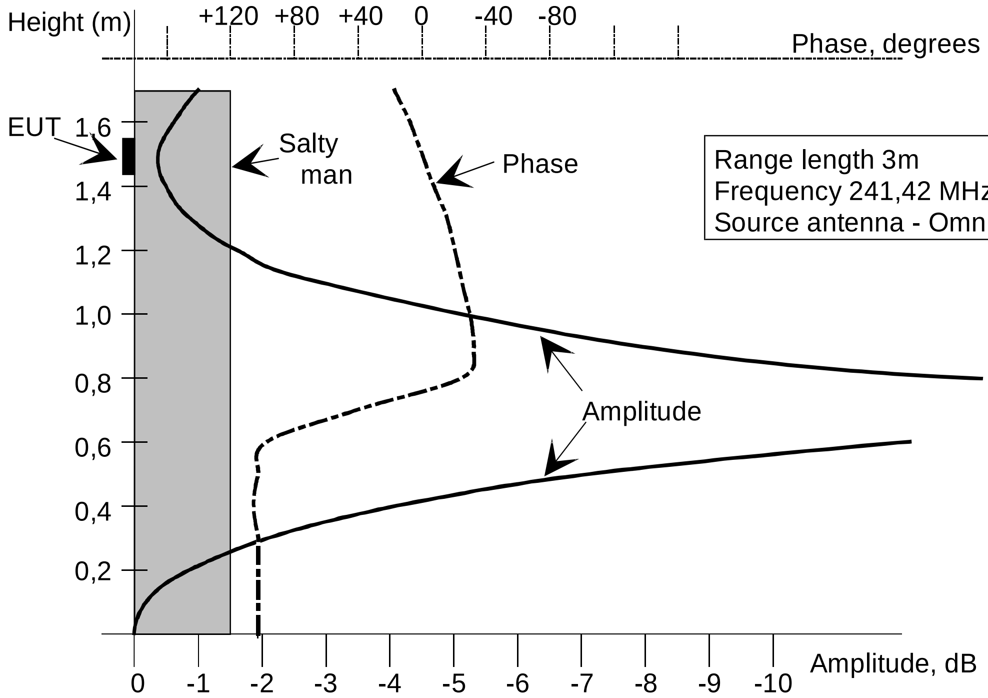


Figure 13: Amplitude and phase distribution along the Salty man over a reflective ground

For example, above 254,2 MHz there will be at least 2 peaks to choose from for the maximum signal (and hence 2 nulls in the illumination over Salty man/Salty-lite), above 381,4 MHz at least 3 peaks (and 3 nulls), etc., up to above 889,9 MHz where there will be at least 7 peaks to choose from with their 7 associated nulls. Since mutual coupling and extraneous reflections can play a significant role in determining the magnitude of these peaks it cannot be ruled out that, in the worst case, all of these theoretically possible peaks and nulls will be present during testing. The value of a test result taken in this worst case of multiple nulling over the Salty man/Salty-lite is difficult to assess.

Conversely, if one imposed the conditions that:

- no null should appear in the illumination across Salty man/Salty-lite and;
- the maximum amplitude variation should not exceed, say, 5 dB (taken for illustration only),

then a 3 m range could only be used for frequencies below about 38,5 MHz and a 10 m range length below about 74,1 MHz.

Contrast this testing environment generated on a ground-reflecting range, to that provided by an ideal Anechoic Chamber offering the same range length (shown in figure 12). Here, the illuminating electric field is reasonably constant in both amplitude and phase along the entire length of the salty column - the variations being dependent on the radiation pattern of the test antenna in the vertical plane and the overall geometry for amplitude and phase respectively.

4.5 Test antenna

A **test antenna** is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the **test antenna** is used to detect the field from the EUT in one stage of the measurement and from the **substitution antenna in the other stage**. When the **test site** is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

The **test antenna** should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. Anechoic Chambers with ground planes and Open Area Test Sites), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 m to 4 m).

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 (1988) [11]) are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

4.6 Substitution antenna

The **substitution antenna** is used to replace the EUT for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the **substitution antenna** should be a dipole antenna (constructed in accordance with ANSI C63.5 (1988) [11]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT it has replaced.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

4.7 Measuring antenna

The **measuring antenna** is used in tests on an EUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the **measuring antenna** should be a dipole antenna (constructed in accordance with ANSI C63.5 (1988) [11]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT.

4.8 Transmitting antenna

The **transmitting antenna** is only used in verification procedures on free field test sites. For measurements in the frequency band 30 MHz to 1 000 MHz, the **transmitting antenna** should be a dipole antenna (constructed in accordance with ANSI C63.5 (1988) [11]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. Optionally, a combination of bicones and log periodics could be used to cover the entire 30 MHz to 1 000 MHz band. For verification in the frequency band 1 GHz to 12,75 GHz, log periodics are recommended.

4.9 Receiving antenna

The **receiving antenna** is only used in verification procedures on free field test sites. For measurements in the frequency band 30 MHz to 1 000 MHz, the **receiving antenna** should be a dipole antenna (constructed in accordance with ANSI C63.5 (1988) [11]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. Optionally, a combination of bicones and log periodics could be used to cover the entire 30 MHz to 1 000 MHz band. For verification in the frequency band 1 GHz to 12,75 GHz, log periodics are recommended.

4.10 Acoustic coupler

4.10.1 General

When radiated measurements are performed on a receiving EUT, the audio output voltage should be transmitted from the receiver to the measuring equipment, with minimal perturbation to the field near the receiver.

For EUTs fitted with an "audio out" socket, this perturbation can be minimized by using wires with high associated resistivity and a high input impedance modulation detector.

When this situation cannot be achieved, an **acoustic coupler** should be used.

NOTE: When using this acoustic coupler care should be exercised that possible ambient noise does not influence the test result.

4.10.2 Description

The **acoustic coupler** comprises a plastic funnel, an acoustic pipe and a microphone with a suitable amplifier. The materials used to fabricate the funnel and pipe should be of low conductivity and of low relative dielectric constant (i.e. less than 1,5).

- The acoustic pipe should be long enough to reach from the EUT to the microphone which should be located in a position that will not disturb the RF field. The acoustic pipe should have an inner diameter of about 6 mm and a wall thickness of about 1,5 mm and should be sufficiently flexible so as not to hinder the rotation of the turntable.
- The plastic funnel should have a diameter appropriate to the size of the loudspeaker in the EUT, with soft foam rubber glued to its edge, it should be fitted to one end of the acoustic pipe and the microphone should be fitted to the other end. It is very important to fix the centre of the funnel in a reproducible position relative to the EUT, since the position of the centre has a strong influence on the frequency response that will be measured. This can be achieved by placing the EUT in a close fitting acoustic mounting jig, supplied by the manufacturer, of which the funnel is an integral part.
- The microphone should have a response characteristic flat within 1 dB over a frequency range of 50 Hz to 20 kHz, a linear dynamic range of at least 50 dB. The sensitivity of the microphone and the receiver audio output level should be suitable to measure a signal to noise ratio of at least 40 dB at the nominal audio output level of the EUT. Its size should be sufficiently small to couple to the acoustic pipe.
- The frequency correcting network should correct the frequency response of the acoustic coupler so that the acoustic SINAD measurement is valid (see IEC 489-3, Appendix F [1]).

4.10.3 Calibration

The aim of the calibration of the acoustic coupler is to determine the acoustic SINAD ratio which is equivalent to the SINAD ratio at the receiver output.

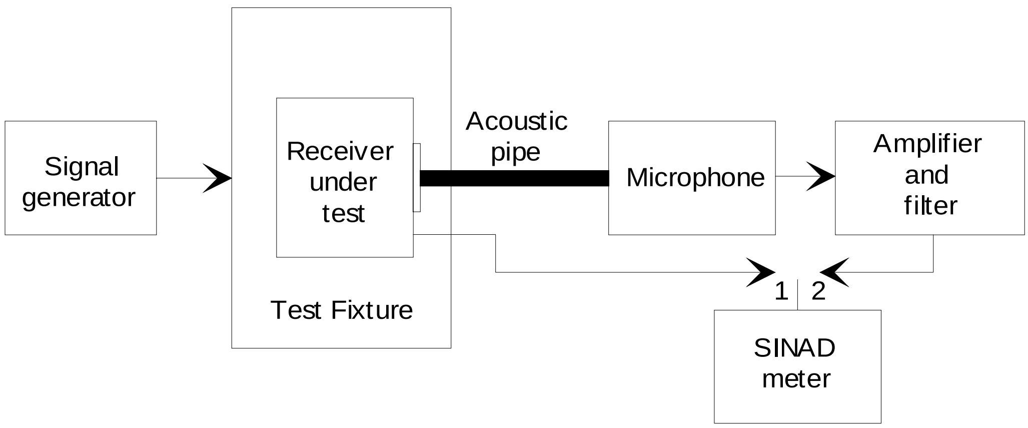


Figure 14: Measuring arrangement for calibration

4.10.3.1 Calibration of the acoustic coupler

a) The acoustic coupler should be mounted close to the EUT which, if necessary, should be mounted in a Test Fixture. A direct electrical connection to the terminals of the output transducer should be made. A signal generator should be connected to the receiver input (or to the Test Fixture input). The signal generator should be at the nominal frequency of the receiver and should be modulated by the *test modulation A-M1*.

b) Where possible, the receiver volume control should be adjusted to give at least 50 % of the *rated audio output power* and, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the *rated audio output power*.

c) The test signal input level should be reduced until an electrical SINAD ratio of 20 dB is obtained, the connection being in position 1 as shown in figure 14. The signal input level should be recorded.

d) With the same signal input level, the acoustic equivalent SINAD ratio should be measured and recorded, the connection being in position 2 as shown in figure 14.

e) Steps c) and d) above should be repeated for an electrical SINAD ratio of 14 dB, and the acoustic equivalent SINAD ratio measured and recorded.

5 Setting up for conducted measurements

This clause is relevant to conducted measurements only, i.e. those tests which can be made using a direct 50 Ω connection to the EUT.

Bit stream measurements should be performed on the "raw" bit stream thus by-passing error correcting coders or decoders unless it is impossible to disassociate one from the other. Message measurements should include error correcting encoders and decoders, if fitted.

For EUTs not fitted with an antenna socket, some measurements can be made using a temporary 50 Ω connector. Details and implications of such a procedure should be stated in the corresponding ETS or EN.

When performing transmitter tests on EUT designed for intermittent operation, the specified maximum transmit time should not be exceeded.

6 Setting up for Radiated tests

This clause details procedures, test equipment arrangements and recommendations that should be carried out BEFORE any of the radiated test methods given in subclauses 7.2 (for transmitting EUTs) and 8.2 (for receiving EUTs) are performed. Some of these schemes are common to all types of test site, others are relevant to individual sites only.

6.1 For all types of test site

The test methods given in subclauses 7.2 and 8.2 apply to integral antenna devices only i.e. EUTs not fitted with either a permanent or a temporary external antenna connector. The Spurious emissions test also applies to EUTs with a detachable antenna.

6.1.1 Verification of the test site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for all the different types of test site considered in clauses 7 and 8 (i.e. Anechoic Chamber, Anechoic Chamber with a ground plane, Open Area Test Site, Stripline and Test Fixture) are given in ETR 273 [6] along with a similar procedure for verifying the serviceability of the two artificial human bodies, namely Salty man and Salty-lite.

6.1.2 Preparation of the EUT

The manufacturer should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of EUT should include, where relevant, carrier power, channel spacing, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 minute on, 4 minutes off).

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsawood, etc.

6.1.3 Power supplies to the EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. In all cases, power leads should be connected to the EUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the EUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the EUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Additionally, where possible, these leads should be twisted together and loaded with ferrite beads at 0,15 m spacing.

6.1.4 Volume control setting for analogue speech tests

Unless otherwise stated, in all receiver measurements for analogue speech the receiver volume control where possible, should be adjusted to give at least 50 % of the *rated audio output power.* In the case of stepped volume controls, to volume control should be set to the first step that provides an output power of at least 50 % of the *rated audio output power*. This control should not be readjusted between *normal and extreme test conditions* in tests involving the Test Fixture.

6.2 For Anechoic Chambers, Anechoic Chambers with ground planes and Open Area Test Sites only

6.2.1 Range length

The range length for these types of test facility should be adequate to allow for testing in the far-field of the EUT i.e. it should be equal to or exceed:

$$\frac{2\left(d_1 + d_2\right)^2}{\lambda}$$

where:

d_1 is the largest dimension of the EUT/dipole after substitution (m);

d_2 is the largest dimension of the test antenna (m);

λ is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1: **For the fully Anechoic Chamber**, no part of the volume of the EUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2: The "quiet zone" is a volume within the Anechoic Chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3: **For the Anechoic Chamber with a ground plane**, a full height scanning capability, i.e. 1 m to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of Anechoic Chamber, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4: **For both the Anechoic Chamber with a ground plane and the Open Area Test Site**, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

6.2.2 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of Anechoic Chamber, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. These cables should be dressed with ferrite beads, spaced 0,15 m apart for their entire lengths above the ground plane/screen. The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (i.e. Anechoic Chambers with ground planes and Open Area Test Sites) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- cable loss: ±0,5 dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

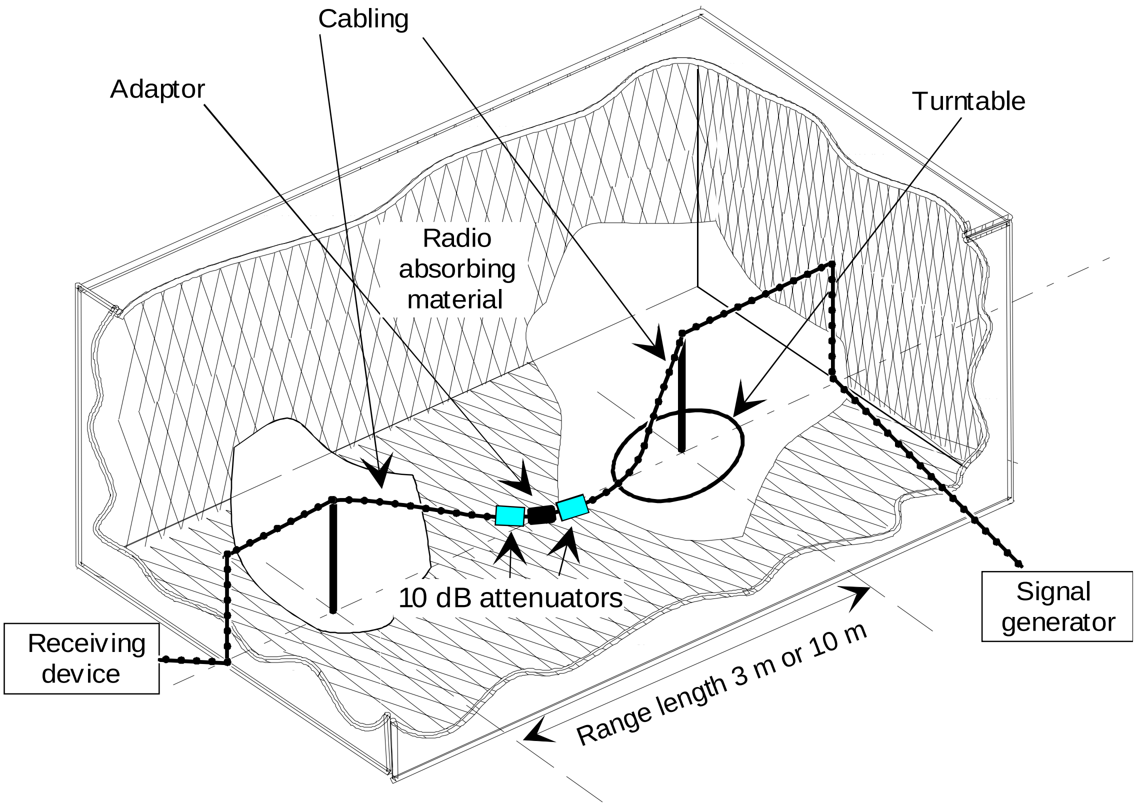


Figure 15: Anechoic Chamber set-up for daily system checking

At the start of each day, system checks should be made on the items of test equipment used on the test site. The following checking procedures, as a minimum requirement, should be carried out.

1 All items of test equipment requiring electrical supplies should be connected to their power sources, switched on and allowed adequate time to stabilize, as recommended by the manufacturers. Where a stabilization period is not given by the manufacturer, 30 minutes should be allowed. After this time period, those items of test equipment which possess the facility should have their self test/self calibration procedures performed.

2 A signal generator should be connected to the existing cabling at the turntable end. The other end of this cable should be connected via a calibrated coaxial cable/10 dB attenuator/adapter/10 dB attenuator/calibrated coaxial cable combination to existing cabling at the other end of the test site. This existing cable should be connected to a receiving device, as illustrated in figure 15 for the case of an Anechoic Chamber. Where the use of a cable is impractical due to the arrangements at the test site, bicones or other suitable antennas could be connected at both ends as appropriate. The signal generator should be scanned across the appropriate frequency range and the response of the receiving device noted. It should be compared with previous tests carried out under similar conditions. Any anomalies should be investigated.

6.2.3 Standard antennas

In the frequency band 30 MHz to 1 000 MHz, except where stipulated, both test and substitution/measuring antennas should be tuned half-wavelength dipoles (constructed as detailed in ANSI C63.5 (1988) [11]) aligned for the same polarization.

NOTE: Due to size constraints a shortened dipole is used over part of this frequency band. For uniformity of procedures across Open Area Test Sites and both types of Anechoic Chamber, a shortened dipole is used from 30 MHz up to 80 MHz. At all these frequencies the 80 MHz arm length (0,889 m) is used attached to the 20 MHz - 65 MHz balun for all test frequencies from 30 MHz to 65 MHz inclusive or to the 65 MHz - 180 MHz balun for 65 MHz to 80 MHz. Tuned half wavelength dipoles, attached to their matching baluns are used for all frequencies in the band 80 MHz - 1 000 MHz inclusive. Table 2B details dipole arm lengths (as measured from the centre of the balun block) and balun type against frequency. Where the test frequency does not correspond to a set frequency in the table the arm length to be used should be determined by linear interpolation between the closest set values.

Table 2B: Dipole arm length and balun type against frequency

Frequency (MHz)	Dipole arm length (m)	Balun type
30	0,889	20 MHz to 65 MHz
35	0,889	
40	0,889	
45	0,889	
50	0,889	
60	0,889	
70	0,889	65 MHz to 180 MHz
80	0,889	
90	0,791	
100	0,714	
120	0,593	
140	0,508	

Frequency (MHz)	Dipole arm length (m)	Balun type
160	0,440	65 MHz to 180 MHz
180	0,391	
200	0,352	180 MHz to 400 MHz
250	0,283	
300	0,235	
400	0,175	
500	0,143	400 MHz to 1 000 MHz
600	0,117	
700	0,102	
800	0,089	
900	0,079	
1 000	0,076	

6.2.4 Mutual coupling and mismatch loss correction factors

Correction factors are included where relevant, to allow for mutual coupling and mismatch loss for the 30 MHz to 180 MHz band, based on using the recommended ANSI C63.5 (1988) [11] dipoles. These have been calculated by computer modelling of their baluns, sectional arms and the testing arrangements (i.e. range length, height above ground plane, etc.) using MiniNec. The factors are only valid for this particular type of dipole. However, if this type is unavailable, an alternative could be used. This alternative should be a tuned half wavelength dipole at the particular test frequency. Since correction factors have not been calculated for any type other than the ANSI C63.5 (1988) [11] dipoles this will result in a greater expanded uncertainty for the measurement unless the test house/manufacturer has performed equivalent modelling on the dipoles used.

6.3 For Stripline test facilities only

The Stripline to be used is that detailed in CENELEC European Standard EN 55020 [12].

The size of a Stripline limits the usable frequency range. To avoid the possibility of generating unwanted field modes (which can disturb the required electric field distribution in the line), the spacing between the plates should not exceed $\lambda/2$ (where λ is the wavelength). The 2-plate Stripline detailed in EN 55020 [12] has a plate spacing of 0,8 m and, consequently, an upper frequency of 150 MHz.

Given the further recommendation that, for best accuracy (i.e. closest approximation to a plane wave within the Stripline), an EUT should not measure more than a third of the plate separation, the overall maximum size of EUT which can be accurately tested is dictated as 0,27 m.

This size restriction only applies to the vertical dimension within the Stripline, but it is a significant limitation since this is also the direction in which the electric vector points. No other dimension of the EUT should exceed $\lambda/2$. These size limitations therefore severely restrict the use of a Stripline. Where larger size EUTs are tested (up to a maximum size in the E-plane of 0,7 m), correction factors need to be applied to the results and significantly greater measurement uncertainty is involved.

6.3.1 Site preparation

The Stripline should be placed on non conducting supports at least 0,8 m above the floor and not closer than 0,8 m to the ceiling. When used inside a room (whether screened or not), continuous lines of vertical panels (at least 1 m high) covered in absorbing material should be placed between the open sides of the Stripline and the walls. The absorbing material should provide an adequate level of absorption (typically 15 dB minimum reflectivity at the frequency of test).

At the start of each day, system checks should be made on the Stripline. The following two procedures, as a minimum requirement, should be carried out.

1 All items of test equipment requiring electrical supplies should be connected to their power sources, switched on and allowed adequate time to stabilize, as recommended by the manufacturers. Where a stabilization period is not given by the manufacturer, 30 minutes should be allowed. After this time period, those items of test equipment which possess the facility should have their self test/self calibration procedures performed.

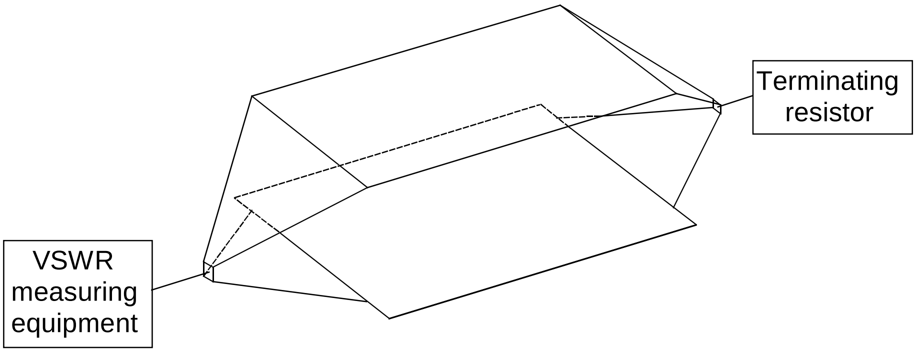


Figure 16: Stripline test facility set-up for daily checking

2 A VSWR measurement (using for example, a network analyser) should be made on the input to the Stripline, using any necessary coaxial cables and adapters, with the far end of the Stripline terminated in a load (a 150 Ω resistor soldered between the output terminals), as shown in figure 16. No attenuators should be connected between the measuring equipment and the Stripline input. The measurement should cover the full band (30 MHz to 150 MHz). The VSWR measurement should be compared with previous tests and any anomalies investigated.

6.3.2 Preparation of the EUT

A block of non-conducting, low dielectric constant (less than 1,5) material should be available, on which the EUT and its bracket can be mounted within the Stripline, so that its volume centre is midway between the plates.

The routing of the cables supplying power to the EUT when inside the Stripline should be straight down towards the bottom plate and out of the facility through a small hole in this plate. The cables should be twisted together and loaded with ferrite beads at 0,15 m intervals for their entire lengths within the Stripline.

All RF cables used during the test should be dressed with ferrite beads, spaced at 0,15 m intervals, for their entire lengths. They should be routed directly away from the Stripline - the feed cable from the signal generator should be along the line of the Stripline's axis, whilst, during the field measurement part of the test (if carried out), the cable from the Monopole to the receiving device should be at right angles to this axis.

6.4 For Test Fixtures only

The Test Fixture should be supplied by the manufacturer of the EUT and should enable testing to be performed under extreme test conditions of temperature and/or voltage, as defined in the relevant standard. It should provide RF connection(s) and allow connection(s) to external power supply(s) and control equipment if necessary.

Tests such as adjacent channel power and certain receiver parameters are, for integral antenna devices, usually only performed in a Test Fixture. In these cases the measurement result under normal conditions is directly related to either the effective carrier power (for the case of adjacent channel power testing) or to maximum usable receiver sensitivity (for a receiver parameter) measured on an accredited Free-Field Test Site (i.e. Anechoic Chamber, Anechoic Chamber with a ground plane and Open Area Test Site).

6.4.1 Site preparation

For the particular type of EUT, the corresponding results of the verification of the Test Fixture (taken at an accredited Free-Field Test Site) should be available. These results should have been taken under normal conditions in full accordance with the procedures described in the relevant part of ETR 273 [6] and should include the associated measurement uncertainty values.

Test fixtures are always used in conjunction with climatic facilities, within which the RF cabling should be kept as short as possible. The RF cables should be routed by the shortest possible means down to, and out from, the climatic facility. Their entire lengths should also be loaded with ferrite beads spaced 0,15 m apart. The power supply cable(s) should also be as short as possible, twisted together and loaded with ferrite beads spaced 0,15 m apart.

At the start of each day, system checks should be made on the test equipment used in the following test methods. The following checking procedures, as a minimum requirement, should be carried out.

1) All items of test equipment requiring electrical supplies should be connected to their power sources, switched on and allowed adequate time to stabilize, as recommended by the manufacturers. Where a stabilization period is not given by the manufacturer, 30 minutes should be allowed. After this time period, those items of test equipment which possess the facility should have their self test/self calibration procedures performed.

2) A network analyser should be connected to the 50 Ω connector of the Test Fixture and a measurement made of its input VSWR. The measurement should be taken across a frequency band which extends 10 MHz both sides of the nominal frequency of the EUT for which the Test Fixture has been supplied. The results of the test should be compared to previous results. Any anomalies should be investigated.

6.5 For Salty man/salty-lite testing only

6.5.1 Range length

Whichever type of free-field test is used for the tests involving the salty device i.e. Anechoic Chamber, Anechoic Chamber with a ground plane or Open Area Test Site, the range length should be adequate to satisfy the far-field requirements given in subclause 6.2.1.

6.5.2 Site preparation

Whichever type of free-field test is used for the tests involving the salty device i.e. Anechoic Chamber, Anechoic Chamber with a ground plane or Open Area Test Site, the site preparation should be carried out in the manner relevant to that Free-Field Test Site (see subclause 6.2.2).

7 Transmitter measurements

7.1 Conducted tests

7.1.1 Frequency error

7.1.1.1 Definition

The frequency error of the transmitter is the difference between the unmodulated carrier frequency and the nominal frequency selected for the test.

7.1.1.2 Method of measurement

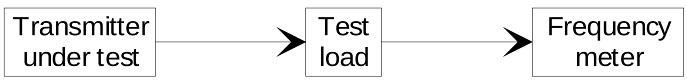


Figure 17: Measurement arrangement

a) The transmitter should be connected to the *test load*. The carrier frequency should be measured in the absence of modulation.

b) The measurement should be repeated under *extreme test conditions.*

7.1.2 Carrier power

7.1.2.1 Definition

The carrier power is the average power delivered to the test load during one radio frequency cycle in the absence of modulation.

7.1.2.2 Method of measurement

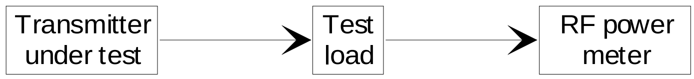


Figure 18: Measurement arrangement

a) The transmitter should be connected to the *test load* and the carrier or mean power delivered to this *test load* measured.

b) The value measured should be compared with the rated RF output power.

c) The measurement should be repeated under *extreme test conditions.*

7.1.3 Adjacent channel power

7.1.3.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

It is specified either as the ratio expressed in decibels of the carrier power to the adjacent channel power or as an absolute value.

7.1.3.2 Method of measurement

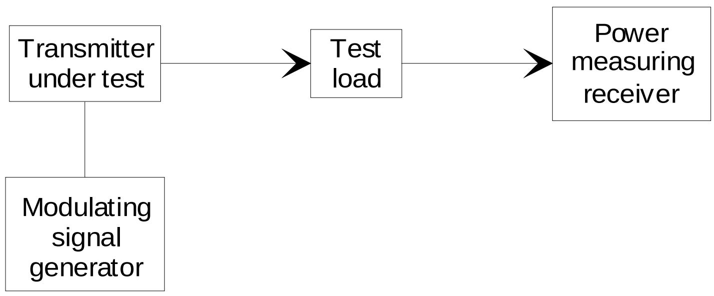


Figure 19: Measurement arrangement

a) The transmitter under test should be connected via the *test load* to a **power measuring receiver** calibrated to measure rms power level. The level at the receiver input should be within its allowed limit. The transmitter should be operated at the maximum operational carrier power level.

b) With the transmitter unmodulated, the tuning of the **power measuring receiver** should be adjusted so that a maximum response is obtained. This is the 0 dB response point. The **power measuring receiver** attenuator setting and the reading of the meter should be recorded.

c) The tuning of the **power measuring receiver** should be adjusted away from the carrier so that its -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the *nominal frequency* of the carrier as given in table 3.

Table 3: Frequency displacement

Channel separation (kHz)	Displacement (kHz)
12,5	8,25
20	13
25	17

The same result may be obtained by tuning the **power measuring receiver** (point D0 in the drawing of the power measuring filter shape) to the *nominal frequency* of the adjacent channel, if it has been suitably calibrated.

d) The transmitter should be modulated as follows:

1) Equipment for analogue speech should be modulated with a 1 250 Hz tone at a level which is 20 dB higher than that required to produce *normal deviation*.

2) Equipment for data bits should be modulated with the *test modulation D-M2* at the agreed deviation.

3) Equipment for messages should be modulated with the *test modulation D-M3* repeated continuously at the agreed deviation.

e) The **power measuring receiver** variable attenuator should be adjusted to obtain the same meter reading as in step b) or a known relation to it. This value should be recorded.

f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in step b) and e), corrected for any differences in the reading of the meter. Alternatively the absolute value of the adjacent channel power may be calculated from the above ratio and the transmitter carrier power.

g) Steps c) to f) should be repeated with the **power measuring receiver** tuned to the other side of the carrier.

7.1.4 Conducted spurious emissions

7.1.4.1 Definition

Conducted spurious emissions are discrete signals whose power is conveyed by conduction to the test load at frequencies other than those of the carrier and sidebands resulting from the normal process of modulation.

They are specified as the power level of any discrete signal delivered into a test load.

7.1.4.2 Method of measurement

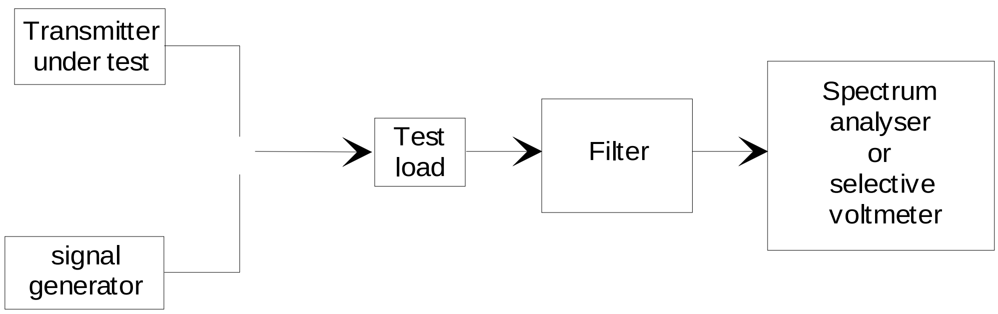


Figure 20: Measurement arrangement

a) The transmitter should be connected to a spectrum analyser or a selective voltmeter through a *test load* and an appropriate filter to avoid overloading of the spectrum analyzer or selective voltmeter. The bandwidth of the spectrum analyser or selective voltmeter should be between 10 kHz and 100 kHz. The equipment used should have sufficient dynamic range and sensitivity to achieve the required measurement accuracy at the specified limit.

For the measurement of spurious emissions below the second harmonic of the carrier frequency the filter used should be a high "Q" (notch) filter centred on the transmitter carrier frequency and attenuating this signal by at least 30 dB.

For the measurement of spurious emissions at and above the second harmonic of the carrier frequency the filter used should be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter should be approximately 1,5 times the transmitter carrier frequency.

Precautions may be required to ensure that the *test load* does not generate or that the high pass filter does not attenuate, the harmonics of the carrier.

b) The transmitter should be unmodulated and operating at the maximum limit of its specified power range.

c) The frequency of the spectrum analyser or selective voltmeter should be adjusted over the specified frequency range. The frequency and level of every spurious emission found should be noted. The emissions within the channel occupied by the transmitter carrier and its adjacent channels should not be recorded.

d) If the spectrum analyser or selective voltmeter has not been calibrated in terms of power level at the transmitter output, the level of any detected components should be determined by replacing the transmitter by the signal generator and adjusting it to reproduce the frequency and level of every spurious emission recorded in step c).

e) The absolute power level of each of the emissions noted should be measured and recorded.

f) The measurement should be repeated with the transmitter in stand-by condition if this option is available.

7.1.5 Intermodulation attenuation

7.1.5.1 Definition

For the purpose of this test the intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal entering the transmitter via its antenna.

It is specified as the ratio, in decibels, of the power level of the third order intermodulation product to the carrier power level.

7.1.5.2 Method of measurement

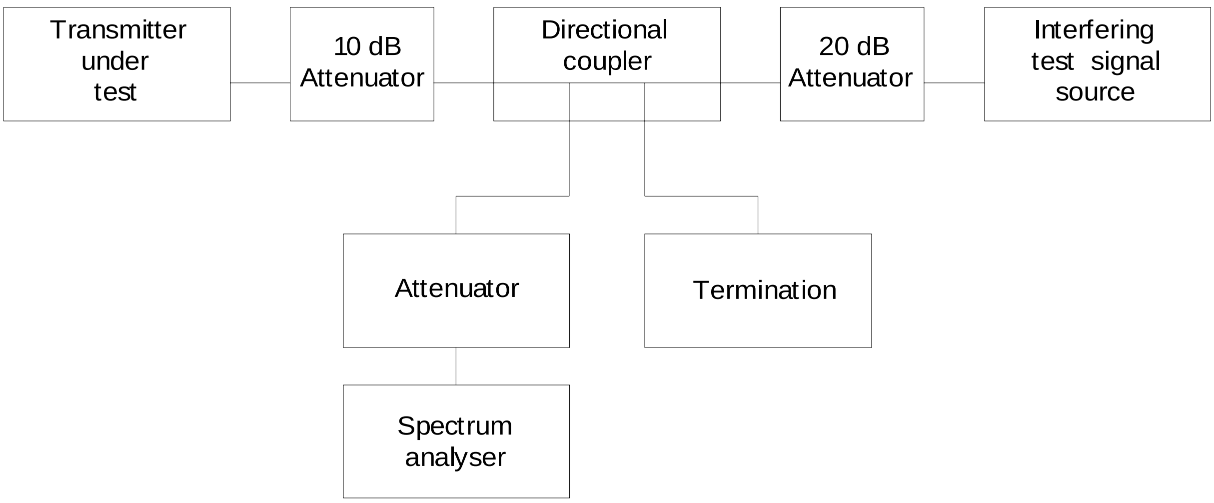


Figure 21: Measurement arrangement

a) Preliminary to the measurement the carrier power of the transmitter under test should be measured according to subclause 7.1.2, under normal conditions only, and the value recorded.

The transmitter should be connected to a 50 Ω 10 dB power attenuator load and via a directional coupler to a spectrum analyser. An attenuator may be required to avoid overloading the spectrum analyser.

The length of the cable between the transmitter under test and the 10 dB power attenuator should be kept to a minimum.

The directional coupler should have an insertion loss of less than 1 dB, a sufficient bandwidth, and a directivity of more than 20 dB.

The test signal source may be a signal generator and a power amplifier or another transmitter, the output power of which is adjustable.

The transmitter under test and the test signal source should be physically separated in such a way that the measurement is not influenced by direct radiation.

b) Replace the transmitter under test in the measurement arrangement above by a RF power meter.

c) The test signal source should be unmodulated and the frequency should be within 50 kHz to 100 kHz above the frequency of the transmitter under test.

   The frequency should be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious emissions.

d) The test signal power level should be adjusted to -30 dB, relative to the carrier power level recorded above, measured on the RF power meter.

e) The transmitter under test should be reconnected to the 10 dB power attenuator, as shown above.

f) The transmitter should be unmodulated and the spectrum analyser adjusted to give a maximum indication with a frequency scan width of 500 kHz.

g) The intermodulation components should be measured by direct observation on the spectrum analyser and the ratio of the largest third order intermodulation component to the carrier recorded which is situated at the same frequency offset (within 50 kHz to 100 kHz) selected in step c), below the transmitter frequency.

h) This measurement should be repeated with the test signal at a frequency within 50 kHz to 100 kHz below the transmitter frequency. In this case the largest third order intermodulation component to be observed in step g) is situated at the same frequency offset selected in step c), above the transmitter frequency.

7.1.6 Attack time

7.1.6.1 Definition

The transmitter attack time is the time interval between the instant at which the final irrevocable logic decision to power up the transmitter is taken and the moment after which:

a) the unmodulated transmitter power always remains within a level -1 dB and +1,5 dB of the steady state carrier power; or

b) the frequency of the carrier always remains within ±1 kHz from its steady state frequency.

NOTE: This may be used for checking the channel efficiency of systems and for defining the timings in protocols.

7.1.6.2 Method of measurement

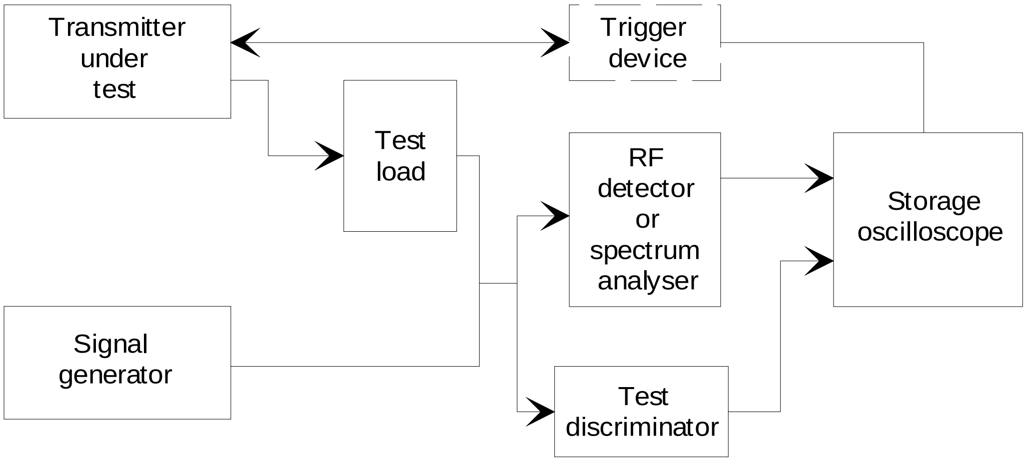


Figure 22: Measurement arrangement

a) The transmitter is connected to a RF detector and to a **test discriminator** via a matched *test load*. The attenuation of the *test load* should be chosen in such a way that the input of the **test discriminator** is protected against overload and the limiter amplifier of the **test discriminator** operates correctly in the limiting range as soon as the transmitter carrier power (before attenuation) exceeds 1 mW. A dual trace storage oscilloscope (or a transient recorder) records the amplitude transient from the detector on a logarithmic scale and the frequency transient from the discriminator. A *trigger device* may be required to ensure that the start of the sweep of the oscilloscope timebase occurs the instant at which the final irrevocable logic decision to power up the transmitter is taken.

b) The traces of the oscilloscope should be calibrated in power and frequency (Y axes) and in time (X axis), using the signal generator.

c) The transmitter attack time should be measured by direct reading on the oscilloscope.

7.1.7 Release time

7.1.7.1 Definition

The transmitter release time is the time interval between the instant at which the final irrevocable logic decision to power down the transmitter is taken and the moment when the unmodulated transmitter power has decayed to a level 50 dB below the rated RF output power.

NOTE: This may be used for checking the channel efficiency of systems and for defining the timings in protocols.

7.1.7.2 Method of measurement

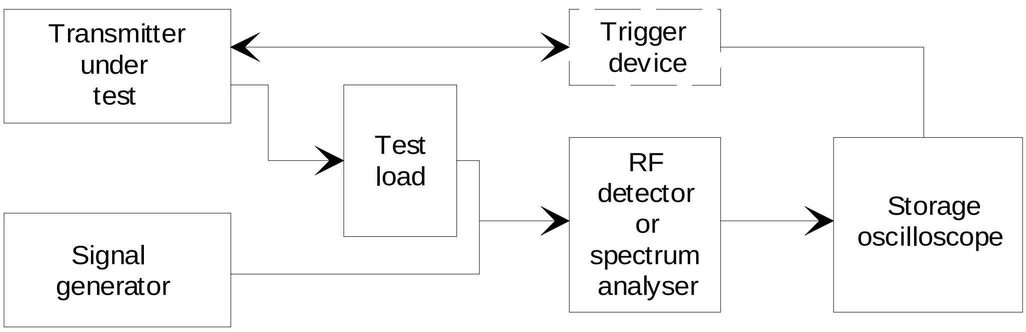


Figure 23: Measurement arrangement

a) The transmitter is connected to a RF detector via a matched *test load*. A storage oscilloscope (or a transient recorder) records the amplitude transients from the detector on a logarithmic scale (dynamic range ≥ 50 dB).

   A *trigger device* may be required to start the sweep of the oscilloscope the instant at which the final irrevocable decision to power down the transmitter is taken.

   If the transmitter possesses an automatic powering down facility (e.g. in the case of fixed length messages transmission), it will replace the *trigger device* for starting the sweep of the oscilloscope.

b) The traces of the oscilloscope should be calibrated in power (Y axis) and in time (X axis) by replacing the transmitter and test load by the signal generator.

c) The transmitter release time should be measured by direct reading on the oscilloscope.

7.1.8 Transient adjacent channel power

7.1.8.1 Definition

The transient adjacent channel power of a transmitter is expressed as the ratio in decibels of the peak power in the adjacent channels, during the rise or decay time, to the unmodulated carrier power.

7.1.8.2 Method of measurement

This method of measurement uses a **power measuring receiver** in the adjacent channels. It should be preceded by two preliminary verifications, in order to guarantee that the transients will not appear outside either of the channels adjacent to the carrier and therefore the measurement should be made in the first adjacent channels next to the carrier only.

7.1.8.2.1 Preliminary verification N°1

This verification has to be made when the transmitter is turned on and off. It uses in both cases the measuring arrangement described for the transmitter "attack time". While the carrier power is greater than 1 mW the instantaneous frequency of the carrier should remain within the tolerance of ±df1, where df1 is the channel separation.

7.1.8.2.2 Preliminary verification N°2

This verification uses the measuring arrangement described for the transmitter "attack time" and transmitter "release time". The rise and decay time measured as the time elapsed between the -30 dB and the -6 dB relative to the steady state carrier power should be greater than 0,2 ms. In addition the shape of the slopes during the rise and decay time should not exhibit abrupt changes in level or parasitic oscillation.

7.1.8.2.3 Measurement

For application of this method it should be noted that, at the present date no power measurement receivers are available on the market giving sufficient accuracy in the case of short transmission times.

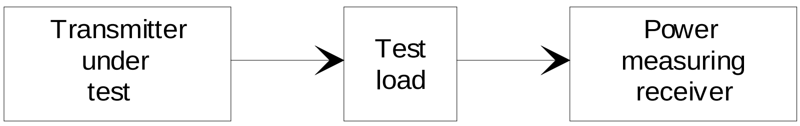


Figure 24: Measurement arrangement

a) The transmitter under test should be connected via the *test load* to a **power measuring receiver** calibrated to measure peak power level. The level at the receiver input should be within its allowed limit. The transmitter should be operated unmodulated at the maximum carrier power level under *normal test conditions*.

b) The tuning of the **power measuring receiver** should be adjusted so that a maximum response is obtained. This is the 0 dB response point. The receiver attenuator setting and the reading of the meter should be recorded and the transmitter switched off.

c) The tuning of the **power measuring receiver** should be adjusted away from the carrier so that its -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the *nominal frequency* of the carrier as given in table 4.

Table 4: Frequency displacement

Channel separation (kHz)	Displacement (kHz)
12,5	8,25
20	13
25	17

The same result may be obtained by tuning the **power measuring receiver** (point D0 in the drawing of the power measuring filter shape) to the nominal frequency of the adjacent channel, if it has been suitably calibrated.

d) The transmitter should be switched on and off once. The receiver variable attenuator should be adjusted to obtain, with the peak transient power, the same level as in step b) or a known relation to it. This value should be recorded.

e) The ratio of adjacent channel peak power to carrier power is the difference between the attenuator settings in steps b) and d), corrected for any differences in the reading of the meter.

f) Steps c) to e) should be repeated with the **power measuring receiver** tuned to the other side of the carrier.

7.1.9 Frequency deviation

7.1.9.1 Definition

The frequency deviation is the maximum difference between the instantaneous frequency of the frequency or phase modulated radio frequency signal and the carrier frequency in the absence of modulation.

7.1.9.2 Method of measurement

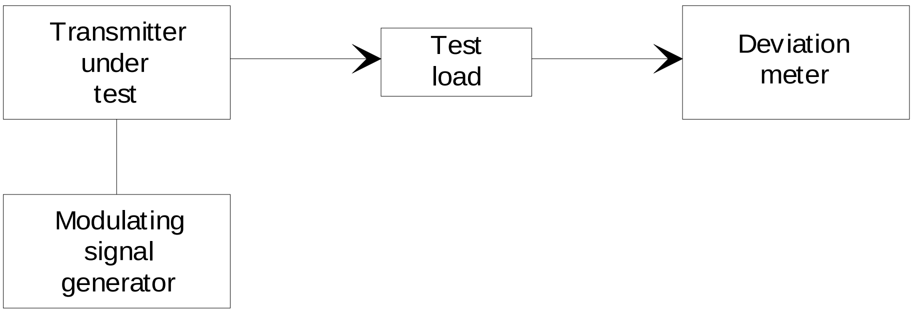


Figure 25: Measurement arrangement

The transmitter should be connected to the *test load*. The frequency deviation should be measured by means of a deviation meter capable of measuring the *maximum permissible frequency deviation*, including that due to any harmonics and intermodulation products which may be produced in the transmitter. The deviation meter bandwidth should be suitable to accommodate the highest modulating frequency and to achieve the required dynamic range.

7.1.9.2.1 Analogue signals within the audio bandwidth

a) The modulation frequency should be varied between 300 Hz and the *upper specified audio frequency limit.* The level of this test signal should be 20 dB above the level corresponding to a deviation at 1 000 Hz of 12 % of the channel separation.

b) The maximum (positive or negative) frequency deviation should be recorded.

7.1.9.2.2 Analogue signals above the audio bandwidth

a) The modulation frequency should be varied between the *upper specified audio frequency limit* and a frequency equal to the channel separation for which the equipment is intended. The level of this signal should correspond to a deviation at 1 000 Hz of 12 % of the channel separation.

b) The maximum (positive or negative) frequency deviation should be recorded.

7.1.9.2.3 Digital signals

For indirect modulation where the digital signal may either phase or frequency modulate an audio frequency sub-carrier which then modulates the radio frequency carrier the following method should be used.

a) The transmitter should be modulated with the *test modulation D-M0* at the *normal deviation* level.

b) The maximum (positive or negative) frequency deviation should be recorded.

c) The transmitter should be modulated with the *test modulation D-M1* at the *normal deviation* level.

d) The maximum (positive or negative) frequency deviation should be recorded.

NOTE: Other types of digital modulation will require an alternative method.

7.1.10 Limiter characteristic for analogue speech

7.1.10.1 Definition

The limiter characteristic expresses the capability of the transmitter to be modulated with a frequency deviation approaching the *maximum permissible frequency deviation.*

7.1.10.2 Method of measurement

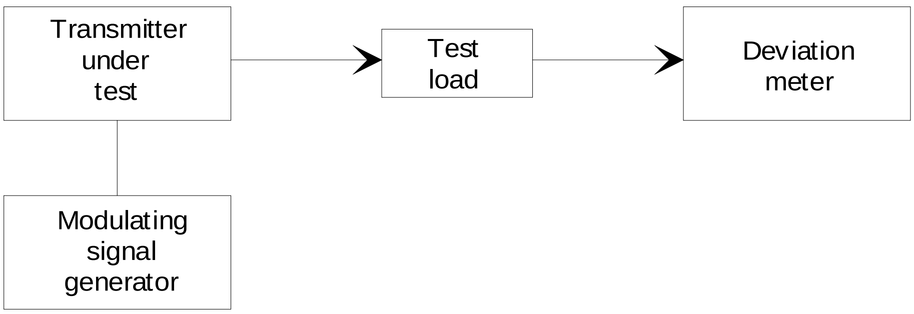


Figure 26: Measurement arrangement

a) The transmitter under test should be connected via the *test load* to the deviation meter.

b) A modulating signal at a frequency of 1 000 Hz should be applied to the transmitter. The level should be adjusted to produce a frequency deviation of 20 % of the *maximum permissible frequency deviation.*

c) The level should be raised 20 dB and the deviation recorded.

d) The measurement should be repeated under *extreme test conditions.*

7.1.11 Acoustic sensitivity of modulator for analogue speech

7.1.11.1 Definition

The acoustic sensitivity of the modulator is the capability of the transmitter to be modulated satisfactorily when an audio frequency signal corresponding to the normal average speech level is applied to the microphone.

7.1.11.2 Method of measurement

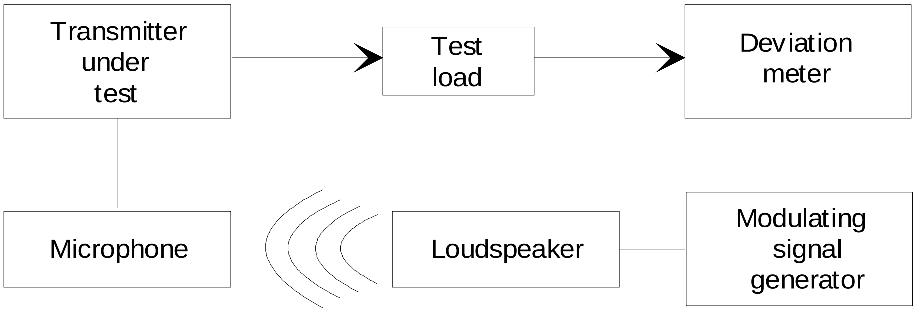


Figure 27: Measurement arrangement

The use of an anechoic acoustic chamber is recommended.

Great care should be taken with the acoustic interface to ensure that background noise is minimized and that the correct loudness level is applied to the microphone.

a) The transmitter under test should be connected via the *test load* to the deviation meter.

b) An audio frequency signal of 1 000 Hz should be applied to the microphone. The level should be adjusted to produce a frequency deviation of 20 % of the maximum permissible frequency deviation.

c) The loudness level at the diaphragm of the microphone should be recorded.

7.1.12 Audio frequency response for analogue speech

7.1.12.1 Definition

The audio frequency response is the variation of the transmitter frequency deviation as a function of the modulating frequency.

7.1.12.2 Method of measurement

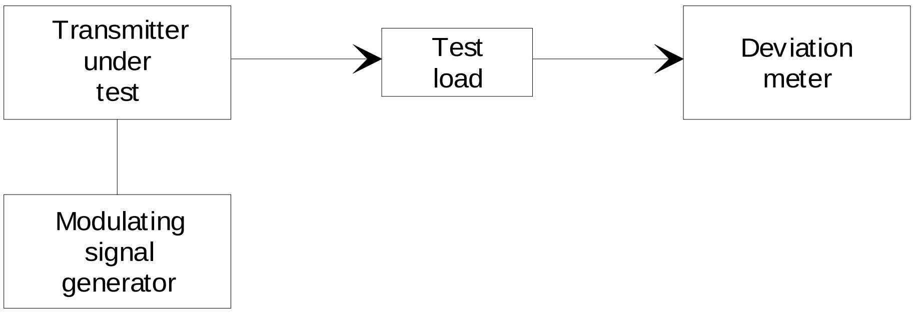


Figure 28: Measurement arrangement

a) The transmitter under test should be connected via the *test load* to the deviation meter.

b) A modulating signal with a frequency of 1 000 Hz should be applied to the transmitter. The level should be adjusted to produce a frequency deviation of 20 % of the maximum permissible frequency deviation.

c) The modulating frequency should be varied between 300 Hz and its upper audio frequency limit. The level of the modulating signal should remain constant.

d) The variation of the deviation should be recorded at suitable intervals of input frequency.

7.1.13 Harmonic distortion for analogue speech

7.1.13.1 Definition

The harmonic distortion of a transmitter when modulated with an audio frequency signal is defined as the ratio, expressed as a percentage, of the rms voltage of all the harmonic components of the fundamental audio frequency to the total rms voltage of the signal after linear demodulation.

7.1.13.2 Method of measurement

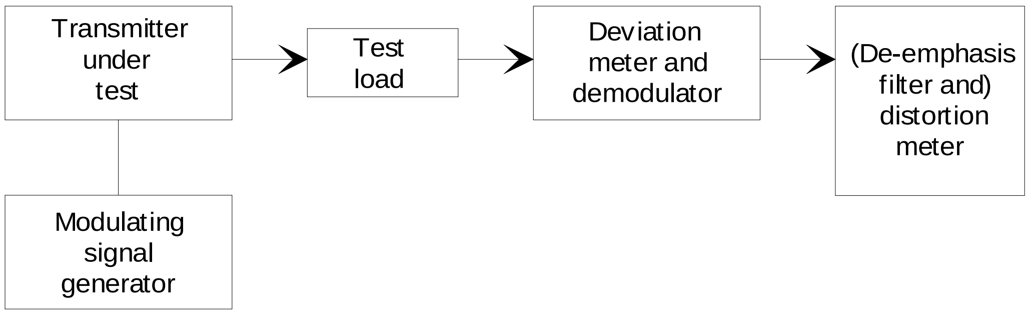


Figure 29: Measurement arrangement

a) The transmitter under test should be connected via the test load to the deviation meter which has a linear audio output. The output of the deviation meter demodulator should be connected to the distortion meter through a 6 dB/octave de-emphasis filter when the transmitter is phase modulated. If the transmitter is frequency modulated then no filter is required.

b) For phase modulation the transmitter should be modulated successively at frequencies of 300 Hz, 500 Hz and 1 000 Hz maintaining a constant modulation index (i.e. keeping the ratio of frequency deviation to the modulating frequency constant). This is the index which produces 60 % of the maximum permissible frequency deviation when modulated at 1 000 Hz.

   For frequency modulation the transmitter should be modulated successively at frequencies of 300 Hz, 500 Hz and 1 000 Hz with a frequency deviation equal to 60 % of the *maximum permissible frequency deviation.*

c) The harmonic distortion should be recorded at each of the frequencies.

d) The measurement should be repeated under *extreme test conditions* with the modulating signal at 1 000 Hz and the frequency deviation equal to 70 % of the *maximum permissible frequency deviation*.

7.1.14 Residual modulation for analogue speech

7.1.14.1 Definition

The residual modulation of a transmitter is the ratio, expressed in decibels, of the audio frequency output power produced after the demodulation of the radio frequency signal in the absence of wanted modulation to the audio frequency output power produced by the application of specified *test modulation*.

7.1.14.2 Method of measurement

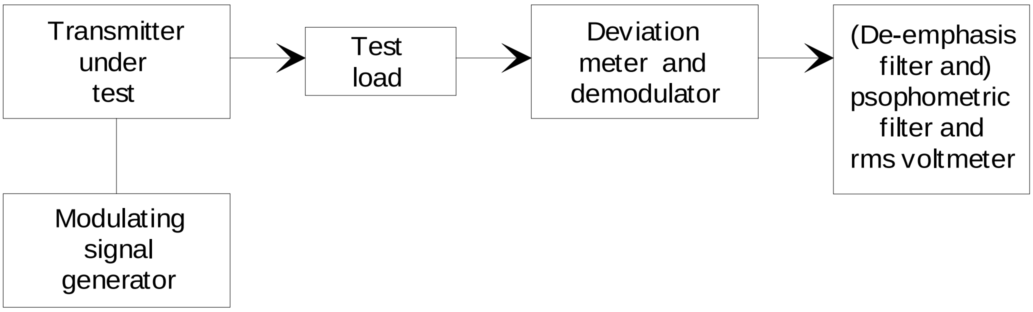


Figure 30: Measurement arrangement

Care should be taken to avoid false results caused by the emphasis of low frequency noise in the demodulator.

a) The transmitter under test should be connected via the *test load* to the deviation meter which has a linear audio output. The output of the deviation meter demodulator should be connected to the rms voltmeter through a 6 dB/octave de-emphasis filter and via the *psophometric weighting network* when the transmitter is phase modulated. If the transmitter is frequency modulated then the de-emphasis filter is not required.

b) *Test modulation A-M1* should be applied to the transmitter and the level on the rms voltmeter recorded.

c) The modulation should be removed and the new level recorded.

d) The residual modulation is the ratio, expressed in dB, of the value recorded in step c) to the value recorded in step b).

7.2 Radiated tests

7.2.1 Frequency error (30 MHz to 1 000 MHz)

Definition

The frequency error of a transmitter is the difference between the measured carrier frequency in the absence of modulation and the nominal frequency of the transmitter as stated by the manufacturer.

7.2.1.1 Anechoic Chamber

7.2.1.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Anechoic Chamber;
- Test antenna (a half wavelength dipole, bicone or LPDA);
- Frequency counter.

The type and serial numbers of all items of test equipment should be recorded in the log book results sheet (table 18).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

7.2.1.1.2 Method of measurement

1) The measurement should always be performed in the absence of modulation.

2) The EUT should be mounted on the turntable, whose surface is at the height specified in the relevant standard or, where not stated, at a convenient height within the "quiet zone" of the Anechoic Chamber. The EUT should be mounted in an orientation which matches that of its normal usage as stated by the manufacturer. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 5).

NOTE 1: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3) The test antenna (dipole, bicone or LPDA) should be oriented for the stated polarization of the EUT. For cases in which the test antenna is a tuned half wavelength dipole, this should be tuned to the appropriate frequency. The output of the test antenna should be connected to the frequency counter via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber (see figure 31). The phase centre of the test antenna should be at the same height above the floor as the mid point of the EUT.

NOTE 2: Where a dipole is used, frequencies below 80 MHz require a shortened version (as defined in subclause 6.2.3) to be used. For any frequency, the dipole arm length (given in table 2B) is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2B) also gives the choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

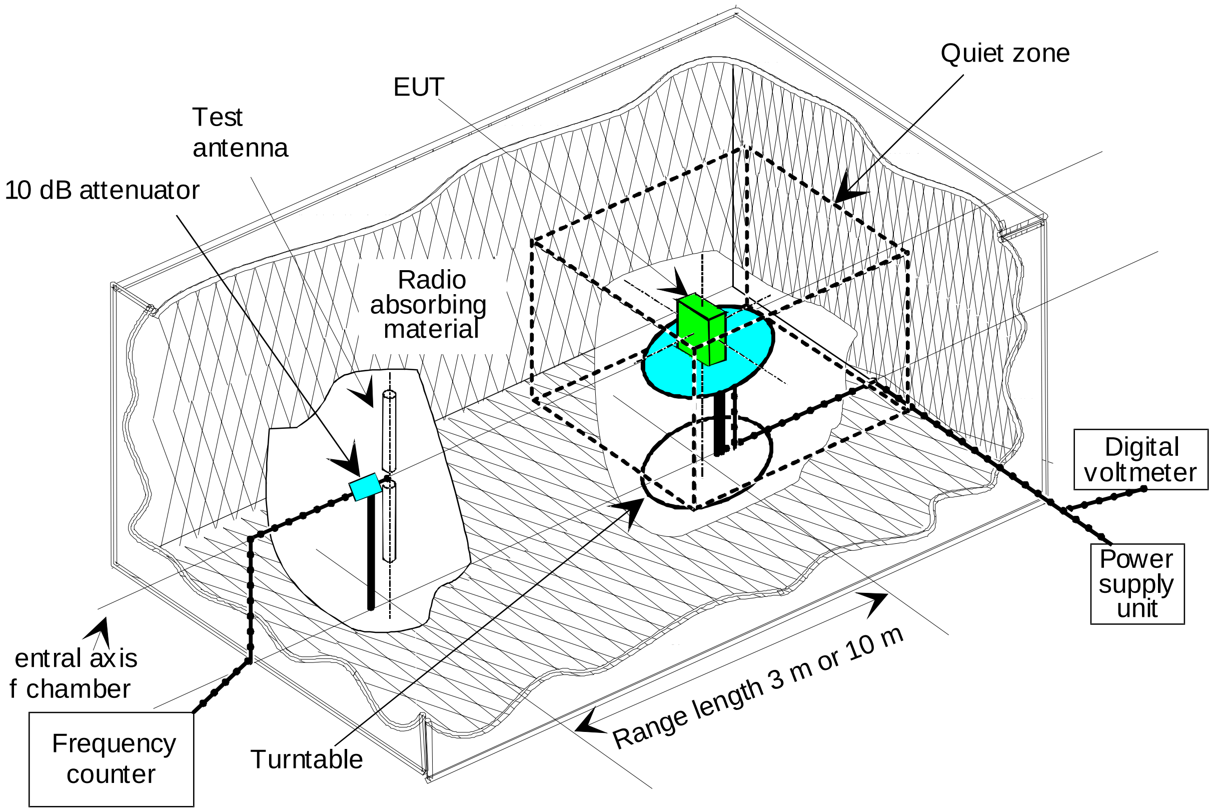


Figure 31: Anechoic Chamber set-up for the Frequency error test

4) The EUT should be switched on without modulation, allowed adequate time to stabilize and the resolution of the frequency counter adjusted to read to the nearest Hz.

5) The value of the frequency displayed on the counter should be recorded in the log book results sheet (table 5).

NOTE 3: In cases where the frequency does not appear stable, this might require observations over a 30 second or 1 minute time period, noting the highest and lowest readings and estimating the average value. In these cases it is the average value that should be recorded in the log book results sheet (table 5).

7.2.1.1.3 Procedure for completion of the results sheets

There are two values that need to be derived before the overall results sheet (table 6) can be completed. Firstly the value for frequency error (from a straightforward calculation of recorded frequency minus the nominal frequency) and secondly, the value of the expanded uncertainty for the test. This should be carried out in accordance with TR 100 028-2 [7], subclause 7.2.1.1.

7.2.1.1.4 Log book entries

Table 5: Log book results sheet

FREQUENCY ERROR		**Date:**		**PAGE 1 of 1**	
Temperature:........................... °C **Manufacturer of EUT: ....**		**Humidity: .... %** **Type No: ....**		**Frequency: .... MHz** **Serial No: ....**	
Range length:					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor/gain**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Ferrite beads			N/A	N/A	N/A
Frequency counter				N/A	N/A
Mounting configuration of EUT					
Reading on frequency counter:	Hz				

7.2.1.1.5 Statement of results

The results should be presented in tabular form as shown in table 6.

Table 6: Overall results sheet

FREQUENCY ERROR **Date:**	**PAGE 1 of 1**
Frequency error	Hz
Expanded uncertainty (95 %)	Hz

7.2.1.2 Anechoic Chamber with a ground plane

For Frequency Error testing in an Anechoic Chamber with a ground plane reference should be made to the Open Area Test Site test method (subclause 7.2.1.3), since the procedures are identical.

The test equipment and EUT set-up for this test is shown in figure 32.

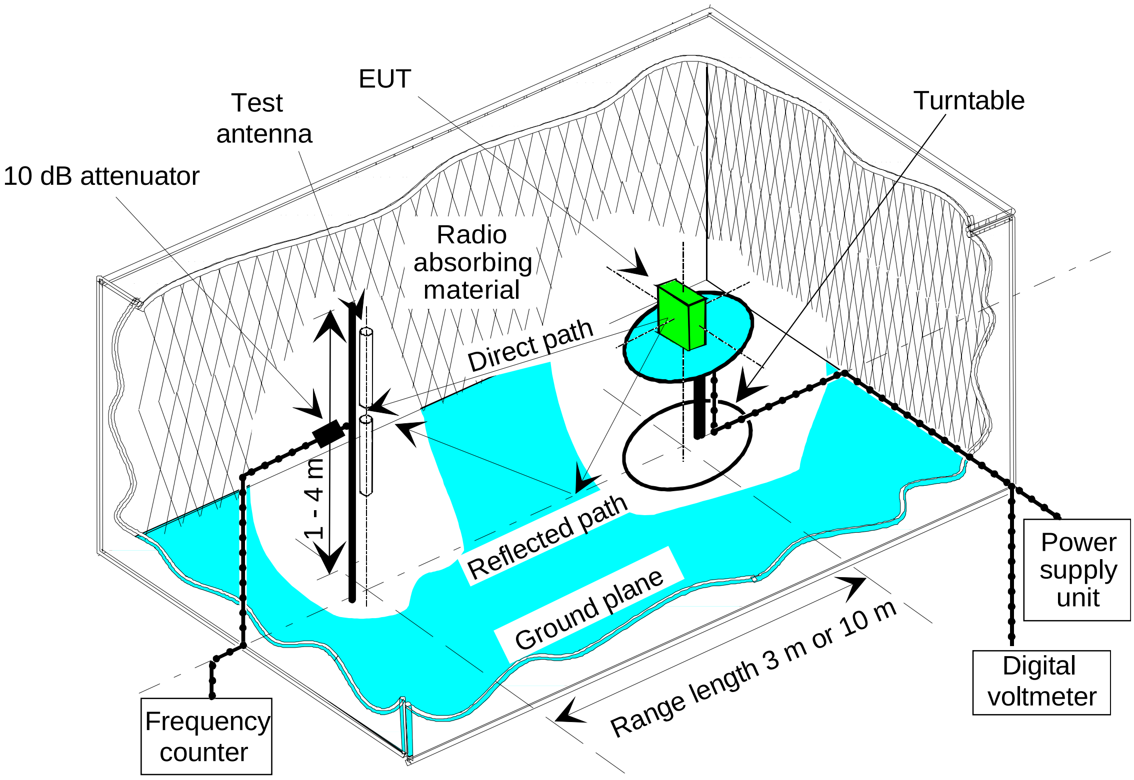


Figure 32: Anechoic Chamber with a ground plane set-up for the Frequency error test

To complete the overall results sheet for this test, the value for expanded measurement uncertainty should be calculated according to TR 100 028-2 [7], subclause 7.2.1.2.

7.2.1.3 Open Area Test Site

7.2.1.3.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Open Area Test Site;
- Test antenna (a half wavelength dipole, bicone or a LPDA);
- Frequency counter.

The type and serial numbers of all items of test equipment should be recorded in the log book results sheet (table 7).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

7.2.1.3.2 Method of measurement

1 The measurement should always be performed in the absence of modulation.

2 The EUT should be mounted on a turntable whose mounting surface is at the height (above the ground plane) specified in the relevant standard. The EUT should be mounted in an orientation which matches that of its normal usage as stated by the manufacturer. This orientation and mounting configuration should be recorded in the log book results sheet (table 7).

NOTE 1: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 The test antenna (dipole, bicone or LPDA) should be mounted on the antenna mast and oriented for the stated polarization of the EUT. For cases in which the test antenna is a tuned half wavelength dipole, this should be tuned to the nominal frequency. The output of the test antenna should be connected to the frequency counter via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site (see figure 33). The phase centre of the test antenna should be at the same height above the floor as the mid point of the EUT.

NOTE 2: Where a dipole is used, frequencies below 80 MHz require a shortened version (as defined in subclause 6.2.3) to be used. For any frequency, the dipole arm length (given in table 2B) is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2B) also gives the choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

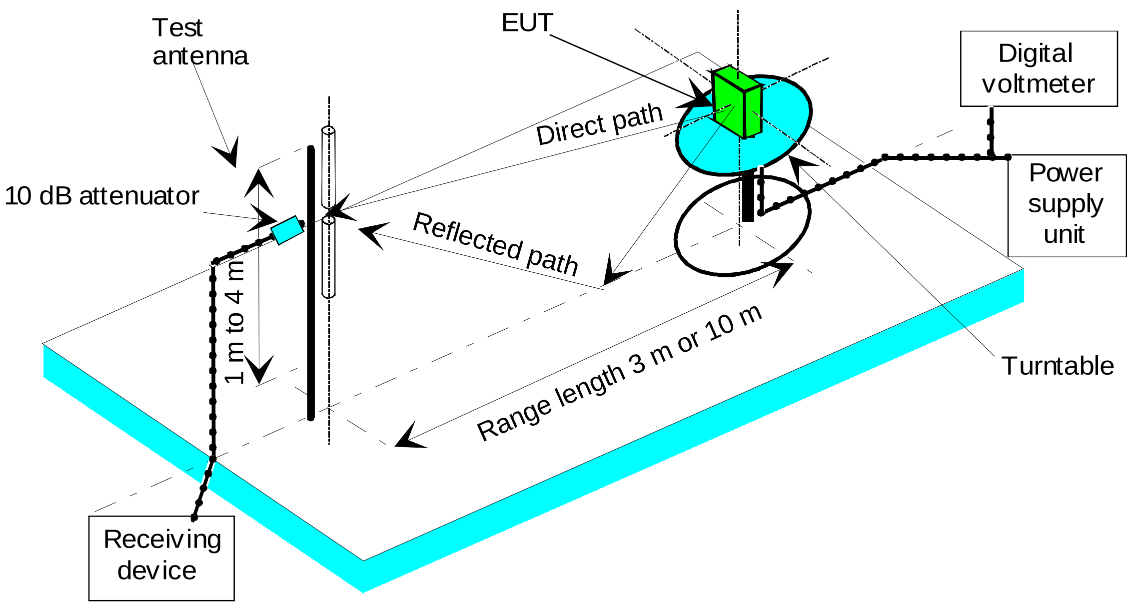


Figure 33: Open Area Test Site set-up for the Frequency error test

4 The EUT should be switched on without modulation, allowed adequate time to stabilize and the resolution of the frequency counter adjusted to read to the nearest Hz.

5 For cases in which no reading is given on the frequency counter, the height of the test antenna on the mast should be varied until a reading does appear.

6 The value of the frequency displayed on the counter should be recorded in the log book results sheet (table 7).

NOTE 3: In cases where the frequency does not appear stable, this might require observations over a 30 second or 1 minute time period, noting the highest and lowest readings and estimating the average value. In these cases it is the average value that should be recorded in the log book results sheet (table 7).

7.2.1.3.3 Procedure for completion of the results sheets

There are only two values that need to be derived before the overall results sheet (table 8) can be completed. Firstly the value for frequency error (from a straightforward calculation of recorded frequency minus the nominal frequency) and secondly, the value of the expanded uncertainty for the test. This should be calculated in accordance with TR 100 028-2 [7], subclause 7.2.1.3 and the resulting value entered in the overall results sheet (table 8).

7.2.1.3.4 Log book entries

Table 7: Log book results sheet

FREQUENCY ERROR			**Date:**		**PAGE 1 of 1**
Temperature:..........................°C **Manufacturer of EUT: ....**		**Humidity: .... %** **Type No: ....**		**Frequency:.................MHz** **Serial No: ....**	
Range length:.......................					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor/gain**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Ferrite beads			N/A	N/A	N/A
Frequency counter				N/A	N/A
Mounting configuration of EUT					
Reading on frequency counter:					**Hz**

7.2.1.3.5 Statement of results

The results should be presented in tabular form as shown in table 8.

Table 8: Overall results sheet

FREQUENCY ERROR	**Date:**	**PAGE 1 of 1**
Frequency error		Hz
Expanded uncertainty (95 %)		Hz

7.2.1.4 Stripline

The frequency error test is not normally carried out in a stripline test facility.

7.2.1.5 Test Fixture

7.2.1.5.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;
- Frequency counter.

The type and serial numbers of all items of test equipment should be recorded in the log book results sheet (table 9).

7.2.1.5.2 Method of measurement

1 The measurement should always be performed in the absence of modulation.

2 The Test Fixture should have been verified for use, with the particular EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the magnitude of the frequency error should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

   a) the EUT by itself on the accredited Free-Field Test Site;

   b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

   c) the frequency presented at the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

   d) the frequency presented at the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

3 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This mounting configuration should be noted in the log book results sheet (table 9).

4 The assembly should be connected to the test equipment as shown in figure 34.

5 Normal conditions (as defined in the relevant standard) should exist within the climatic facility.

6 The EUT should be turned on without modulation, allowed adequate time to stabilize and the resolution of the frequency counter adjusted to read to the nearest Hz.

7 The value of the frequency displayed on the counter should be recorded in the log book results sheet (table 9).

NOTE 1: In cases where the frequency does not appear stable, this step might require observations over a 30 second or 1 minute time period, noting the highest and lowest readings and estimating the average value. In these cases it is the average value that should be recorded in the log book results sheet (table 9).

8 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

9 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required. Steps 6 and 7 should then be repeated.

NOTE 2: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 3: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

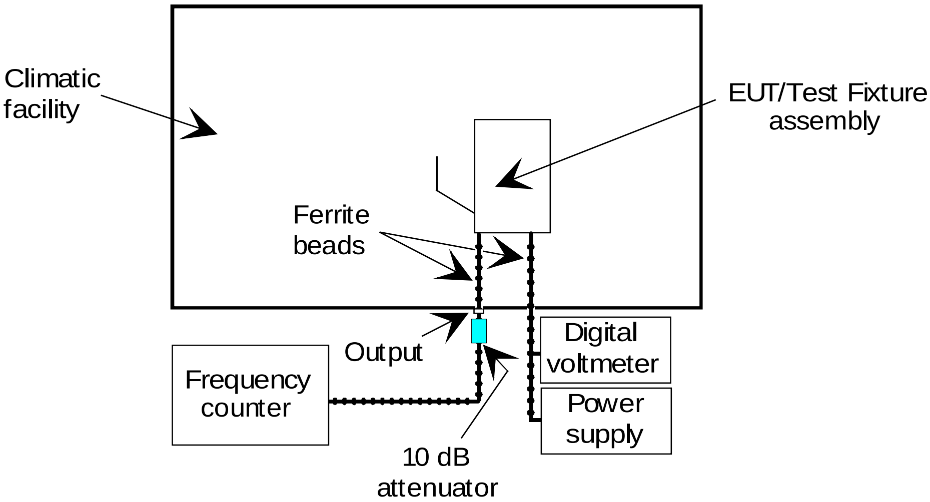


Figure 34: Set-up for Frequency error measurement using a Test Fixture

10 The supply voltage to the EUT should be set to the upper extreme as given in the relevant Standard. Steps 6 and 7 should then be repeated.

11 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant Standard. Steps 6 and 7 should then be repeated.

12 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

13 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 4: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 5: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

14 The supply voltage to the EUT should be set to the lower extreme as given in the relevant standard. Steps 6 and 7 should then be repeated.

15 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant standard. Steps 6 and 7 should then be repeated.

16 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

7.2.1.5.3 Procedure for completion of the results sheets

There are two values that need to be derived before the overall results sheet (table 3) can be completed. Firstly the value for frequency error (from a straightforward calculation of recorded frequency minus the nominal frequency) and secondly, the value of the expanded uncertainty for the test which should be calculated in accordance with TR 100 028-2 [7], subclause 7.2.1.5.

7.2.1.5.4 Log book entries

Table 9: Log book results sheet

FREQUENCY ERROR	Date:			PAGE 1 of 1
Frequency: ....MHz **Manufacturer of EUT: ....**	**Free-field test site type: ....** **Type number:.. Serial No: ....**			
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
RF cable to frequency counter input				
RF cable within climatic facility				
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
Frequency counter				N/A
Mounting configuration in the climatic facility				

	T (normal)	T (high)		T (low)	
	V (normal)	V (high)	V (low)	V (high)	V (low)
Reading on frequency counter	Hz	Hz	Hz	Hz	Hz

7.2.1.5.5 Statement of results

The results are presented in tabular form as shown in table 10.

Table 10: Overall results sheet

FREQUENCY ERROR	Date:			PAGE 1 of 1	
	T (normal)	T (high)		T (low)	
	V (normal)	V (high)	V (low)	V (high)	V (low)
Frequency error	Hz	Hz	Hz	Hz	Hz
Expanded uncertainty (95 %)	Hz				

7.2.2 Effective radiated power (30 MHz to 1 000 MHz)

Definition

The effective radiated power is the power radiated in the direction of the maximum field strength under specified conditions of measurement, in the absence of modulation.

7.2.2.1 Anechoic Chamber

7.2.2.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Anechoic Chamber;
- Test antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Substitution antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Receiving device (measuring receiver or spectrum analyser);
- Signal generator.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 12).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

7.2.2.1.2 Method of measurement

1 The measurement should always be performed in the absence of modulation.

2 The EUT should be mounted directly onto the turntable, whose surface is at the height specified in the relevant standard or, where not stated, at a convenient height within the "quiet zone" of the Anechoic Chamber. The EUT should be mounted in an orientation which matches that of its normal usage as stated by the manufacturer. The normal to the reference face of the EUT should point directly down the chamber towards the test antenna support. This is the 0° reference angle for the test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 12). The items of test equipment should be set-up as shown in figure 35.

NOTE 1: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 In cases where the position of the phase centre of the EUT's antenna is known, the EUT should be positioned on the turntable such that this phase centre is as coincident with the axis of rotation of the turntable as possible and either on the central axis of the chamber or at a convenient height within the quiet zone. Alternatively, if the position of the phase centre is unknown, but the antenna is a single rod which is visible and vertical in normal usage, the axis of the antenna should lie on the axis of rotation whilst its base should be positioned on the chamber's central axis (or at a convenient height within the quiet zone). If the phase centre of the EUT is unknown and no antenna is visible, the volume centre of the EUT should be used instead. The offset from the central axis of the chosen phase centre datum, should be entered on page 2 of the log book results sheet (table 12).

4 The test antenna (in the recommended scheme a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) should be tuned to the appropriate frequency and oriented for vertical polarization. Its output should be connected to the receiving device via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber. The height of the phase centre of the test antenna should be at the same offset (if any) from the central axis of the chamber as the phase centre/antenna base/volume centre of the EUT, so that the measurement axis is parallel to the central axis.

NOTE 2: The measurement axis is the straight line between the phase centres of transmitting and receiving devices.

NOTE 3: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

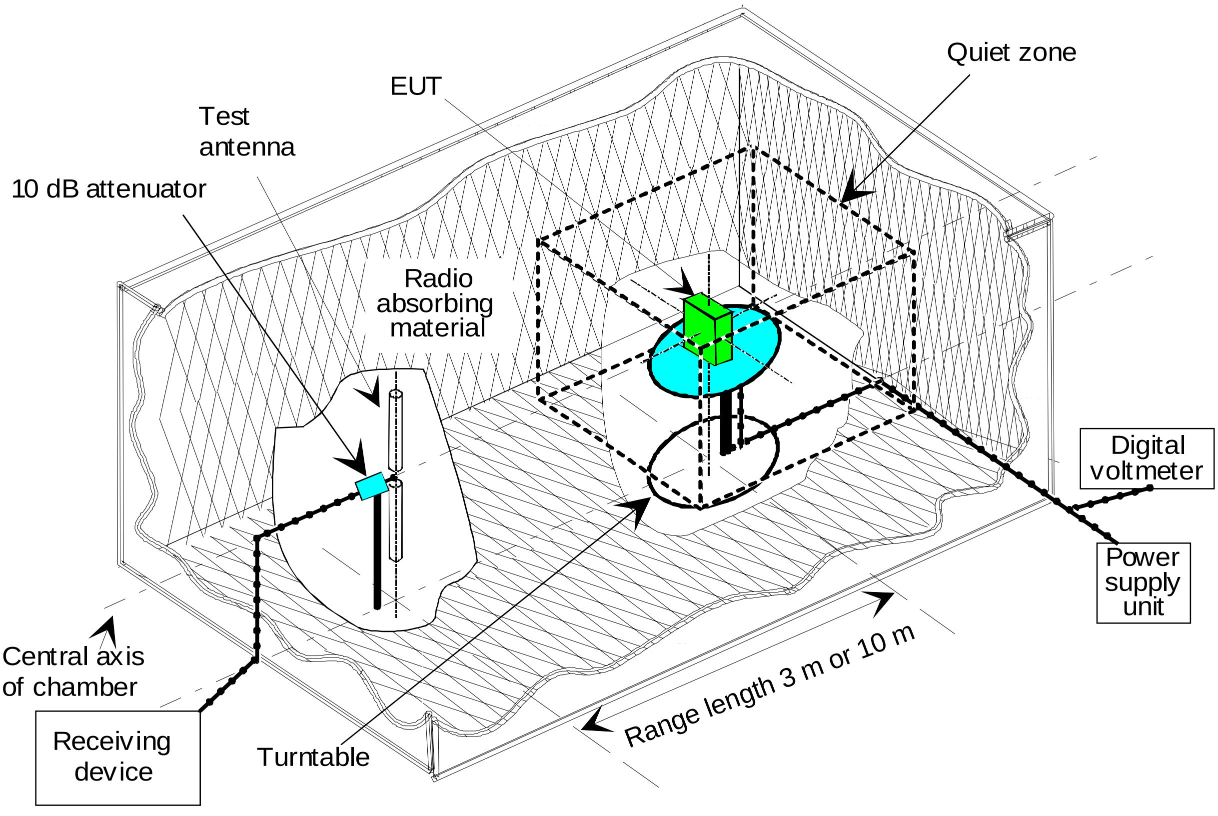


Figure 35: Anechoic Chamber set-up for the Effective radiated power measurement on the EUT

5 The EUT should be switched on without modulation, and the receiving device tuned to the appropriate frequency.

6 The EUT should be rotated through 360° in the horizontal plane until the maximum signal is detected on the receiving device. The angle with reference to the nominal orientation of the EUT and the maximum signal level (dBm) detected by the receiving device should be recorded on page 2 of the log book results sheet (table 12).

7 The EUT should be replaced on the turntable by the substitution antenna (identical to the test antenna), which has been adjusted to correspond to the frequency of the EUT. See figure 36.

8 The phase centre of the substitution antenna should lie directly over the axis of rotation of the turntable, whilst its height should be at the same offset from the central axis of the chamber as the phase centre of the test antenna, so that the measurement axis is again parallel to the central axis.

9 The substitution antenna should be oriented for vertical polarization and connected via a 10 dB attenuator to a calibrated signal generator using the calibrated, ferrited coaxial cable associated with the turntable end of the chamber.

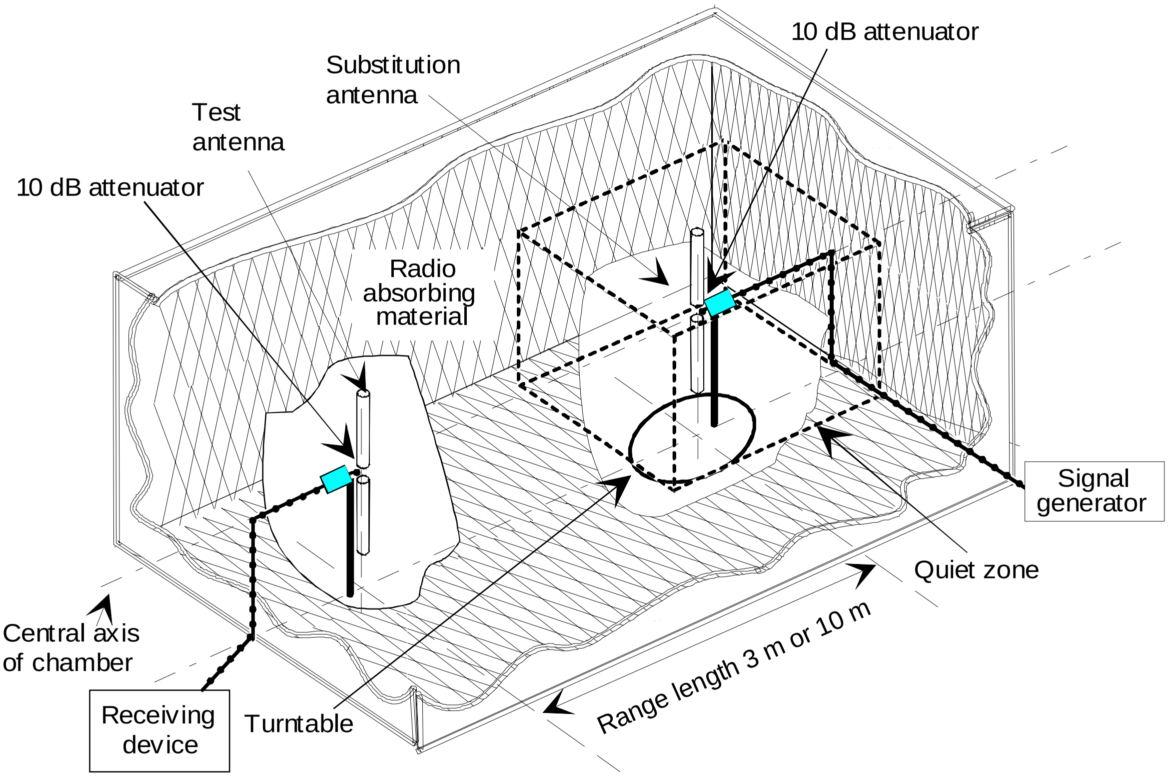


Figure 36: Substitution antenna replacing the EUT

10 The signal generator should be tuned to the appropriate frequency and its output level adjusted until the level measured on the receiving device, is at least 20 dB above the level with the output from the signal generator switched off.

11 The substitution antenna should be rotated until the maximum level is detected on the receiving device.

NOTE 4: This is to correct for possible misalignment of a directional beam i.e. dipoles used in horizontally polarized tests. This step can be omitted when dipoles are used in vertically polarized tests.

12 The output level of the signal generator should be adjusted until the level, measured on the receiving device, is identical to that recorded in step 6. This output signal level (dBm) from the signal generator should be recorded on page 2 of the log book results sheet (table 12).

NOTE 5: In the event of insufficient range of signal generator output level, the receiving device input attenuation should be decreased to compensate. The signal generator output level (dBm) and the change in attenuation (dB) should both be recorded on page 2 of the log book results sheet (table 12) in this case.

13 The EUT should be remounted on the turntable as stipulated in steps 2 and 3, the test antenna oriented for horizontal polarization and steps 4 to 12 repeated with the substitution antenna also oriented for horizontal polarization.

7.2.2.1.3 Procedure for completion of the results sheets

There are two values that need to be derived before the overall results sheet (table 13) can be completed. These are the overall measurement correction and the expanded uncertainty values.

Guidance for deriving the values of the correction factors is given in table 11.

When the correction factors have been derived, they should be entered on page 2 of the log book results sheet (table 12) as a result of which the overall correction can be calculated as follows:

overall correction = *substitution antenna cable loss*

\+ *substitution antenna attenuator loss*

\+ *substitution antenna balun loss*

\+ *mutual coupling and mismatch loss (where applicable)*

\- *gain of substitution antenna*

NOTE: For frequencies greater than 180 MHz the mutual coupling and mismatch loss factor should be taken as 0,00 dB

The resulting value for the overall correction factor should then be entered on page 2 of the log book result sheet (table 12). The effective radiated power can then be calculated:

effective *radiated power* = *signal generator output level*

\- *reduction in the input attenuation of receiving device (if any)*

\+ *overall correction*

The only calculation that remains to be performed before the overall results sheet (table 13) can be completed is the determination of the expanded measurement uncertainty. This should be calculated in accordance with TR 100 028-2 [7], subclause 7.2.2.1.

Table 11: Guidance for deriving correction factors

Figures for correction factors:
Substitution antenna cable loss: Obtained directly from the calibration data.
Substitution antenna attenuator loss: Obtained from calibration data.
Substitution antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss factors between the test antenna and substitution antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A.19. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Gain of substitution antenna: For ANSI dipoles (30 MHz to 1 000 MHz) the value is 2,10 dBi. For other types, the value can be obtained from calibration data.

7.2.2.1.4 Log book entries

Table 12: Log book results sheet

EFFECTIVE RADIATED POWER		**Date:**			**PAGE 1 of 2**
Temperature:.................................. °C		**Humidity: ....%**		**Frequency: .... MHz**	
Manufacturer of EUT:		**Type No: ....**		**Serial No:.....................**	
Bandwidth of Receiving Device: ....Hz					
Range length:..					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor/gain**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Substitution antenna				N/A	
Substitution antenna attenuator					N/A
Substitution antenna cable					N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Receiver device				N/A	N/A
Signal generator				N/A	N/A
Ferrite beads			N/A	N/A	N/A
Mounting configuration of EUT					

EFFECTIVE RADIATED POWER		Date:	PAGE 2 of 2
Vertical Polarization		**Horizontal Polarization**	
Offset of EUT's phase centre from the central axis		Offset of EUT's phase centre from the central axis	
Maximum signal level on receiving device	dBm	Maximum signal level on receiving device (dBm)	dBm
Angle at which the maximum signal is received		Angle at which the maximum signal is received	
Output level from signal generator into substitution antenna (dBm)	dBm	Output level from signal generator into substitution antenna (dBm)	dBm
Change in receiver attenuator	dB	Change in receiver attenuator	dB
Correction factors			
Substitution antenna cable loss(es)		Substitution antenna cable loss(es)	
Substitution antenna attenuator loss		Substitution antenna attenuator loss	
Substitution antenna balun loss		Substitution antenna balun loss	
Mutual coupling and mismatch loss (30 MHz - 180 MHz)		Mutual coupling and mismatch loss (30 MHz - 180 MHz)	
Gain of the substitution antenna		Gain of the substitution antenna	
Overall measurement correction	dB	Overall measurement correction	dB

7.2.2.1.5 Statement of results

The results should be presented in tabular form as shown in table 13.

Table 13: Overall results sheet

EFFECTIVE RADIATED POWER		Date:	PAGE 1 of 1
Vertical Polarization		**Horizontal Polarization**	
Effective radiated power	dBm	Effective radiated power	dBm
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)	dB

7.2.2.2 Anechoic Chamber with a ground plane

For Effective radiated power testing in an Anechoic Chamber with a ground plane, reference should be made to the Open Area Test Site test method (subclause 7.2.2.3), since the procedures are identical.

The test equipment set-up for the EUT measurement is shown in figure 37 whilst the set-up for the substitution part of the test is shown in figure 38.

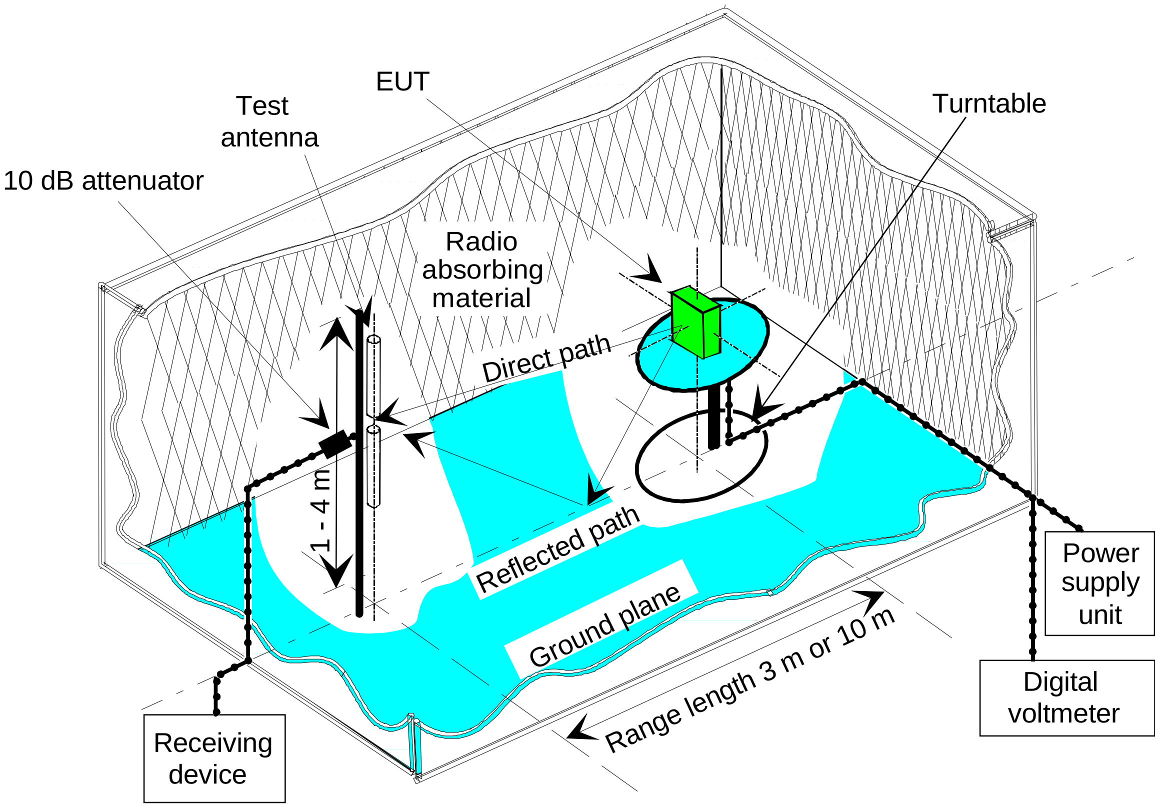


Figure 37: Anechoic Chamber with a ground plane set-up for the Effective radiated power measurement on the EUT

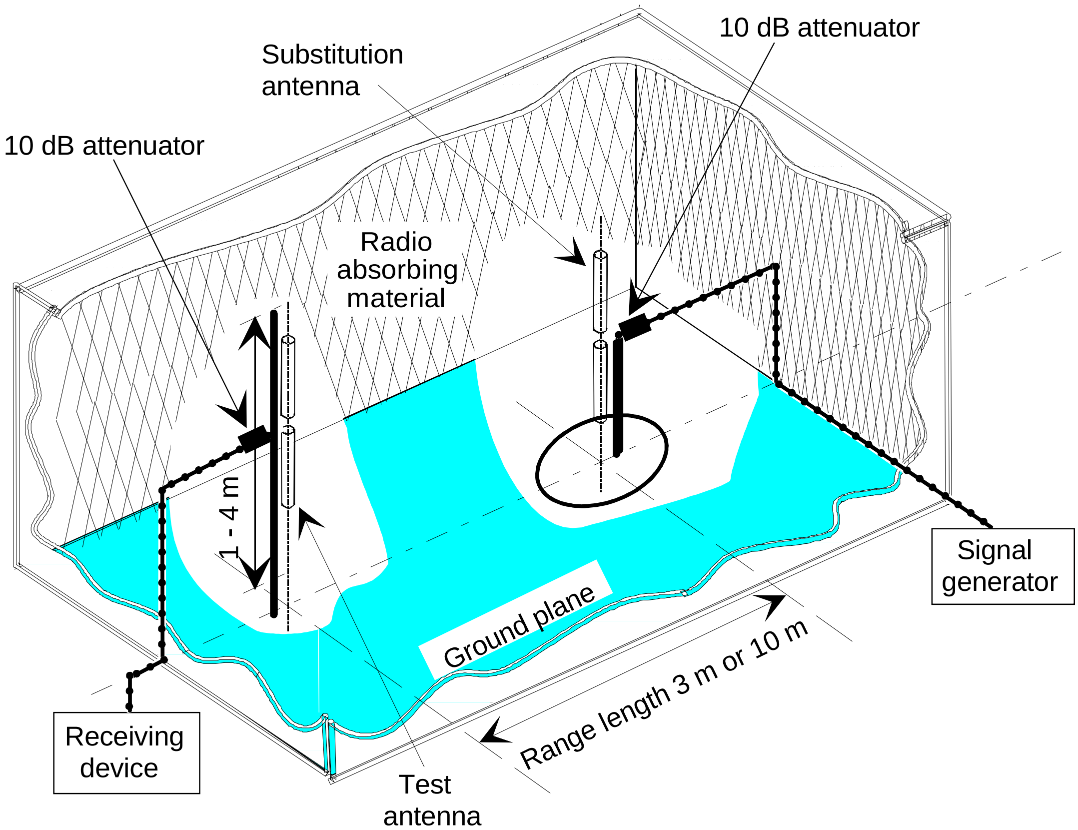


Figure 38: Anechoic Chamber with a ground plane set-up for the Effective radiated power substitution measurement

To complete the overall results sheet for this test, the value for expanded measurement uncertainty should be calculated according to TR 100 028-2 [7], subclause 7.2.2.2.

7.2.2.3 Open Area Test Site

7.2.2.3.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Open Area Test Site;
- Test Antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Substitution antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Receiving device (measuring receiver or spectrum analyser);
- Signal generator.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 15).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

7.2.2.3.2 Method of measurement

1 The measurement should always be performed in the absence of modulation.

2 The EUT should be mounted directly onto the turntable, whose surface is at the height (above the ground plane) specified in the relevant Standard, in an orientation which matches that of its normal usage (as stated by the manufacturer). The normal to the reference face of the EUT should point directly down the test site towards the test antenna support. This is the 0° reference angle for the test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 15). The items of test equipment should be set-up as shown in figure 39.

NOTE 1: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 In cases where the position of the phase centre of the EUT's antenna is known, the EUT should be positioned on the turntable such that this phase centre is as coincident with the axis of rotation as possible. Alternatively, if the position of the phase centre is unknown, but the antenna is a single rod which is visible and vertical in normal usage, the axis of the antenna should be used. If neither alternative is possible, the volume centre of the EUT should be used instead.

4 The height above the ground plane of the phase centre (if known) of the EUT should be recorded on page 1 of the log book results sheet (table 15). If the position of the phase centre is unknown, but the antenna is visible, then the height above the ground plane of the point at which the antenna meets the case of the EUT should be recorded. If neither alternative is possible, the volume centre of the EUT should be used instead.

5 The test antenna (in the recommended scheme a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) should be

mounted on the antenna mast, tuned to the appropriate frequency and oriented for vertical polarization. Its output should be connected to the receiving device via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site.

NOTE 2: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

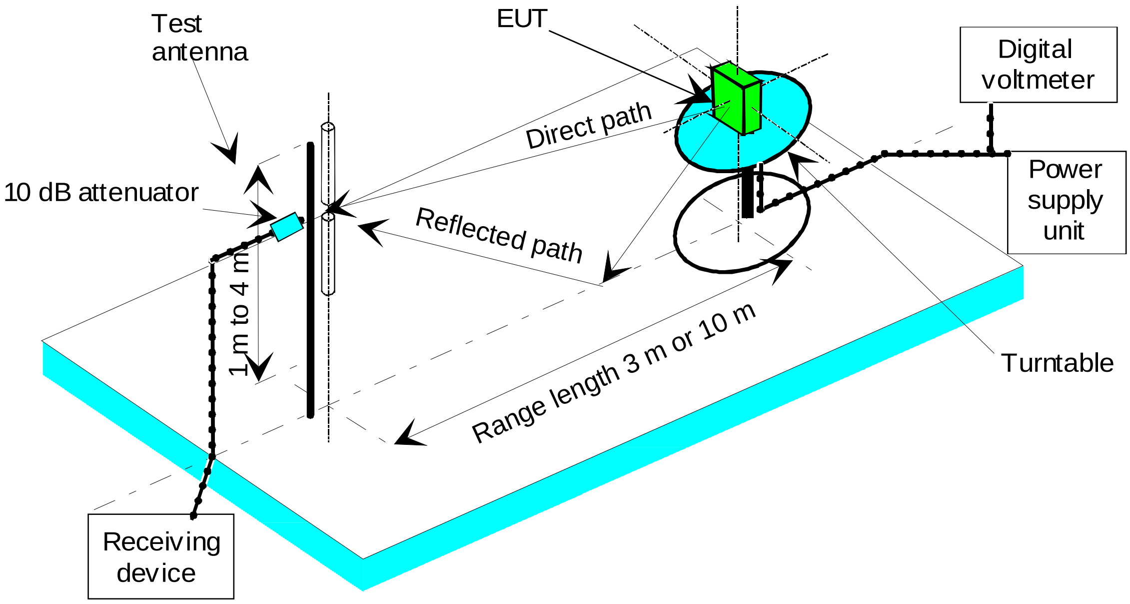


Figure 39: Open Area Test Site set-up for Effective radiated power measurement on the EUT

6 The EUT should be switched on without modulation, and the receiving device tuned to the nominal frequency.

7 The test antenna should be raised and lowered through the specified range of heights (1 m - 4 m, ensuring that no part of the antenna is less than 0,25 m from the ground plane at any time) until the maximum signal level is detected on the receiving device. The height of the test antenna on the mast should be recorded on page 2 of the log book results sheet (table 15).

NOTE 3: The true maximum may lie beyond the top of the mast, in which case the maximum receivable level should be at the top of the height range.

8 The EUT should be rotated through 360° in the horizontal plane until the maximum signal is detected on the receiving device. The angle with reference to the nominal orientation of the EUT and the maximum signal level (dBm) detected by the receiving device should be recorded on page 2 of the log book results sheet (table 15).

9 The EUT should be replaced on the turntable by the substitution antenna (identical to the test antenna), which has been adjusted to correspond to the frequency of the EUT. See figure 40.

10 The height of the phase centre of the substitution antenna should be located at the height recorded in step 3, whilst the phase centre should lie on the axis of rotation of the turntable.

11 The substitution antenna should be oriented for vertical polarization and connected via a 10 dB attenuator to a calibrated signal generator using the calibrated, ferrited coaxial cable associated with the turntable end of the test site.

12 The signal generator should be tuned to the appropriate frequency and its output level adjusted until the level measured on the receiving device, is at least 20 dB above the level with the output from the signal generator switched off.

13 The test antenna should be raised and lowered through the specified range of heights until the maximum signal level is achieved on the receiving device. The height of the test antenna on the mast should be recorded on page 2 of the log book results sheet (table 15).

NOTE 4: The true maximum may lie beyond the top of the mast, in which case the maximum received level should be at the top of the height range.

14 The substitution antenna should be rotated until the maximum level is detected on the receiving device.

NOTE 5: This is to correct for possible misalignment of a directional beam i.e. dipoles used in horizontally polarized tests. This step can be omitted when dipoles are used in vertically polarized tests.

15 The output level of the signal generator should be adjusted until the level, measured on the receiving device, is identical to that recorded in step 8. This output signal level (dBm) from the signal generator should be recorded on page 2 of the log book results sheet (table 15).

NOTE 6: In the event of insufficient range of signal generator output level, the receiving device input attenuation should be decreased to compensate. The signal generator output level (dBm) and the change in attenuation (dB) should both be recorded on page 2 of the log book results sheet (table 15) in this case.

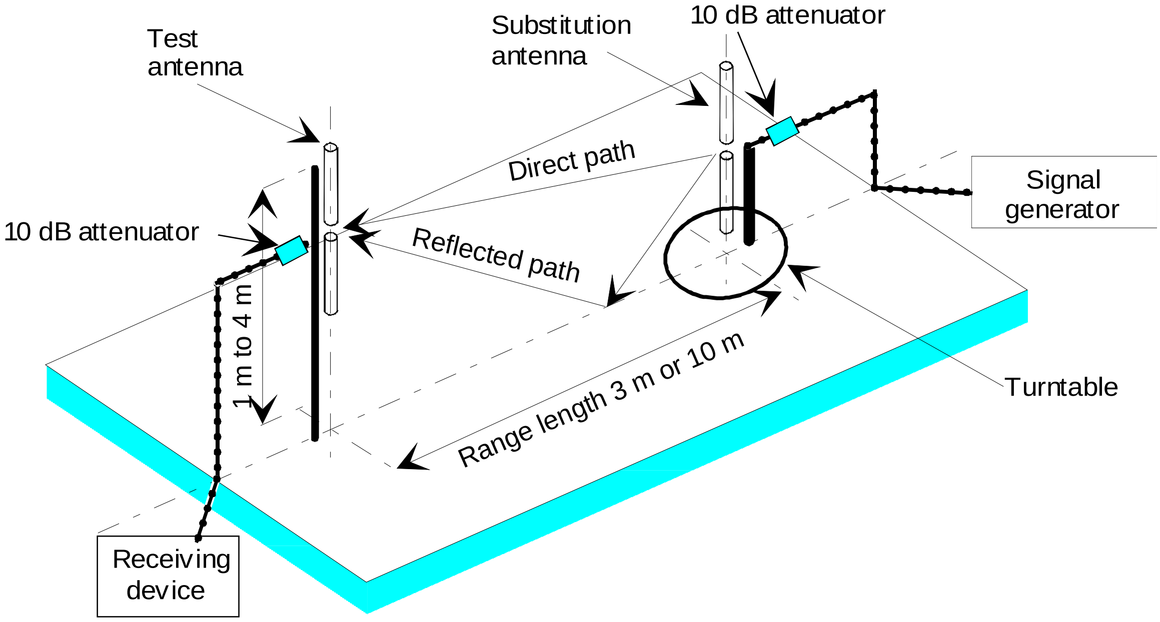


Figure 40: Open Area Test Site set-up for the Effective radiated power substitution measurement

16 The EUT should be remounted on the turntable as stipulated in steps 2, 3 and 4, the test antenna oriented for horizontal polarization and steps 5 to 15 repeated with the substitution antenna also oriented for horizontal polarization.

7.2.2.3.3 Procedure for completion of the results sheets

There are two values that need to be derived before the overall results sheet (table 16) can be completed. These are the overall measurement correction and the expanded uncertainty values.

Guidance for deriving the values of the correction factors is given in table 14.

When the correction factors have been derived, they should be entered on page 2 of the log book results sheet (table 15) as a result of which the overall correction can be calculated as follows:

overall correction = substitution antenna cable loss

+ substitution antenna attenuator loss

+ substitution antenna balun loss

+ mutual coupling and mismatch loss (where applicable)

+ correction for measurement distance

+ correction for off-boresight elevation angles

- gain of substitution antenna

NOTE: For frequencies greater than 180 MHz the mutual coupling mismatch loss factor should be taken as 0,00 dB.

The resulting value for the overall correction factor should then be entered on page 2 of the log book result sheet (table 15). The effective radiated power can then be calculated:

effective radiated power =signal generator output level

- reduction in the input attenuation of receiving device (if any)

+ overall correction

The only calculation that remains to be performed before the overall results sheet (table 16) can be completed is the determination of the expanded measurement uncertainty. This should be carried out in accordance with TR 100 028-2 [7], subclause 7.2.2.3 and the resulting value entered in the overall results sheet (table 16).

Table 14: Guidance for deriving correction factors

Figures for correction factors:
Substitution antenna cable loss: Obtained directly from the calibration data.
Substitution antenna attenuator loss: Obtained from calibration data.
Substitution antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss factors between the test antenna and substitution antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A.20. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Measurement distance: for different heights of the test antenna. The correction is the difference between the values for the 2 heights (if different) in the 2 stages of the test. A value for each height should be taken from annex A: figure A.7. Value 1 (height for the measurement on the EUT).......................dB Value 2 (height for the substitution measurement)....................dB Correction value is: (value 2 - value 1) dB
Off boresight angle in elevation plane (for vertically polarized case only): for different heights of the test antenna. The correction is the difference between the values for the 2 heights (if different) in the 2 stages of the test. A value for each height should be taken from annex A: figure A.8. Value 1 (height for the measurement on the EUT).......................dB Value 2 (height for the substitution measurement)....................dB Correction value is: (value 2 - value 1) dB NOTE: For horizontally polarized tests this is 0,00 dB.
Gain of substitution antenna: For ANSI dipoles (30 MHz to 1 000 MHz) the value is 2,10 dBi. For other types, the value can be obtained from calibration data.

7.2.2.3.4 Log book entries

Table 15: Log book results sheet

EFFECTIVE RADIATED POWER		**Date:**			**PAGE 1 of 2**
Temperature:...................................... °C **Manufacturer of EUT: ....** **Bandwidth of Receiving Device: ....Hz**	**Humidity: .... %** **Type No: ....**		**Frequency: .... MHz** **Serial No:...................**		
Range length:...					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor/gain**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Substitution antenna				N/A	
Substitution antenna attenuator					N/A
Substitution antenna cable					N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Ferrite beads			N/A	N/A	N/A
Mounting configuration of EUT					

EFFECTIVE RADIATED POWER		Date:	PAGE 2 of 2
Vertical polarization		**Horizontal polarization**	
Height of the phase centre, antenna attachment point or volume centre of the EUT		Height of the phase centre, antenna attachment point or volume centre of the EUT	
Height of test antenna (EUT measurement)		Height of test antenna (EUT measurement)	
Maximum signal level on receiving device	dBm	Maximum signal level on receiving device	dBm
Angle at which the maximum signal is received		Angle at which the maximum signal is received	
Height of test antenna (substitution measurement)		Height of test antenna (substitution measurement)	
Output level from signal generator into substitution antenna	dBm	Output level from signal generator into substitution antenna	dBm
Change in receiver attenuator	dB	Change in receiver attenuator	dB
Correction factors			
Substitution antenna cable loss		Substitution antenna cable loss	
Substitution antenna attenuator loss		Substitution antenna attenuator loss	
Substitution antenna balun loss		Substitution antenna balun loss	
Mutual coupling and mismatch loss (30 MHz - 180 MHz)		Mutual coupling and mismatch loss (30 MHz - 180 MHz)	
Measurement distance		Measurement distance	
Off boresight in elevation plane		Off boresight in elevation plane	
Gain of the substitution antenna		Gain of the substitution antenna	
Overall measurement correction	dB	Overall measurement correction	dB

7.2.2.3.5 Statement of results

The results should be presented in tabular form as shown in table 16.

Table 16: Overall results sheet

EFFECTIVE RADIATED POWER		Date:	PAGE 1 of 1
Vertical polarization		**Horizontal polarization**	
Effective radiated power	dBm	Effective radiated power	dBm
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)	dB

7.2.2.4 Stripline

The effective radiated power test is not normally carried out in a stripline test facility.

7.2.2.5 Test Fixture

7.2.2.5.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;

- Receiving device (measuring receiver or spectrum analyser).

The type and serial numbers of all items of test equipment should be recorded in the log book results sheet (table 17).

7.2.2.5.2 Method of measurement

1 The measurement should always be performed in the absence of modulation.

2 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of effective radiated power should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

a) the EUT by itself on the accredited Free-Field Test Site;

b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

c) the power measured at the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

d) the power measured at the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

The value recorded for configuration b) during the verification procedure should be entered in the log book results sheet (table 17).

3 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This position should be recorded in the log book results sheet (table 17).

4 The Test Fixture/EUT assembly should be connected to the test equipment as shown in figure 41.

5 Normal conditions (as defined in the relevant standard) should exist within the climatic facility.

6 The EUT should be switched on without modulation, allowed time to stabilize and the receiving device tuned to the appropriate frequency.

7 The signal level detected on the receiving device should be recorded (dBm) in the log book results sheet (table 17).

8 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

9 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 1: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 2: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

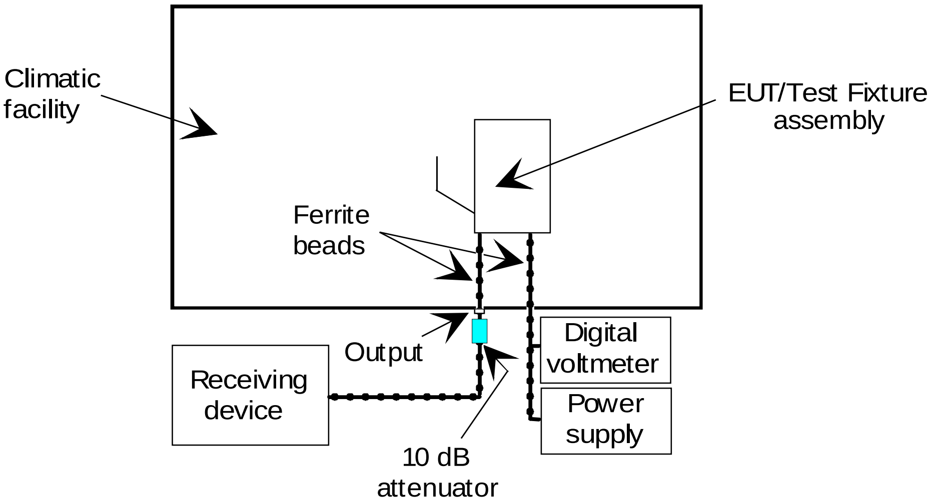


Figure 41: Set-up for Effective radiated power measurement using a Test Fixture

10 The EUT should be switched on and its supply voltage should be set to the upper extreme as given in the relevant standard. Step 7 should then be repeated.

11 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant standard. Step 7 should then be repeated.

12 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

13 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 3: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 4: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

14 The EUT should be switched on and its supply voltage should be set to the lower extreme as given in the relevant standard. Step 7 should then be repeated.

15 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant standard. Step 7 should then be repeated.

16 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

7.2.2.5.3 Procedure for completion of the results sheets

Because the measurement of effective radiated power in a Test Fixture is a relative measurement with all circuit components remaining present during all the tests, no corrections to measured values are required.

However, a calculation does have to be performed within the overall results sheet (table 18) in order to relate the measured values of received signal level to the effective radiated power measurement on the accredited Free-Field Test Site. For each value of received signal level measured in this procedure, the effective radiated power is derived by adding to it the difference between the accredited Free-Field Test Site value and the received signal level in the climatic facility under normal conditions of both temperature and voltage i.e.:

effective radiated power for T( ), V( ) = *received signal level for T ( ), V( )*

+ *effective radiated power on accredited Free-Field Test Site for T (n), V (n)*

- *received signal level for T (normal), V (normal)*

The final value that needs to be derived for inclusion in the overall results sheet (table 18) is the expanded measurement uncertainty. This should be calculated in accordance with TR 100 028-2 [7], subclause 7.2.2.5.

7.2.2.5.4 Log book entries

Table 17: Log book results sheet

EFFECTIVE RADIATED POWER		**Date:**		**PAGE 1 of 2**
Temperature: .... °C **Manufacturer of EUT: ....** **Bandwidth of Receiving Device: ....Hz**	**Humidity: .... %** **Type No: ....**		**Frequency: ....MHz** **Serial No:...............................**	
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
RF cable to receiver input				
RF cable within climatic facility				
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
Receiving device				N/A
Result of measurement on accredited Free-Field Test Site: Type of test site:.. Effective radiated power (dBm):............................				
Mounting configuration of EUT				

	Temperature/Voltage				
	T(normal)	T(high)		T(low)	
	V(normal)	V(high)	V(low)	V(high)	V(low)
Received signal level dBm					

7.2.2.5.5 Statement of results

The results are presented in tabular form as shown in table 18.

Table 18: Overall results sheet

EFFECTIVE RADIATED POWER	Date:				PAGE 1 of 1
	Temperature/Voltage				
	T(normal)	T(high)		T(low)	
	V(normal)	V(high)	V(low)	V(high)	V(low)
Effective radiated power dBm					
Expanded uncertainty (95 %)	dB				

7.2.3 Radiated spurious emissions (30 MHz to 4 GHz or 12,75 GHz)

Definition

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal modulation.

The level of a spurious emission should be measured as either:

- the effective radiated power of the cabinet and integral antenna together, in the case of EUTs not fitted with an external antenna connector; or
- the effective radiated power of the cabinet and structure of the equipment combined (this is termed cabinet radiation) in the case of EUTs fitted with a external antenna connector.

7.2.3.1 Anechoic Chamber

7.2.3.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Anechoic Chamber;
- Shielded chamber (Non-Anechoic);
- Broadband test antenna (biconic, typically 30 MHz to 200 MHz, LPDAs, typically 200 MHz to 1 GHz and 1 GHz to 12,75 GHz or waveguide horns, typically 1 GHz to 12,75 GHz);
- Substitution antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended 30 MHz to 1 000 MHz and waveguide horns for 1 GHz to 12,75 GHz);
- Receiving device (measuring receiver or spectrum analyser);
- Signal generator;
- High "Q" notch filter and high pass filter - only for tests on equipment not fitted with a permanent antenna connector;
- 50 Ω load - only for tests on EUTs fitted with a permanent antenna connector. This load should perform well throughout the entire frequency band (typically VSWR 1,25:1 up to 1 000 MHz, better than 2,0:1 for 1 GHz to 4 GHz or 12,75 GHz). It should be able to absorb the maximum carrier power at the nominal frequency of the EUT.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 20).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz -400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

7.2.3.1.2 Method of measurement

Characterization

The process of characterization should take place within a shielded, reflecting enclosure where no absorbing material is present.

C1 The EUT should be mounted on a non-conducting turntable of low relative dielectric constant (preferably less than 1,5) material(s) in a shielded enclosure. (i.e. no absorber).

C2 The test equipment should be arranged as shown in figure 42. The protecting filter should only be used for EUTs which are not fitted with an external antenna connector or if the cabinet radiation is expected to be very high. For those which do have such a connector, the broadband 50 Ω load should be connected to the EUT and the filter becomes unnecessary.

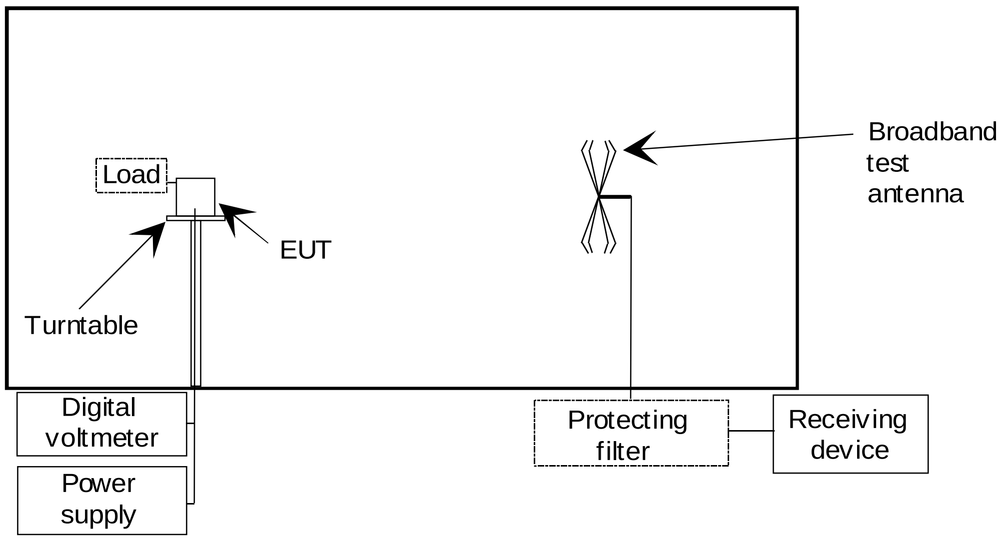


Figure 42: Elevation view of shielded chamber set up for the characterization tests

C3 The EUT should be mounted in the position closest to normal use as declared by the manufacturer. This mounting configuration should be recorded on page 1 of the log book results sheet (table 20).

C4 The broadband test antenna should be aligned for vertical polarization and spaced a convenient distance away from the EUT.

NOTE 1: For the purposes of this characterization procedure, the range length does not have to meet the conditions for far-field testing given earlier.

C5 The EUT should be switched on, without modulation, and the receiving device scanned through the appropriate frequency band, avoiding the carrier frequency and its adjacent channels. All frequencies producing a response on the receiving device should be recorded on page 2 of the log book results sheet (table 20).

NOTE 2: The test antenna should be changed as necessary to ensure that the complete frequency range is covered.

C6 The broadband test antenna should be aligned for horizontal polarization and step C5 repeated.

NOTE 3: The only information provided by the characterization procedure is which frequencies should be measured in the Anechoic Chamber.

Measurement

NOTE 4: The following procedure steps involve, for every frequency identified in the characterization procedure, scanning for the peak of the spurious emission in both horizontal and vertical planes around the EUT. The amplitude peak in both planes is measured in both horizontal and vertical polarizations. Large EUTs, however, may possess highly directional spurious emissions particularly at high frequencies and, despite the two plane scanning, there remains for these cases, a small possibility that no spurious can be detected.

1 The measurement should always be performed in the absence of modulation.

2 The EUT should be mounted directly onto the turntable, whose surface is at the height specified in the relevant standard or, where not stated, at a convenient height within the "quiet zone" of the Anechoic Chamber. The EUT should be mounted in an orientation which matches that of its normal usage as stated by the manufacturer. The normal to the reference face of the EUT should point directly down the chamber towards the test antenna support. This is the 0° reference angle for the test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 20). The items of test equipment should be set-up as shown in figure 43.

NOTE 5: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 The EUT should be positioned such that its volume centre lies on the axis of rotation of the turntable and either on the central axis of the chamber or at a convenient height within the quiet zone. See figure 43. The offset from the central axis of the volume centre should be entered on page 2 of the log book results sheet (table 20).

4 For EUTs fitted with an external antenna connector, the broadband 50 Ω load should be connected in place of the antenna.

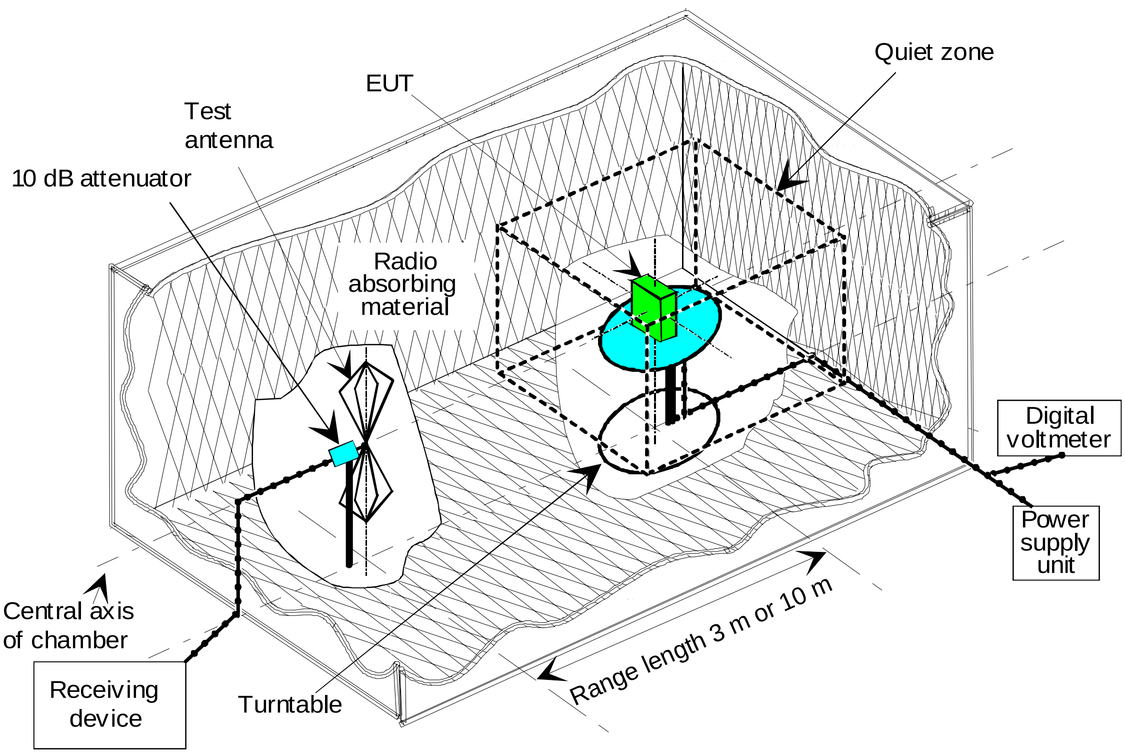


Figure 43: Anechoic Chamber set up for Spurious emissions testing on the EUT

5 The test antenna (biconic, LPDA or waveguide horn) should be oriented for vertical polarization. Its output should be connected to the receiving device via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber, and a protective filter (only if the EUT does not possess an external antenna connector). The height of the phase centre of the test antenna should be at the same offset (as recorded in step 3) from the central axis of the chamber as the volume centre of the EUT, so that the measurement axis is parallel to the central axis.

NOTE 6: The measurement axis is the straight line between the phase centres of transmitting and receiving devices.

6 The EUT should be switched on, without modulation, and the receiving device tuned to the first frequency recorded on page 2 of the log book results sheet (table 20).

7 The EUT should be rotated through 360º in the azimuth plane until the maximum signal level is observed on the receiving device. The corresponding received level (dBm_1) and the angle of the turntable ($angle_1$) should be recorded on page 2 of the log book results sheet (table 20).

8 The polarization of the test antenna should be changed to horizontal and the received signal level (dBm_2) again recorded on page 2 of the log book results sheet (table 20). If this value of signal level is more than 20 dB below that measured in step 7, the peak of this spurious, to be entered on page 2 of the log book results sheet (table 20) as "Spurious level 1", is simply the level measured in step 7. Equally, if dBm_2 exceeds dBm_1 by more than 20 dB, "Spurious level 1" is simply dBm_2. Alternatively, the spurious level should be calculated as:

$$\textit{Spurious level}\ 1 = 20\log\left(10^{\left(\frac{dBm_1}{20}\right)} + 10^{\left(\frac{dBm_2}{20}\right)}\right) \text{dBm}$$

The resulting value should be entered in the log book results sheet as "Spurious level 1".

9 Retaining the test antenna polarization (horizontal), the EUT should be rotated about its volume centre to lie on its side as shown in figure 44. The EUT should again be rotated through 360º in the azimuth plane until the maximum signal level is observed on the receiving device. The corresponding received level (dBm_3) and the angle of the turntable ($angle_2$) should be recorded on page 2 of the log book results sheet (table 20).

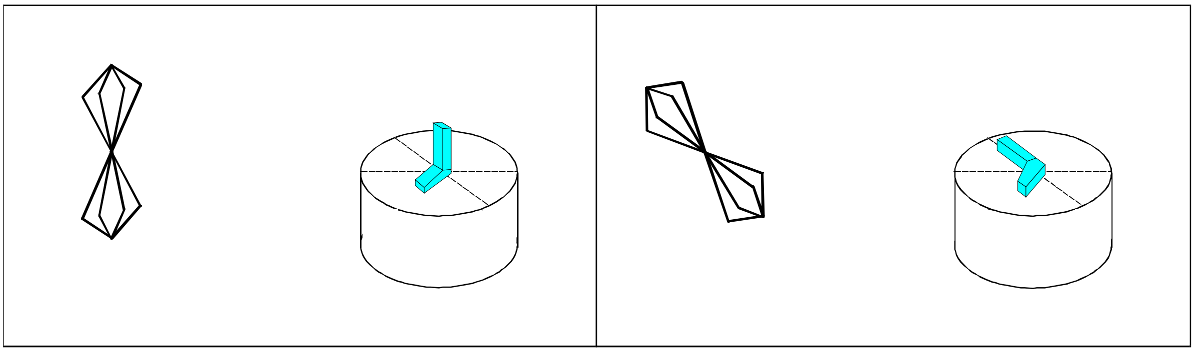


Figure 44: Turning the EUT

10 The polarization of the test antenna should be changed to vertical and the received signal level (dBm_4) again recorded on page 2 of the log book results sheet (table 20). If this value of signal level is more than 20 dB below that measured in step 9, the peak of this spurious, to be entered on page 2 of the log book results sheet (table 20) as "Spurious level 2", is simply the level measured in step 9. Equally, if dBm_4 exceeds dBm_3 by more than 20 dB, "Spurious level 2" is simply dBm_4. Alternatively, the spurious level should be calculated as:

$$\textit{Spurious level}\ 2 = 20\log\left(10^{\left(\frac{dBm_3}{20}\right)} + 10^{\left(\frac{dBm_4}{20}\right)}\right) \text{dBm}$$

The resulting value should be entered in the log book results sheet as "Spurious level 2".

Whichever value is the larger of "Spurious level 1" and "Spurious level 2" should be entered as "Overall spurious level" on page 2 of the log book results sheet (table 20).

11 The EUT should be replaced on the turntable by the substitution antenna (a tuned half wavelength dipole which has been adjusted to correspond to the appropriate frequency or waveguide horn). See figure 45.

NOTE 7: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

12 The phase centre of the substitution antenna should lie directly over the axis of rotation of the turntable, whilst its height should be at the same offset (as recorded in step 3) from the central axis of the chamber, so that the measurement axis is again parallel to the central axis.

NOTE 8: The phase centre of a dipole is in the centre of its two rods and for a waveguide horn it is in the centre of its open mouth.

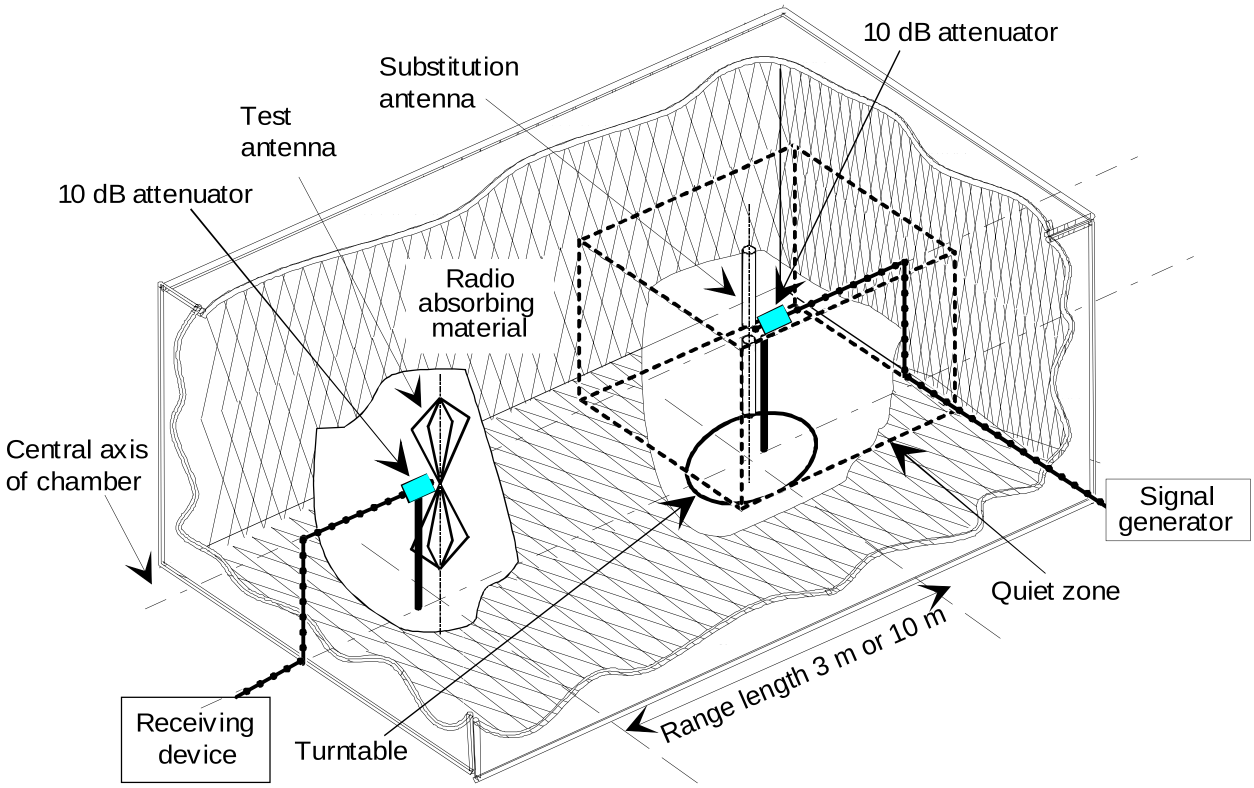


Figure 45: Substitution antenna replacing the EUT for spurious emission testing in an Anechoic Chamber

13 The substitution antenna should be oriented for vertical polarization and connected to a calibrated signal generator via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber.

14 The signal generator should be tuned to the appropriate frequency and its output level adjusted until the level measured on the receiving device, is at least 20 dB above the level with the output from the signal generator switched off.

15 The substitution antenna should be rotated until the maximum level is detected on the receiving device.

NOTE 9: This is to correct for possible misalignment of a directional beam (i.e. as produced by waveguide horns in all tests and by dipoles when used in horizontally polarized tests only). This step can be omitted for dipoles used in vertically polarized tests.

16 The output level of the signal generator should be adjusted until the level, measured on the receiving device, is identical to the "Overall spurious level" recorded in step 10. This output signal level should be recorded (dBm_5) on page 2 of the log book results sheet (table 20).

NOTE 10: In the event of insufficient range of signal generator output level, the input attenuation to the receiving device should be decreased to compensate. The signal generator output level (dBm_6) and the change in attenuation (dB, where a decrease is taken as +dB, an increase is taken as -dB) should be recorded on page 2 of the log book results sheet (table 20).

17 Steps 2 to 16 should be repeated for all the other frequencies recorded in the log book results sheet (table 20), changing the antennas as necessary.

7.2.3.1.3 Procedure for completion of the results sheets

There are several values that remain to be entered in the overall results sheet (table 21). These are the overall spurious emission levels (corrected for the systematic offsets involved in the measurement) and the expanded measurement uncertainty.

Guidance for deriving the values of the correction factors is given in table 19.

When the correction factors have been derived, they should be entered on page 2 of the log book results sheet (table 20). The overall correction for each spurious frequency can be calculated as follows:

overall correction = substitution antenna cable loss

+ substitution antenna attenuator loss

+ substitution antenna balun loss

+ mutual coupling and mismatch loss (where applicable)

- gain of substitution antenna

NOTE: For frequencies greater than 180 MHz the mutual coupling and mismatch loss factor should be taken as 0,00 dB.

The resulting values should be entered on page two of the results sheet (table 20) and the effective radiated power of each spurious emission calculated from:

spurious ERP = signal generator output level

- reduction in the input attenuation of receiving device (if any)

+ overall correction

Each value of spurious emission effective radiated power should be entered on page 2 of the log book results sheet (table 20) and in the overall results sheet (table 21).

The final value to be entered in the overall results sheet (table 28) is that for the expanded uncertainty; this should be carried out as given in TR 100 028-2 [7], subclause 7.2.3.1 and the resulting value entered in the overall results sheet (table 21).

Table 19: Guidance for deriving correction factors

Figures for correction factors:
Substitution antenna cable loss: Obtained directly from the calibration data.
Substitution antenna attenuator loss: Obtained from calibration data.
Substitution antenna balun loss: For dipoles: if not known from calibration data, the value should be taken as 0,30 dB. For waveguide horns: taken as 0,00 dB.
Mutual coupling and mismatch loss factors between the test antenna and substitution antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A.19. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles and waveguide horns this value is 0,00 dB.
Gain of substitution antenna: For ANSI dipoles (30 MHz to 1 000 MHz) the value is 2,10 dBi. For other types of antennas (non-ANSI dipoles or waveguide horns), the value can be obtained from calibration data.

7.2.3.1.4 Log book entries

Table 20: Log book results sheet

SPURIOUS EMISSIONS **Date:** **PAGE 1 of 2**					
Temperature:.................................°C **Humidity: .... %** **Frequency:......................... MHz** **Manufacturer of EUT: ....** **Type No: ....** **Serial No: ....** **Bandwidth of Receiving Device: ....Hz**					
Range length:..					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor/gain**
Broadband test antenna (typically 30 MHz to 200 MHz)				N/A	
Broadband test antenna (typically 200 MHz to 1 GHz)				N/A	
Broadband test antenna (typically 1 to 12,75 GHz)				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Substitution antenna (typically ANSI C63.5 (1988) [11] 30 MHz to 1 000 MHz)				N/A	
Substitution antenna (typically waveguide horns 1 GHz to 12,75 GHz)				N/A	
Substitution antenna attenuator					N/A
Substitution antenna cable					N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Ferrite beads			N/A	N/A	N/A
High "Q" notch filter					N/A
High pass filter					N/A
Mounting configuration of EUT (Characterization)					
Mounting configuration of EUT (Measurement)					

SPURIOUS EMISSIONS	**Date:**					**PAGE 2 of 2**
Offset of volume centre of the EUT from the central axis of the chamber:……………..m							
Frequency (MHz)							
dBm_1							
$angle_1$							
dBm_2							
Spurious level 1 (dBm)							
dBm_3							
$angle_2$							
dBm_4							
Spurious level 2 (dBm)							
Overall spurious level (dBm)							
Signal generator output level dBm_5 (dBm)							
Change in attenuator level (dB)							
Spurious emission ERP (dBm)							
Correction factors							
Frequency (MHz)							
Substitution antenna cable loss							
Substitution antenna attenuator loss							
Substitution antenna balun loss							
Mutual coupling and mismatch loss (30 MHz - 180 MHz)							
Gain of the substitution antenna							
Overall measurement correction	dB	dB	dB	dB	dB	dB	dB

7.2.3.1.5 Statement of results

The results should be presented in tabular form as shown in table 21.

Table 21: Overall results sheet

SPURIOUS EMISSIONS	**Date:**					**PAGE 1 of 1**	
Frequency (MHz)							
Spurious emission ERP (dBm)							
Expanded uncertainty (95 %)	dB	dB	dB	dB	dB	dB	dB

7.2.3.2 Anechoic Chamber with a ground plane

For Spurious emission testing in an Anechoic Chamber with a ground plane reference should be made to the Open Area Test Site test method (subclause 7.2.3.3), since the procedures are identical.

The test equipment set-up for the EUT measurement is shown in figure 46 whilst the set-up for the substitution part of the test is shown in figure 47.

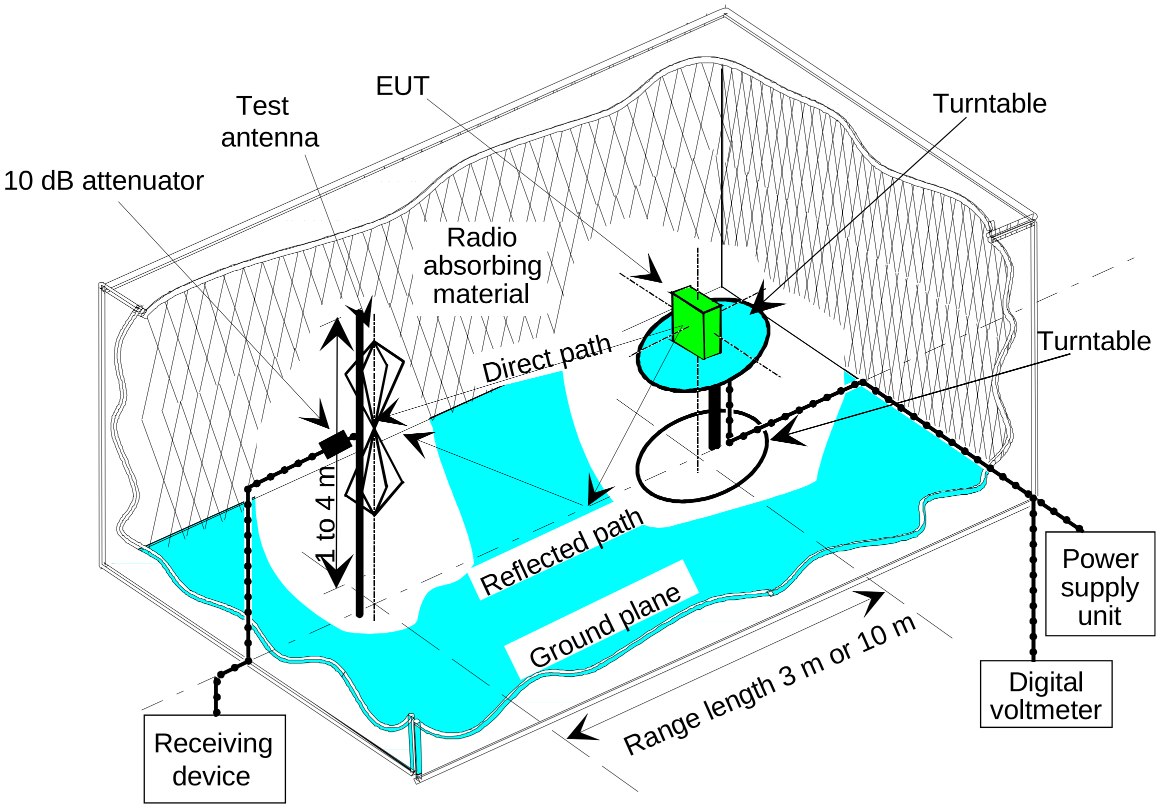


Figure 46: Anechoic Chamber with a ground plane set-up for Spurious emission testing on the EUT

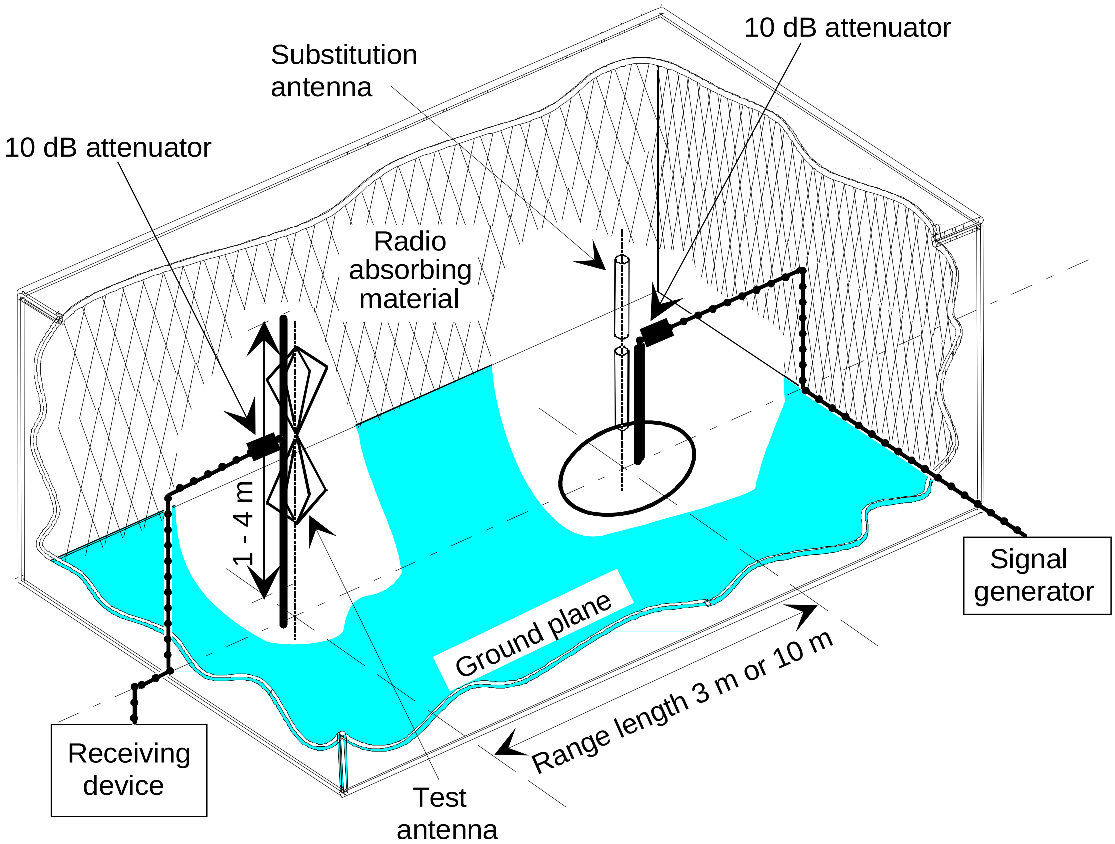


Figure 47: Substitution antenna replacing the EUT for Spurious emission testing in an Anechoic chamber with a ground plane

To complete the overall results sheet for this test, the value for expanded measurement uncertainty should be calculated according to TR 100 028-2 [7], subclause 7.2.3.2.

7.2.3.3 Open Area Test Site

7.2.3.3.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB Attenuators;
- Power supply;
- Connecting cables;
- Open Area Test Site;
- Shielded chamber (Non-Anechoic);
- Broadband test antenna (biconic, typically 30 MHz to 200 MHz, LPDAs, typically 200 MHz to 1 GHz and 1 GHz to 12,75 GHz or waveguide horns, typically 1 GHz to 12,75 GHz));
- Substitution antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended 30 MHz to 1 000 MHz and waveguide horns 1 GHz to 12,75 GHz);
- Receiving device (measuring receiver or spectrum analyser);
- Signal generator;

- High "Q" notch filter and high pass filter - only for tests on EUTs not fitted with a permanent antenna connector;
- 50 Ω load - only for tests on EUTs fitted with a permanent antenna connector. This load should perform well throughout the entire frequency band (typically VSWR 1,25:1 up to 1 000 MHz, better than 2,0:1 over 1 GHz to 4 GHz or 12,75 GHz). It should be able to absorb the maximum carrier power at the nominal frequency of the EUT.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 23).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

7.2.3.3.2 Method of measurement

Characterization

The process of characterization should take place within a shielded, reflecting enclosure where no absorbing material is present.

C1 The EUT should be mounted on a non-conducting turntable of low relative dielectric constant (preferably less than 1,5) material(s) in a shielded enclosure. (i.e. no absorber).

C2 The test equipment should be arranged as shown in figure 48. The protecting filter should only be used for EUT which are not fitted with an external antenna connector or if expected cabinet radiation is very high. For those which do have such a connector, the broadband 50 Ω load should be connected to the EUT and the filter becomes unnecessary.

C3 The EUT should be mounted in the position closest to normal use as declared by the manufacturer. This mounting configuration should be recorded on page 1 of the log book results sheet (table 23).

C4 The broadband test antenna should be aligned for vertical polarization and spaced a convenient distance away from the EUT.

NOTE 1: For the purposes of this characterization procedure, the range length does not have to meet the conditions for far-field testing given earlier.

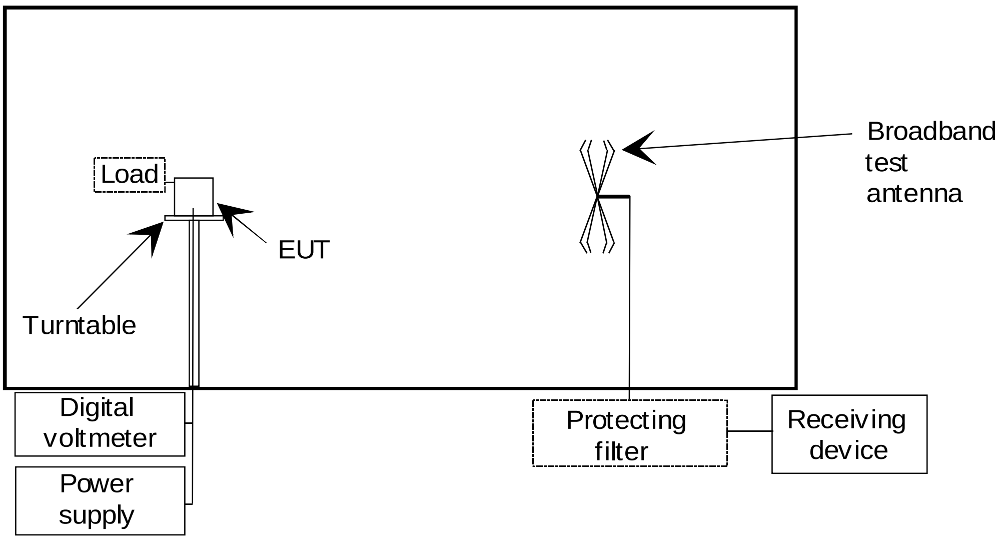


Figure 48: Elevation view of shielded chamber set up for the characterization tests

C5 The EUT should be switched on, without modulation, and the receiving device scanned through the appropriate frequency band, avoiding the carrier frequency and its adjacent channels. All frequencies producing a response on the receiving device should be recorded on page 2 of the log book results sheet (table 23).

NOTE 2: The test antenna should be changed as necessary to ensure that the complete frequency range is covered.

C6 The broadband test antenna should be aligned for horizontal polarization and step C5 repeated.

NOTE 3: The only information provided by the characterization procedure is which frequencies should be measured on the Open Area Test Site.

Measurement

NOTE 4: The following procedure steps involve, for every frequency identified in the Characterization procedure, scanning for the peak of the spurious emission in both horizontal and vertical planes around the EUT. The amplitude peak in both planes is measured in both horizontal and vertical polarizations. Large EUTs, however, may possess highly directional spurious emissions particularly at high frequencies and, despite the two plane scanning, there remains for these cases, a small possibility that no spurious can be detected.

1 The measurement should always be performed in the absence of modulation.

2 The EUT should be mounted directly onto the turntable whose mounting surface is at the height (above the ground plane) specified in the relevant Standard. The items of test equipment should be set-up as shown in figure 49.

NOTE 5: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 The EUT should be mounted in an orientation which matches that of its normal usage as declared by the manufacturer. The normal to the reference face of the EUT should point directly down the test site towards the antenna mast. This is the 0° reference angle for this test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 23).

4 The volume centre of the EUT should be positioned on the turntable such that it lies on the axis of rotation of the turntable.

5 The height above the ground plane of the volume centre of the EUT should be recorded on page 2 of the log book results sheet (table 23).

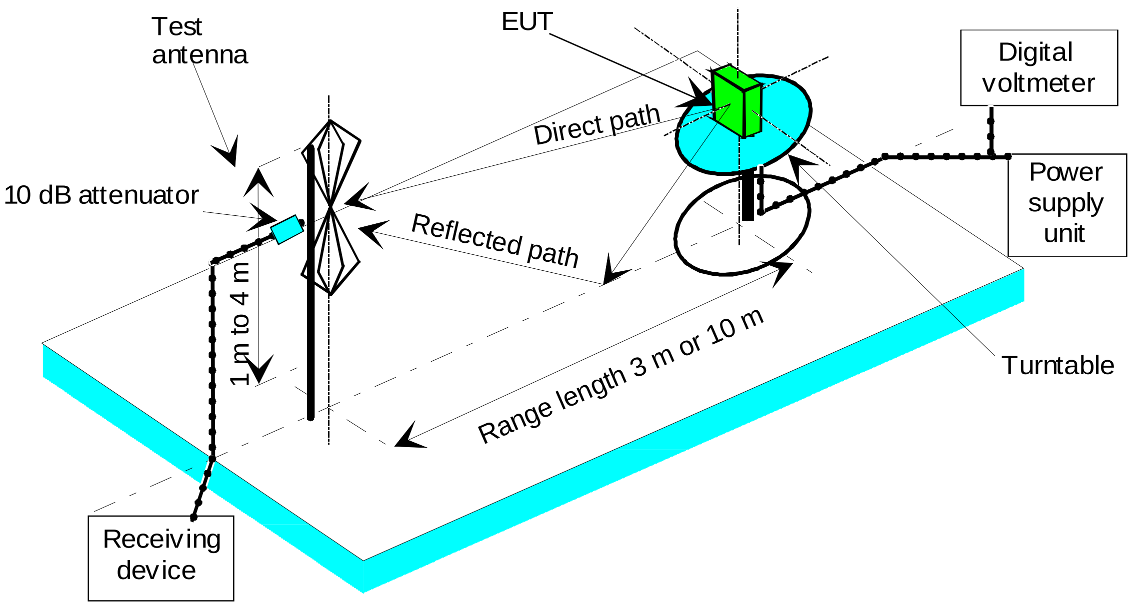


Figure 49: Open Area Test Site set-up for spurious emission testing on the EUT

6 For EUTs fitted with a permanent antenna connector, the broadband 50 Ω load should be connected in place of the antenna.

7 The test antenna (a biconic, LPDA or waveguide horn) should be mounted on the antenna mast and oriented for vertical polarization. Its output should be connected to the receiving device via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site, and a protective filter (if the EUT does not possess an external antenna connector).

8 The EUT should be switched on, without modulation, and the receiving device tuned to the first frequency recorded on page 2 of the log book results sheet (table 23).

9 The test antenna should be raised and lowered through the specified range of heights (1 m- 4 m, ensuring that no part of the antenna is less than 0,25 m from the ground plane at any time) until the maximum signal level is detected on the receiving device.

NOTE 6: The true maximum may lie beyond the top of the mast, in which case the maximum receivable level should be at the top of the height range.

10 The EUT should be rotated through 360º in the azimuth plane until the maximum signal level is observed on the receiving device. The corresponding received level (dBm_1), height of the test antenna on the mast ($height_1$) and angle of the turntable ($angle_1$) should be recorded on page 2 of the log book results sheet (table 23). Retaining the same height of the test antenna on the mast and angle of turntable, the power to the EUT should be turned off and the value of the level of the noise floor (amb_1) for the receiving device recorded on page 2 of the log book results sheet (table 23).

11 The polarization of the test antenna should be changed to horizontal, the antenna height on the mast readjusted for maximum signal and the resulting received signal level (dBm_2) and the new height of the antenna on the mast ($height_2$) recorded on page 2 of the log book results sheet (table 23). Again, by turning off the power to the EUT, a value for the level of the noise floor (amb_2) for the receiving device should be recorded on page 2 of the log book results (table 23).

12 Retaining the test antenna polarization (horizontal), the EUT should be rotated about its volume centre to lie on its side as shown in figure 50. The height of the test antenna on the mast should be adjusted for maximum received signal level. Using the turntable, the EUT should then be rotated through 360º in the azimuth plane to locate the angle of at which the maximum received signal level is again found. This maximum received level (dBm_3), the height of the test antenna on the mast ($height_3$) and the angle of the turntable ($angle_2$) should be recorded on page 2 of the log book results sheet (table 23). Retaining the same height of the test antenna on the mast and angle of turntable, the power to the EUT should be turned off and the value of the level of the noise floor (amb_3) for the receiving device recorded on page 2 of the log book results sheet (table 23).

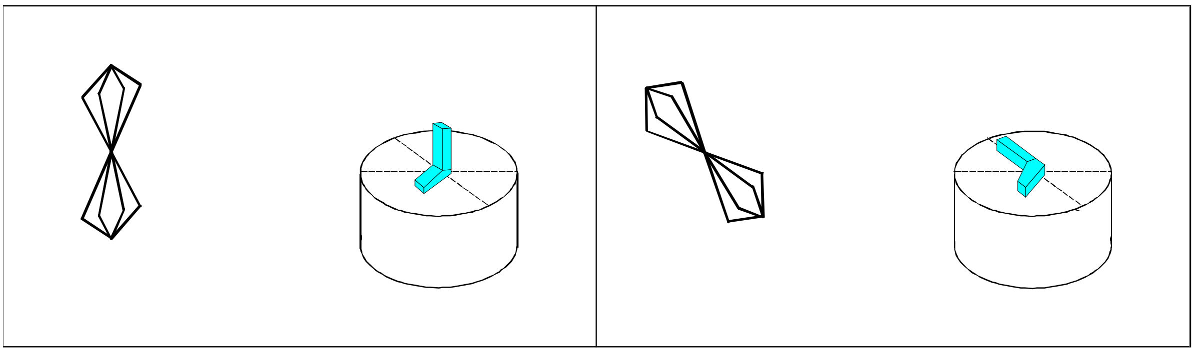


Figure 50: Turning the EUT

13 The polarization of the test antenna should be changed to vertical, the antenna height on the mast readjusted for maximum signal and the resulting received signal level (dBm_4) and the new height of the antenna on the mast ($height_4$) recorded on page 2 of the log book results sheet (table 23). Again, by turning off the power to the EUT, a value for the level of the noise floor (amb_4) for the receiving device should be recorded on page 2 of the log book results (table 23).

14 The EUT should be replaced on the turntable by the substitution antenna (a tuned half wavelength dipole which has been adjusted to correspond to the appropriate frequency or waveguide horn). See figure 51.

NOTE 7: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

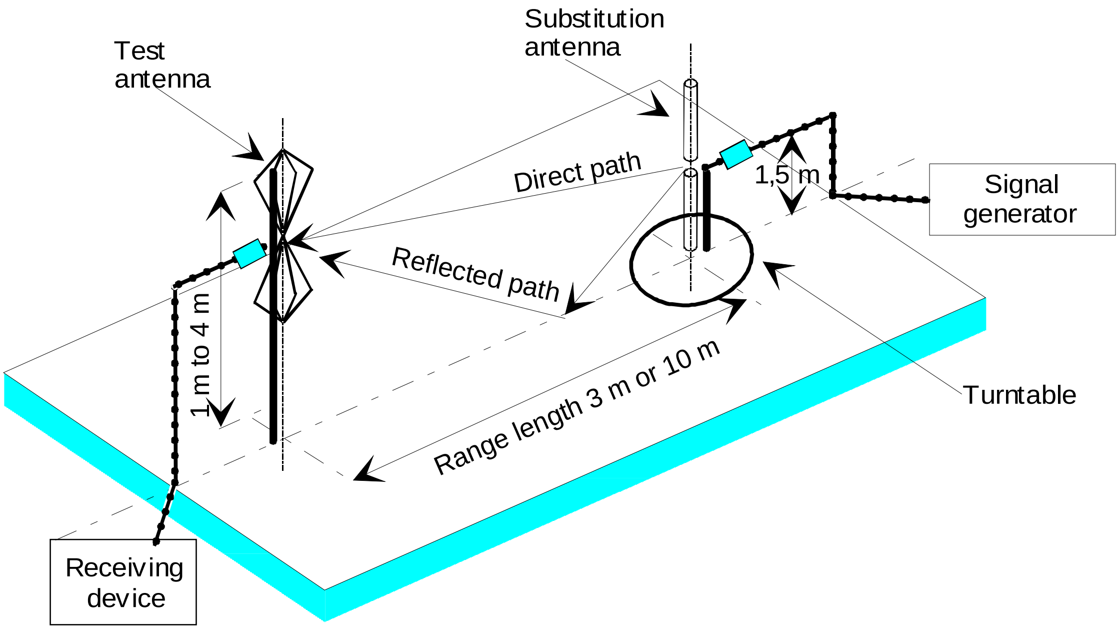


Figure 51: Substitution antenna replacing the EUT for Spurious emissions testing on an Open Area Test Site

15 The phase centre of the substitution antenna should be located at the same height above the floor as noted in step 5 and should lie directly on the axis of rotation of the turntable.

NOTE 8: The phase centre of a dipole is in the centre of its two rods. That for a waveguide horn is in the centre of its open mouth.

16 The substitution antenna should be oriented for vertical polarization and connected to a calibrated signal generator via a 10 dB attenuator and the calibrated, ferrited, coaxial cable associated with that end of the test site.

17 The signal generator should be tuned to the appropriate frequency and its output level adjusted until the level measured on the receiving device, is at least 20 dB above the level with the output from the signal generator switched off.

18 The test antenna should be raised and lowered through the specified range of heights until the maximum signal level is recorded on the receiving device. The height of the test antenna on the mast ($height_5$) should be recorded on page 2 of the log book results sheet (table 23).

NOTE 9: The true maximum may lie beyond the top of the mast, in which case the maximum receivable level should be at the top of the height range.

19 The substitution antenna should be rotated until the maximum level is detected on the receiving device.

NOTE 10: This is to correct for possible misalignment of a directional beam (i.e. as produced by waveguide horns in all tests and by dipoles when used in horizontally polarized tests only). This step can be omitted for dipoles used in vertically polarized tests.

20 The output level of the signal generator should be adjusted until the level, measured on the receiving device, is the same as the larger of dBm_1 and dBm_4. This output signal level (dBm_5) should be recorded on page 2 of the log book results sheet (table 23).

NOTE 11: In the event of insufficient range of signal generator output level, the input attenuation to the receiving device should be decreased to compensate. The signal generator output level (dBm_5) and the change in attenuation (dB_1, where a decrease is taken as +dB, an increase is taken as -dB) should be recorded on page 2 of the log book results sheet (table 23).

21 The test antenna and the substitution antenna should both be oriented for horizontal polarization and steps 17 to 20 repeated. This time, $height_6$ is recorded in step 18 and dBm_6 and dB_2 recorded in step 20 after adjustment of the signal generator output level until the receiving device level is the larger of dBm_2 and dBm_3.

22 Steps 1 to 21 should be repeated for all the other frequencies recorded in the log book results sheet (table 23) changing the antennas as necessary.

7.2.3.3.3 Procedure for completion of the results sheets

There are several values that remain to be entered in the overall results sheet (table 24). These are the overall spurious emission levels (corrected for the systematic offsets involved in the measurement) and the expanded measurement uncertainty.

Initially, the overall correction factors for each of the two polarizations should be calculated. Then, all received signal levels (i.e. dBm_1 to dBm_4) should be corrected to convert them into effective radiated power figures, the corrections not only accounting for the systematic offsets (cable losses, attenuator loss, etc.) but also for the different measurement distances and off boresight elevation angles involved. All corrections should be made relating the measurement to the corresponding substitution measurement for that polarization.

Table 22 lists all the correction factors involved in this procedure along with giving guidance on how their values can be obtained. It should be noted that some values differ depending on the polarization considered.

Table 22: Guidance for deriving correction factors

Figures for correction factors
Substitution antenna cable loss: Obtained directly from the calibration data.
Substitution antenna attenuator loss: Obtained from calibration data.
Substitution antenna balun loss: For dipoles only, if not known from calibration this value should be taken as 0,3 dB. For waveguide horns the value is 0,00 dB.
Mutual coupling mismatch loss correction factors between the test antenna and the substitution antenna: For ANSI dipoles (30 MHz to 180 MHz) can be obtained from annex A, table A.20. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Measurement distance: (only for different heights of the test antenna). The correction is the difference between the values for the 2 heights in the 2 stages of the test. A value for each height should be taken from annex A: figure A.7. Value 1 (height for the measurement on the EUT).......................dB Value 2 (height for the substitution measurement)....................dB Correction value is: (value 2 - value 1) dB
Off boresight angle in elevation plane (for vertically polarized case only): (only for different heights of the test antenna). The correction is the difference between the values for the 2 heights in the 2 stages of the test. A value for each height should be taken from annex A: figure A.8. Value 1 (height for the measurement on the EUT).......................dB Value 2 (height for the substitution measurement)....................dB Correction value is: (value 2 - value 1) dB NOTE: For horizontally polarized tests this is 0,00 dB.
Gain of substitution antenna: 2,10 dBi for ANSI dipoles (30 MHz to 1 000 MHz) for other types the value can be obtained from calibration data.

Once derived, all the various corrections should be incorporated into the following formula for overall correction for both polarizations:

overall correction = *substitution antenna cable loss*

+ *substitution antenna attenuator loss*

+ *substitution antenna balun loss*

+ *mutual coupling and mismatch loss (where applicable)*

+ *correction for measurement range*

+ correction for off-boresight elevation angles

- gain of substitution antenna

- decrease in input attenuation to receiving device (if any)

NOTE: For frequencies greater than 180 MHz the mutual coupling and mismatch loss factor should be taken as 0,00 dB.

Both values of overall correction factor should be entered on page 2 of the log book results sheet (table 23).

All four received signal levels (dBm_1 to dBm_4) should then be corrected by the relevant overall correction factor (i.e. dBm_1 and dBm_4 with the vertically polarized correction factor, dBm_2 and dBm_3 with the horizontally polarized one) to reveal effective radiated power levels (erp_1, erp_2, erp_3 and erp_4 respectively) in dBm. These four new values should be entered on page 2 of the log book results sheet (table 23).

The final calculation is to combine the two polarization components of each of the two spurious in the following manner.

- If the calculated effective radiated power value erp_1 is more than 20 dB greater than erp_2, then "Spurious level 1", is simply the value of erp_1. Similarly, if erp_2 exceeds erp_1 by more than 20 dB, "Spurious level 1" is simply erp_2. Alternatively, the spurious level should be calculated as:

$$Spuriouslevel\,1 = 20\log\left(10^{\left(\frac{erp_1}{20}\right)} + 10^{\left(\frac{erp_2}{20}\right)}\right)\text{dBm}$$

- The resulting value should be entered on page 2 of the log book results sheet as "Spurious level 1".
- If the calculated ERP value erp_3 is more than 20 dB greater than erp_4, then "Spurious level 2", is simply the value of erp_3. Similarly, if erp_4 exceeds erp_3 by more than 20 dB, "Spurious level 2" is simply erp_4. Alternatively, the spurious level should be calculated as:

$$Spuriouslevel\,2 = 20\log\left(10^{\left(\frac{erp_3}{20}\right)} + 10^{\left(\frac{erp_4}{20}\right)}\right)\text{dBm}$$

- The resulting value should be entered on page 2 of the log book results sheet as "Spurious level 2".
- Whichever value is the larger of "Spurious level 1" and "Spurious level 2" should be entered as "Overall spurious level" on page 2 of the log book results sheet (table 23). The resulting value is the ERP of the Spurious emission and should entered as such in the overall results table (table 24).

The final value to be entered in the overall results sheet (table 24) is that for the expanded uncertainty. This should be calculated in accordance with TR 100 028-2 [7], subclause 7.2.3.3.

7.2.3.3.4 Log book entries

Table 23: Log book results sheet

SPURIOUS EMISSIONS		**Date:**			**PAGE 1 of 2**
Temperature:........................... °C **Manufacturer of EUT: ....** **Bandwidth of Receiving Device: ....Hz**		**Humidity:........... %** **Type No: ....**		**Frequency:......................... MHz** **Serial No: ....**	
Range length:..					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor/gain**
Broadband test antenna (typically 30 MHz to 200 MHz)				N/A	
Broadband test antenna (typically 200 MHz to 1 GHz)				N/A	
Broadband test antenna (typically 1 GHz to 12,75 GHz)				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Substitution antenna (typically ANSI C63.5 (1988) [11] 30 MHz to 1 000 MHz)				N/A	
Substitution antenna (typically waveguide horns 1 GHz to 12,75 GHz)				N/A	
Substitution antenna attenuator					N/A
Substitution antenna cable					N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Ferrite beads			N/A	N/A	N/A
High "Q" notch filter					N/A
High pass filter					N/A
Mounting configuration of EUT (Characterization)					
Mounting configuration of EUT (Measurement)					

SPURIOUS EMISSIONS			**Date:**				**PAGE 2 of 2**
Height above the ground plane of the volume centre of the EUT ....m							
Frequency (MHz)							
dBm$_1$							
Height$_1$							
Angle$_1$							
amb$_1$							
dBm$_2$							
Height$_2$							
amb$_2$							
dBm$_3$							
Height$_3$							
Angle$_2$							
amb$_3$							
dBm$_4$							
Height$_4$							
amb$_4$							
Signal generator output level (dBm$_5$)							
Change in attenuator level (dB$_1$)							
Signal generator output level (dBm$_6$)							
Change in attenuator level (dB$_2$)							
Overall correction factor - Vertical polarization							
Overall correction factor - Horizontal polarization							
erp$_1$							
erp$_2$							
erp$_3$							
erp$_4$							
Spurious level 1							
Spurious level 2							
Overall Spurious level dBm							

Correction factors														
	polarization													
Frequency (MHz)														
	V	H	V	H	V	H	V	H	V	H	V	H	V	H
Substitution antenna cable loss														
Substitution antenna attenuator loss														
Substitution antenna balun loss														
Mutual coupling and mismatch loss (30 MHz - 180 MHz)														
Measurement distance														
Off-elevation boresight level														
Gain of the substitution antenna														
Overall measurement correction	dB		dB		dB		dB		dB		dB		dB	

7.2.3.3.5 Statement of results

The results should be presented in tabular form as shown in table 24.

Table 24: Overall results sheet

SPURIOUS EMISSIONS			**Date:**				**PAGE 1 of 1**
Frequency (MHz)							
Spurious emission ERP (dBm)							
Expanded uncertainty (95 %)	dB	dB	dB	dB	dB	dB	dB

7.2.3.4 Stripline

The spurious emission test is not normally carried out in a Stripline test facility.

7.2.3.5 Test Fixture

The spurious emission test is not normally carried out in a Test Fixture.

7.2.4 Adjacent channel power

Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

It is specified either as the ratio expressed in decibels of the carrier power to the adjacent channel power or as an absolute value.

7.2.4.1 Anechoic Chamber

The adjacent channel power test is not normally carried out in an Anechoic Chamber.

7.2.4.2 Anechoic Chamber with a ground plane

The adjacent channel power test is not normally carried out in an Anechoic Chamber with a ground plane.

7.2.4.3 Open Area Test Site

The adjacent channel power test is not normally carried out in an Open Area Test Site.

7.2.4.4 Stripline

The adjacent channel power test is not normally carried out in a Stripline test facility.

7.2.4.5 Test Fixture

7.2.4.5.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;
- Power measuring receiver (as defined in ETR 027 [5]).

Additional requirements for analogue speech:

- AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 26).

7.2.4.5.2 Method of measurement

NOTE 1: In the following test method, an adjacent channel power meter is assumed. For cases in which a spectrum analyser is used, appropriate changes to the method, results and calculations should be made.

1 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of effective radiated power should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

a) the EUT by itself on the accredited Free-Field Test Site;

b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

c) the power measured at the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

d) the power measured at the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

The value recorded for configuration b) during the verification procedure should be entered in the log book results sheet (table 26).

2 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This position should be noted in the log book results sheet (table 26).

3 The assembly should be connected to the test equipment as shown in figure 52.

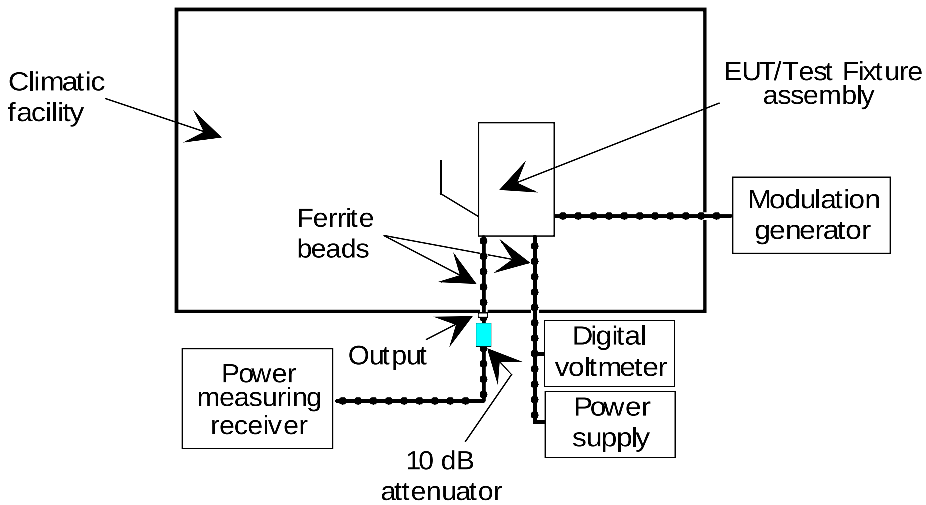


Figure 52: Set-up for Adjacent channel power test using a Test Fixture

4 Normal conditions (as stated in the relevant standard) should exist within the climatic facility.

5 The EUT should be switched on without modulation, allowed time to stabilize and the power measuring receiver tuned so that the maximum response is obtained. The level of the response (dBm) and the setting of the input attenuator (dB) should be recorded on page 2 of the log book results sheet (table 26).

6 Retaining the unmodulated transmitter, the tuning of the power measuring receiver should be adjusted away from the carrier so that its -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the *nominal frequency* of the carrier as given in table 25.

Table 25: Frequency displacement

Channel separation (kHz)	Displacement (kHz)
12,5	8,25
20	13
25	17

NOTE 2: The same result may be obtained by tuning the power measuring receiver to the *nominal frequency* of the adjacent channel, if it has been suitably calibrated.

7 Modulation should be applied to the transmitter under test as follows, depending on whether the test is for analogue speech, bit stream or messages:

For analogue speech:

The transmitter should be modulated with a 1 250 Hz tone at a level which is 20 dB higher than that required to produce normal deviation.

For bit stream:

The transmitter should be modulated with the test modulation D-M2 at a deviation of 12 % of the channel spacing.

For messages:

The transmitter should be modulated with the test modulation D-M3 repeated continuously at a deviation of 12 % of the channel spacing.

8 The variable attenuator on the power measuring receiver should be adjusted until the same reading (or a known relation to it) as obtained in step 5 is observed. The signal level and the setting of the input attenuator should be recorded on page 2 of the log book results sheet (table 26).

9 Steps 6, 7 and 8 should be repeated for the power measuring receiver tuned to the other side of the carrier frequency.

10 The transmitter under test and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

11 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required.

NOTE 3: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 4: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

12 The supply voltage to the EUT should be set to the upper extreme as given in the relevant standard. Steps 5, 6, 7, 8, 9 and 10 should then be repeated.

13 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant standard. Steps 6, 7, 8, 9 and 10 should then be repeated.

14 The EUT/Test Fixture assembly power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

15 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 5: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 6: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

16 The supply voltage to the EUT should be set to the lower extreme as given in the relevant Standard. Steps 5, 6, 7, 8, 9 and 10 should then be repeated.

17 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant Standard. Steps 6, 7, 8, 9 and 10 should then be repeated.

18 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

7.2.4.5.3 Procedure for completion of the results sheets

At the end of the test method, the log book results sheet (table 26) will be complete apart from entries in the 15 "Overall level" cells. These are calculated by adding the received power level to the attenuator setting for the particular frequency of test.

NOTE: The attenuator setting is always to be taken as positive (i.e. > 0) dB.

The "Adjacent channel power" cells in the overall results sheet (table 10) can then be completed by subtracting the adjacent channel "Overall level" cells from the carrier frequency "Overall level" cells (for the same values of temperature and voltage) on page 2 of the log book results sheet (table 26).

There are no correction factors involved in this test, since the adjacent channel power figures are derived from an entirely relative test in which all test components (i.e. cables, adapters, modulation source, attenuator, power measuring receiver, frequency, etc.) remain unchanged.

Some test standards require that the adjacent channel power is given in absolute power terms. For these cases, the relative (i.e. dB) results for the adjacent channel power have to be referenced to the accredited Free-Field Test Site result for effective radiated power. The absolute values are derived by subtraction of the relative values from the accredited Free-Field Test Site value.

The final value that needs to be calculated in order to complete the overall results sheet (table 27) is that of the expanded uncertainty for the test. This should be calculated in accordance with TR 100 028-2 [7], subclause 7.2.4.5.

7.2.4.5.4 Log book entries

Table 26: Log book results sheet

ADJACENT CHANNEL POWER TEST		**Date:**		**PAGE 1 of 2**
Temperature:.........°C		**Humidity:...............%**		**Frequency:.............MHz**
Bandwidth of Receiving Device:...................Hz				
Manufacturer of EUT:.....................		**Type No:..............**		**Serial No:..................**
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
Receiver cable				
RF cable within climatic facility				
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
Power measuring receiver				N/A
AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)				
Audio load (if applicable)				
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)				
Acoustic coupler (if applicable)				
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)				
Result of measurement on accredited Free-Field Test Site: Type of test site:... Effective radiated power (dBm):............................				
Mounting configuration of EUT				

ADJACENT CHANNEL POWER TEST		Date:			PAGE 2 of 2	
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V(high)	V(low)	V(high)	V(low)
Carrier	Received signal level (dBm):					
	Attenuator setting (dB):					
	Overall level (i.e. received signal level + attenuator setting) dBm:					
Adjacent channel (LOW)	Received signal level (dBm):					
	Attenuator setting (dB):					
	Overall level (i.e. received signal level + attenuator setting) dBm:					
Adjacent channel (HIGH)	Received signal level (dBm):					
	Attenuator setting (dB):					
	Overall level (i.e. received signal level + attenuator setting) dBm:					

7.2.4.5.5 Statement of results

The results are presented in tabular form as shown in table 27.

Table 27: Overall results sheet

ADJACENT CHANNEL POWER TEST	Date:				PAGE 1 of 1
Temperature:	T(normal)	T(high)		T(low)	
Voltage:	V(normal)	V(high)	V(low)	V(high)	V(low)
Adjacent channel power (LOW): dB					
Adjacent channel power (HIGH): dB					
Expanded uncertainty (95 %)	dB				

8 Receiver measurements

8.1 Conducted tests

For all measurements which are applicable to EUTs capable of reception of analogue speech, a *psophometric weighting network* followed by the SINAD meter (or a distortion factor meter incorporating a *1 000 Hz band-stop filter*) should be connected to the receiver output terminals via an *audio frequency load* or by an **acoustic coupler** for receivers not fitted with a direct connection. In the latter case, the acoustic equivalent of the SINAD ratio of 20 dB or 14 dB is measured.

For all receiver measurements for analogue speech, unless otherwise stated, the receiver volume control where possible, should be adjusted to give at least 50 % of the *rated audio output power*. In the case of stepped volume controls, the receiver volume control should be set to the first step that provides an output power of at least 50 % of the *rated audio output power.* This control should not be readjusted between *normal and extreme test conditions*.

For all measurements which are applicable to EUTs capable of reception of bit streams, a bit error measuring test set should be connected to the receiver via a suitable *audio frequency termination*. For bit stream measurements the bit pattern of the modulating signal should be compared to the bit pattern obtained from the receiver after demodulation, during at least 2 500 bits or 5 sequences of D-M2 modulation when it is used. However for the purpose of identifying some physical phenomena shorter sequences can be used.

For all measurements which are applicable to EUTs capable of reception of messages, a response measuring test set should be connected to the receiver output terminals via a suitable *audio frequency termination*.

8.1.1 Measured usable sensitivity

8.1.1.1 Measured usable sensitivity for analogue speech

8.1.1.1.1 Definition

The measured usable sensitivity for analogue speech of the receiver is the minimum level of signal, expressed as an emf, at the *nominal frequency* of the receiver and with specified test modulation which produces through a *psophometric weighting network* a SINAD ratio of 20 dB.

8.1.1.1.2 Method of measurement

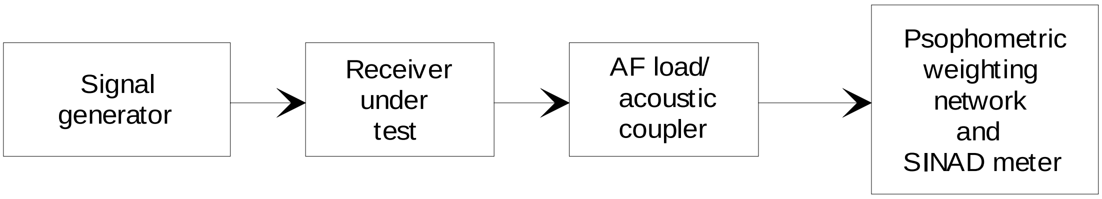


Figure 53: Measurement arrangement

a) A signal generator should be connected to the receiver input. The signal generator should be at the *nominal frequency* of the receiver and should have test modulation A-M1.

b) The amplitude of the signal generator should be adjusted until a SINAD ratio of 20 dB is obtained.

c) The test signal input level under these conditions is the value of the measured usable sensitivity for analogue speech. This level should be recorded.

d) The measurement should be repeated under *extreme test conditions.*

8.1.1.2 Measured usable sensitivity for bit stream

8.1.1.2.1 Definition

The measured usable sensitivity for bit stream of the receiver is the minimum level of signal expressed as an emf, at the *nominal frequency* of the receiver modulated with specified test signal which produces, after demodulation, a data signal with a bit error ratio of 10^{-2}.

NOTE: A BER of 10^{-2} is the value used in ETS 300 113 and ETS 300 390.

8.1.1.2.2 Method of measurement

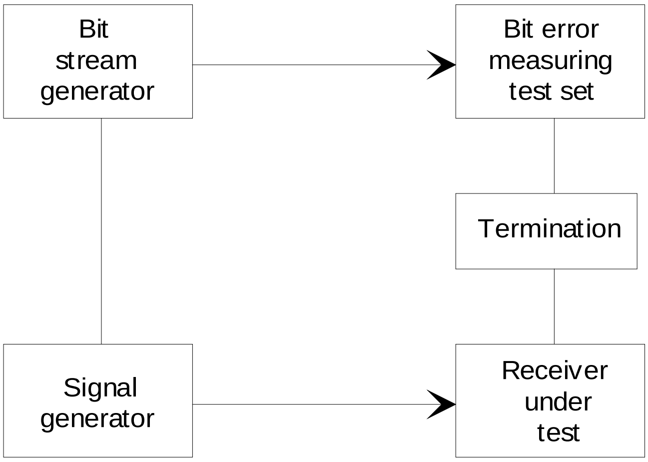


Figure 54: Measurement arrangement

a) A signal generator should be connected to the receiver input. The signal generator should be at the *nominal frequency* of the receiver and should be modulated by the *test modulation D-M2*.

b) The amplitude of the signal generator should be adjusted until the bit error ratio of 10^{-2} is obtained.

c) The measured usable sensitivity for bit stream should be recorded as the emf of the input signal to the receiver.

d) The measurement should be repeated under *extreme test conditions.*

8.1.1.3 Measured usable sensitivity for messages

8.1.1.3.1 Definition

The measured usable sensitivity for messages of the receiver is the minimum level of signal, expressed as an emf, at the *nominal frequency* of the receiver modulated by a test signal which produces, after demodulation, a message acceptance ratio of 80 %.

8.1.1.3.2 Method of measurement

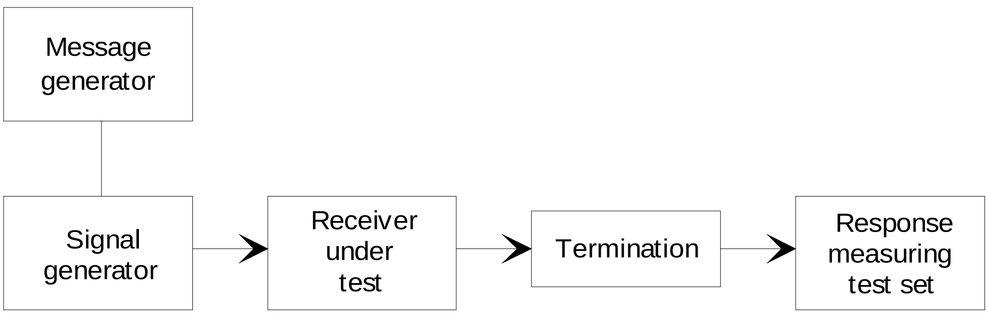


Figure 55: Measurement arrangement

a) A signal generator should be connected to the receiver input. The signal generator should be at the *nominal frequency* of the receiver and should be modulated by the *test modulation D-M3.*

b) The amplitude of the signal generator should be adjusted so that a successful message response ratio of less than 10 % is obtained.

c) The test signal should be applied repeatedly whilst observing in each case whether or not a successful response is obtained. The input level should be increased by 2 dB for each occasion that a successful response is not obtained. The procedure should be continued until three consecutive successful responses are observed. The level of the input signal should be recorded.

d) The input signal level should be reduced by 1 dB and the new value recorded. The test signal should then be continuously repeated. In each case, if a response is not obtained, the input level should be increased by 1 dB and the new value recorded. If a successful response is obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the input level should be reduced by 1 dB and the new value recorded. No input signal levels should be recorded unless preceded by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

e) The measured usable sensitivity for messages is the average of the values recorded in steps c) and d).This value is recorded.

f) The measurement should be repeated under *extreme test conditions.*

8.1.2 Co-channel rejection

8.1.2.1 Co-channel rejection for analogue speech

8.1.2.1.1 Definition

The co-channel rejection for analogue speech is a measure of the capability of the receiver to receive a wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of an unwanted modulated signal also at the *nominal frequency*.

It is specified as the ratio in decibels of the level of the unwanted signal to the specified *wanted signal level* at the receiver input which produces through a *psophometric weighting network* a SINAD ratio of 14 dB.

8.1.2.1.2 Method of measurement

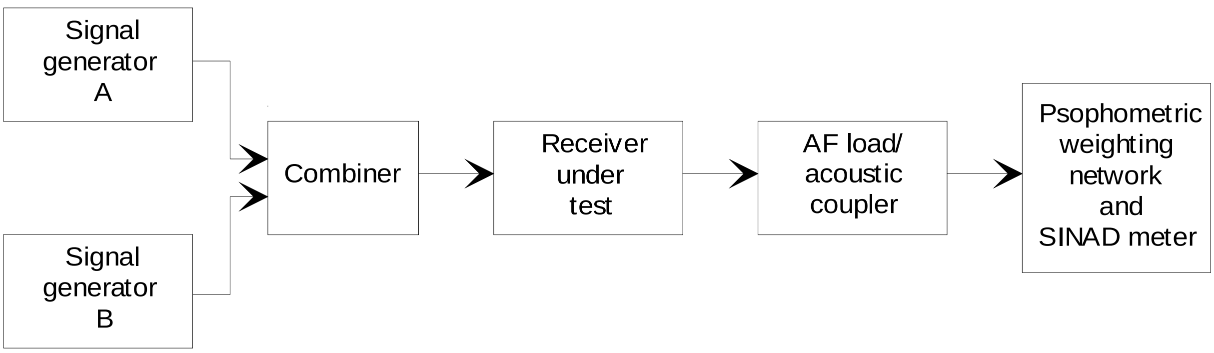


Figure 56: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation A-M1*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3*. Both input signals should be at the *nominal frequency* of the receiver under test.

b) Initially the unwanted signal should be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input. The unwanted signal should then be switched on and its level should be adjusted until the SINAD ratio through a *psophometric weighting network* is reduced to 14 dB.

c) The co-channel rejection ratio for analogue speech should be recorded as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver input for which the specified reduction in SINAD occurs.

8.1.2.2 Co-channel rejection for bit stream

8.1.2.2.1 Definition

The co-channel rejection for bit stream is a measure of the capability of the receiver to receive a wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of an unwanted modulated signal also at the *nominal frequency*.

It is specified as the ratio in decibels of the level of the unwanted signal recorded in step d) to the specified *wanted signal level* at the receiver input, for which the bit error ratio is 10^{-2}.

8.1.2.2.2 Method of measurement

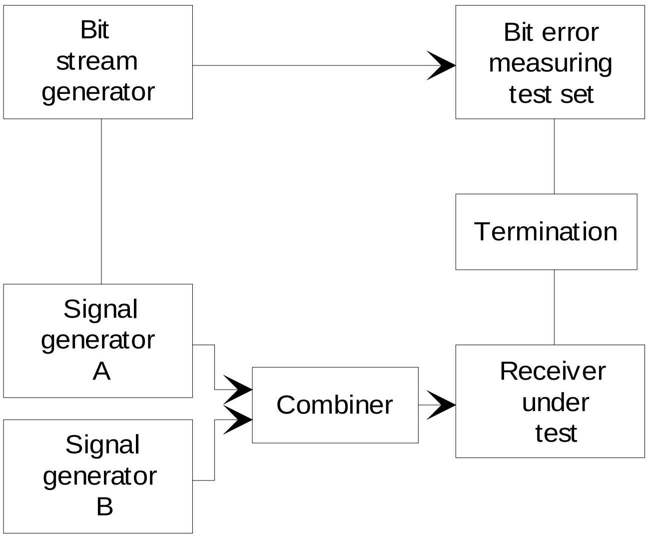


Figure 57: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M2.* The unwanted signal, represented by signal generator B, should have *test modulation A-M3*. Both input signals should be at the *nominal frequency* of the receiver under test.

b) Initially signal generator B should be switched off. The amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The unwanted signal should then be switched on, and its input level adjusted until a bit error ratio of about 10^{-1} is obtained.

d) The wanted signal should then be transmitted whilst observing the bit error ratio. The level of the unwanted signal should be reduced in steps of 1 dB until a bit error ratio of 10^{-2} or better is obtained. The level of the unwanted signal should then be recorded.

e) The co-channel rejection ratio for bit stream should be recorded as the ratio in dB of the levels of the unwanted signal recorded in step d) to the level of the wanted signal, at the receiver input.

8.1.2.3 Co-channel rejection for messages

8.1.2.3.1 Definition

The co-channel rejection for messages is a measure of the capability of the receiver to receive a wanted signal at the *nominal frequency* modulated by a test signal without exceeding a given degradation due to the presence of an unwanted modulated signal also at the nominal frequency.

It is specified as the ratio in decibels of the level of the unwanted signal to the specified *wanted signal level* at the receiver input for which the message acceptance ratio is 80 %.

8.1.2.3.2 Method of measurement

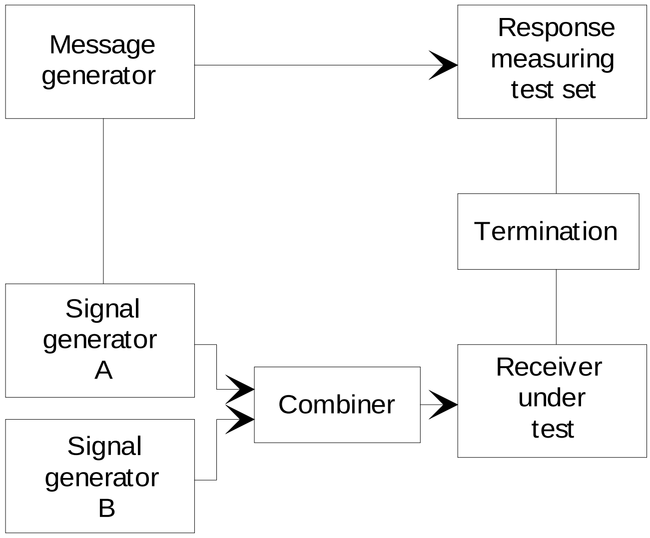


Figure 58: Measurement arrangement

a) Two signal generators, A and B should be connected to the receiver via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M3*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3*. Both input signals should be at the *nominal frequency* of the receiver under test.

b) Initially signal generator B should be switched off. The amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The wanted signal should then be transmitted repeatedly and the signal generator B should be switched on. The input level of the unwanted signal should be adjusted until a successful message ratio of less than 10 % is obtained.

d) The level of the unwanted signal should be reduced by 2 dB for each occasion that a successful response is not observed. The procedure should be continued until three consecutive successful responses are observed. The level of the input signal should then be recorded.

e) The unwanted input signal should then be increased by 1 dB and the new value recorded. The wanted signal should then be continuously repeated. In each case if a response is not obtained the level of the unwanted signal should be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal should be increased by 1 dB and the new value recorded. No levels of the unwanted signal should be recorded unless preceded by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

f) The co-channel rejection ratio for messages should be recorded as the ratio in dB of the average of the levels of the unwanted signal recorded in steps d) and e) to the level of the wanted signal, at the receiver input.

8.1.3 Adjacent channel selectivity

8.1.3.1 Adjacent channel selectivity for analogue speech

8.1.3.1.1 Definition

The adjacent channel selectivity for analogue speech is a measure of the capability of the receiver to receive a wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

It is specified as the lower value of the ratios in decibels for the upper and lower adjacent channels of the level of the unwanted signal to a specified level of the wanted signal which produces through a *psophometric weighting network* a SINAD ratio of 14 dB.

8.1.3.1.2 Method of measurement

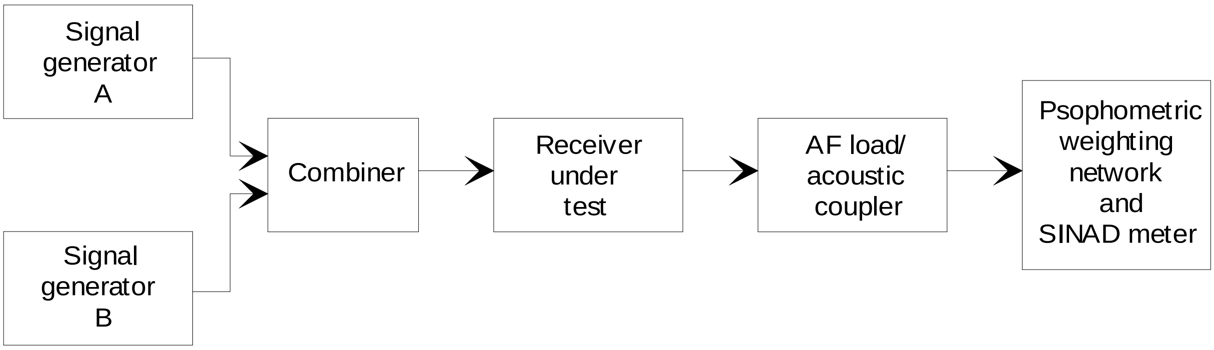


Figure 59: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation A-M1*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be at the frequency of the channel immediately above that of the wanted signal.

b) Initially the unwanted signal should be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input. The unwanted signal should then be switched on and its level should be adjusted until the SINAD ratio through a *psophometric weighting network* is reduced to 14 dB. This level should be recorded.

c) The measurement should be repeated with an unwanted signal at the frequency of the channel below that of the wanted signal.

d) The adjacent channel selectivity for analogue speech should be recorded for the upper and lower adjacent channels as the ratio in dB of the level of the unwanted signal to the level of the wanted signal.

e) The measurements should be repeated under *extreme test conditions* using the relevant value of the *wanted signal level.*

8.1.3.2 Adjacent channel selectivity for bit stream

8.1.3.2.1 Definition

The adjacent channel selectivity for bit stream is a measure of the capability of the receiver to receive a wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

It is specified as the lower value of the ratios in decibels for the upper and lower adjacent channels of the level of the unwanted signal to a specified level of the wanted signal for which the bit error ratio is 10^{-2}.

8.1.3.2.2 Method of measurement

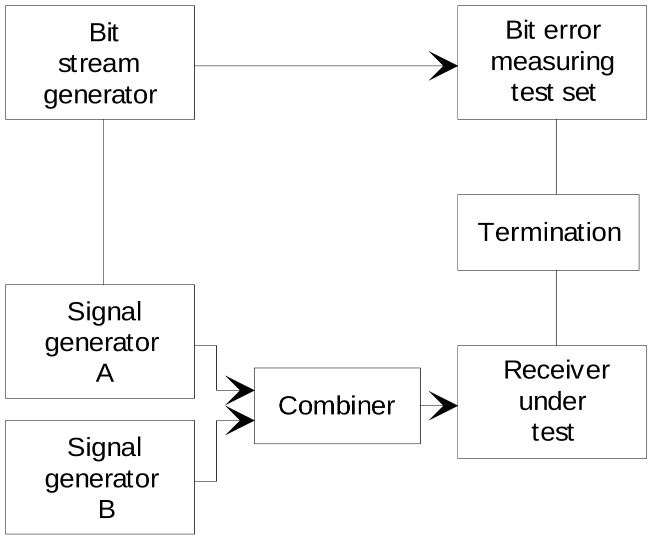


Figure 60: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to the frequency of the channel immediately above that a wanted signal.

b) Initially signal generator B should be switched off. The amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The unwanted signal should then be switched on, and the input level adjusted until a bit error ratio of about 10^{-1} is obtained.

d) The wanted signal should then be transmitted whilst observing the bit error ratio. The level of the unwanted signal should be reduced in steps of 1 dB until a bit error ratio of 10^{-2} or better is obtained. The level of the unwanted signal should then be recorded.

e) The adjacent channel selectivity for bit stream should be recorded as the ratio in dB of the level of the unwanted signal to the level of the wanted signal, at the receiver input.

f) The measurement should be repeated with the unwanted signal at the frequency of the channel below that of the wanted signal.

g) The measurement should be repeated under *extreme test conditions* using the relevant value of the *wanted signal level*.

8.1.3.3 Adjacent channel selectivity for messages

8.1.3.3.1 Definition

The adjacent channel selectivity for messages is a measure of the capability of the receiver to receive a wanted signal at the *nominal frequency* modulated by a test signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

It is specified as the lower value of the ratios in decibels for the upper and lower adjacent channels of the level of the unwanted signal to a specified level of the wanted signal for which the message acceptance ratio is 80 %.

8.1.3.3.2 Method of measurement

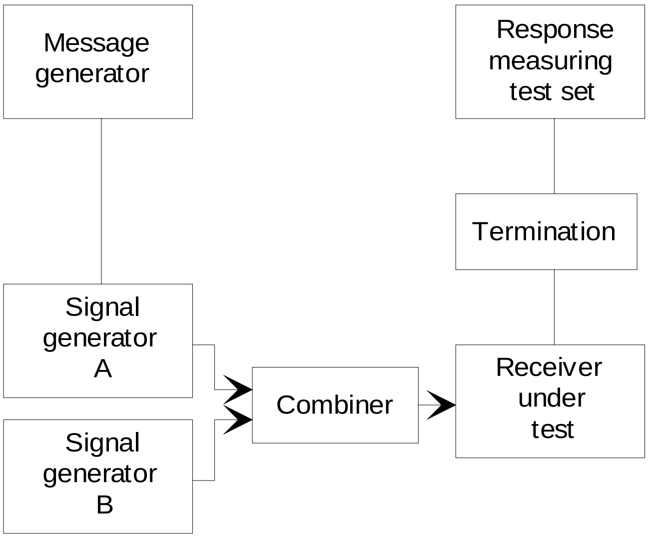


Figure 61: Measurement arrangement

a) Two signal generators, A and B should be connected to the receiver via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M3*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to the frequency of the channel immediately above that of the wanted signal.

b) Initially signal generator B should be switched off. The amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The wanted signal should then be transmitted repeatedly and the signal generator B should be switched on. The input level of the unwanted signal should be adjusted until a successful message ratio of less than 10 % is obtained.

d) The level of the unwanted signal should be reduced by 2 dB for each occasion that a successful response **is not** observed. The procedure should be continued until three consecutive successful responses are observed. The level of the input signal should then be noted.

e) The unwanted input signal should then be increased by 1 dB and the new value recorded. The wanted signal should then be continuously repeated. In each case if a response **is not** obtained the level of the unwanted signal should be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal should be increased by 1 dB and the new value recorded. No levels of the unwanted signal should be recorded unless **preceded** by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

f) The measurement should be repeated with the unwanted signal at the frequency of the channel below that of the wanted signal.

g) The adjacent channel selectivity for messages should be recorded for the upper and lower adjacent channels as the average of the levels of the unwanted signal noted in steps d) and e) to the level of the wanted input signal.

h) The measurement should be repeated under *extreme test conditions* using the relevant value of the *wanted signal level*.

8.1.4 Spurious response immunity

The particular method to be used when performing the calculation of the limited frequency range and the actual spurious frequencies should be included in the appropriate ETS or EN.

8.1.4.1 Spurious response immunity for analogue speech

8.1.4.1.1 Definition

The spurious response immunity for analogue speech is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the *nominal frequency* and an unwanted signal at any other frequency at which a response is obtained.

It is specified as the ratio in decibels of the level of the unwanted signal to the level of the wanted signal at the receiver input, which produces through a *psophometric weighting network* a SINAD ratio of 14 dB.

8.1.4.1.2 Method of measurement

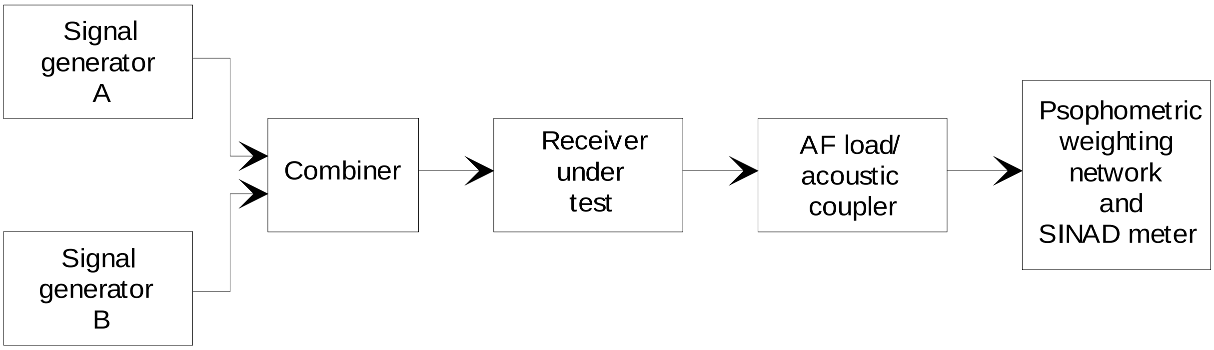


Figure 62: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation A-M1*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3*.

b) Initially the unwanted signal should be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input. The unwanted signal should then be switched on and its level should be adjusted to level which is 80 dB in excess of the *wanted signal level*, when measured at the receiver input. The frequency of the unwanted signal should then be varied over the specified *limited frequency range* plus other frequencies within the full specified frequency range at which it is calculated that a spurious response could occur. The frequencies of all responses should be noted.

c) At any frequency at which a response is obtained, the unwanted signal level should be adjusted until the SINAD ratio through a *psophometric weighting network* is reduced to 14 dB.

d) The spurious response immunity ratio for analogue speech should be recorded for the frequency concerned as the ratio in dB between the unwanted signal and the wanted signal at the receiver input.

8.1.4.2 Spurious response immunity for bit stream

8.1.4.2.1 Definition

The spurious response immunity for bit stream is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the *nominal frequency* and an unwanted signal at any other frequency at which a response is obtained.

It is specified as the ratio in decibels of the level of the unwanted signal to a specified level of the wanted signal at the receiver input for which the bit error ratio is 10^{-2}.

8.1.4.2.2 Method of measurement

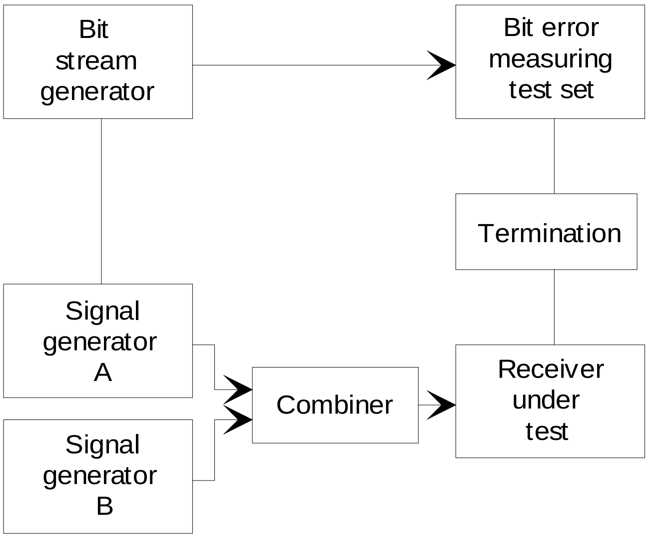


Figure 63: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to a frequency within the specified frequency range at which it is calculated that a spurious response could occur.

b) Initially signal generator B should be switched off. The amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The unwanted signal should then be switched on, and the input level adjusted until a bit error ratio of about 10^{-1} is obtained.

d) The wanted signal should then be transmitted whilst observing the bit error ratio. The level of the unwanted signal should be reduced in steps of 1 dB until a bit error ratio of 10^{-2} or better is obtained. The level of the unwanted signal should then be recorded.

e) The measurement should be repeated at each frequency within the specified frequency range at which it is calculated that a spurious response could occur.

f) The spurious response immunity for bit stream should be recorded for the frequency concerned as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver input.

8.1.4.3 Spurious response immunity for messages

8.1.4.3.1 Definition

The spurious response immunity for messages is a measure of the capability of the receiver to discriminate between the wanted signal modulated by a test signal at the *nominal frequency* and an unwanted signal at any other frequency at which a response is obtained.

It is specified as the ratio in decibels of the level of the unwanted signal to a specified level of the wanted signal at the receiver input for which the message acceptance ratio is 80 %.

8.1.4.3.2 Method of measurement

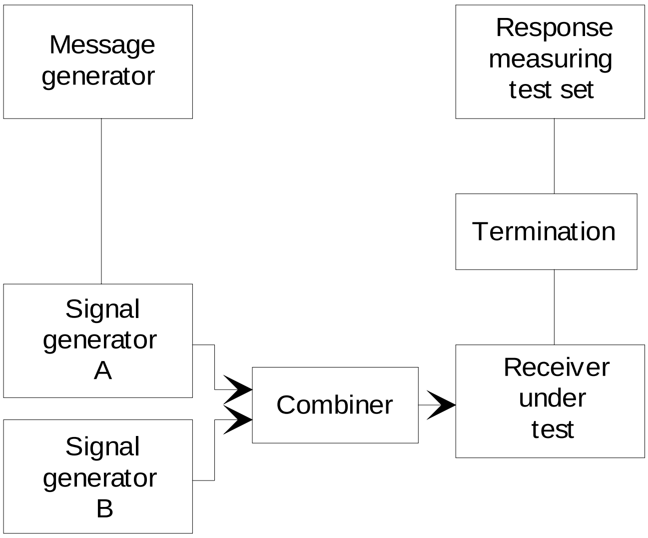


Figure 64: Measurement arrangement

a) Two signal generators, A and B should be connected to the receiver via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M3*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to a frequency within the specified frequency range at which it is calculated that a spurious response could occur.

b) Initially signal generator B should be switched off. The amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The wanted signal should then be transmitted repeatedly and the signal generator B should be switched on. The input level of the unwanted signal should be adjusted until a successful message ratio of less than 10 % is obtained.

d) The level of the unwanted signal should be reduced by 2 dB for each occasion that a successful response is not observed. The procedure should be continued until three consecutive successful responses are observed. The level of the input signal should then be recorded.

e) The unwanted input signal should then be increased by 1 dB and the new value recorded. The wanted signal should then be continuously repeated. In each case if a response is not obtained the level of the unwanted signal should be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal should be increased by 1 dB and the new value recorded. No levels of the unwanted signal should be recorded unless preceded by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

f) The measurement should be repeated at each frequency within the specified frequency range at which it is calculated that a spurious response could occur.

g) The spurious response immunity for messages should be recorded for the frequency concerned as the ratio in dB of the average of the levels of the unwanted signal recorded in steps d) and e) to the level of the wanted signal at the receiver input.

8.1.5 Intermodulation immunity

8.1.5.1 Intermodulation immunity for analogue speech

8.1.5.1.1 Definition

The intermodulation immunity for analogue speech is a measure of the capability of a receiver to receive a wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

For the purpose of this measurement it is specified as the ratio in decibels of the common level of two equal unwanted signals to a specified level of the wanted signal at the receiver input, which produces through a *psophometric weighting network* a SINAD ratio of 14 dB.

8.1.5.1.2 Method of measurement

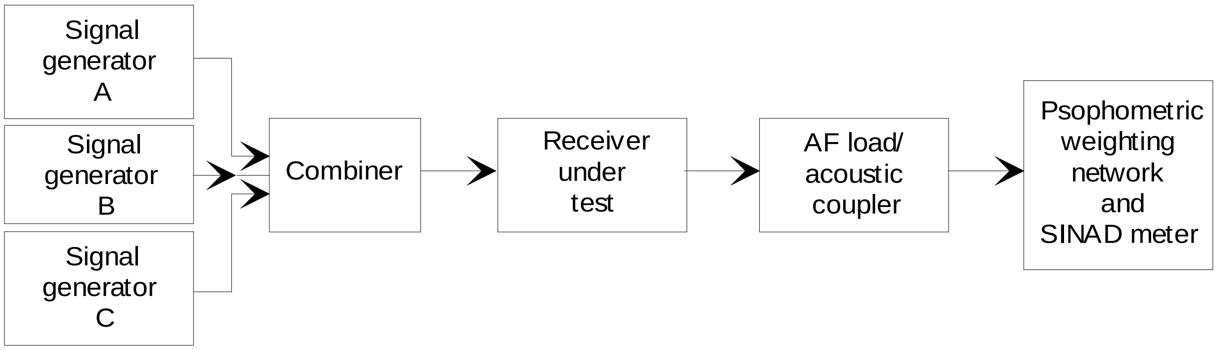


Figure 65: Measurement arrangement

a) Three signal generators, A, B and C should be connected to the receiver via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation A-M1*. The unwanted signal, represented by signal generator B, should be unmodulated and adjusted to the frequency 50 kHz above the *nominal frequency* of the receiver. The second unwanted signal, represented by signal generator C, should have *test modulation A-M3* and adjusted to a frequency 100 kHz above the *nominal frequency* of the receiver.

b) Initially the unwanted signals should be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The two unwanted signals should then be switched on. The amplitude of the two unwanted signals should be maintained equal and should be adjusted until the SINAD ratio, through a *psophometric weighting network* is reduced to 14 dB. The frequency of signal generator B should be adjusted to produce the maximum degradation of the SINAD ratio. The level of the two unwanted test signals should be readjusted to restore the SINAD ratio of 14 dB. This level should be recorded.

d) The intermodulation immunity for analogue speech should be recorded as the ratio in dB of the level of the unwanted signals recorded in step c) to the level of the wanted signal.

e) The measurements should be repeated with the unwanted signal generator B at the frequency 50 kHz below that of the wanted signal and the frequency of the unwanted signal generator C at the frequency 100 kHz below that of the wanted signal.

8.1.5.2 Intermodulation immunity for bit stream

8.1.5.2.1 Definition

The intermodulation immunity for bit stream is a measure of the capability of a receiver to receive a wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

For the purpose of this measurement it is specified as the ratio in decibels of the common level of two equal unwanted signals to a specified level of the wanted signal at the receiver input for which the bit error ratio is 10^{-2}.

8.1.5.2.2 Method of measurement

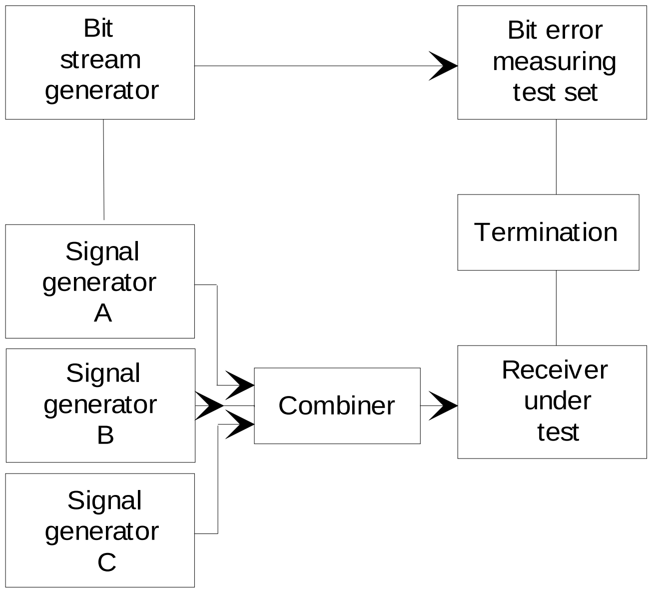


Figure 66: Measurement arrangement

a) Three signal generators, A, B and C should be connected to the receiver via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*. The unwanted signal, represented by signal generator B, should be unmodulated and adjusted to the frequency 50 kHz above the *nominal frequency* of the receiver. The second unwanted signal, represented by signal generator C, should have *test modulation A-M3* and adjusted to a frequency 100 kHz above the *nominal frequency* of the receiver.

b) Initially signal generators B and C will be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) Signal generators B and C should then be switched on. The output levels of the two signal generators should be maintained equal and adjusted to a value such that a bit error ratio of about 10^{-1} is obtained.

d) The wanted signal should then be transmitted whilst observing the bit error ratio. The level of the unwanted signals should be reduced in steps of 1 dB until a bit error ratio of 10^{-2} or better is obtained. This level should be recorded.

e) The intermodulation immunity for bit stream should be recorded as the ratio in dB of the level of the unwanted signals recorded in step d) to the level of the wanted signal.

f) The measurement should be repeated with the unwanted signal generator B at the frequency 50 kHz below that of the wanted signal and the frequency of the unwanted signal generator C at the frequency 100 kHz below that of the wanted signal.

8.1.5.3 Intermodulation immunity for messages

8.1.5.3.1 Definition

The intermodulation immunity for messages is a measure of the capability of a receiver to receive a wanted signal at the *nominal frequency* modulated by a test signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

For the purpose of this measurement it is specified as the ratio in decibels of the common level of two equal unwanted signals to a specified level of the wanted signal at the receiver input, for which the message acceptance ratio is 80 %.

8.1.5.3.2 Method of measurement

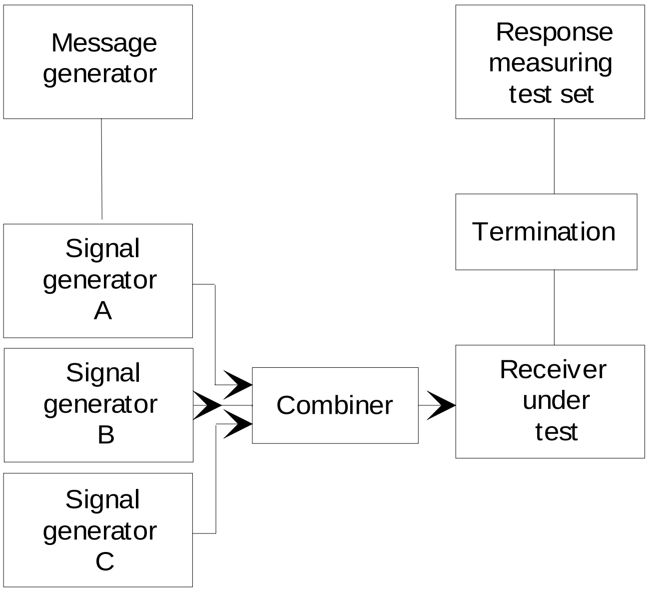


Figure 67: Measurement arrangement

a) Three signal generators, A, B and C should be connected to the receiver via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M3*. The unwanted signal, represented by the signal generator B, should be unmodulated and adjusted to the frequency 50 kHz above the nominal frequency of the receiver. The second unwanted signal, represented by the signal generator C, should have *test modulation A-M3* and should be adjusted to a frequency 100 kHz above the nominal frequency.

b) Initially signal generators B and C will be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The wanted signal should then be transmitted repeatedly and signal generators B and C should be switched on. The output levels of the two signal generators should be maintained equal and adjusted to a value such that a successful message ratio of less then 10 % is obtained.

d) The levels of the unwanted signals should be reduced by 2 dB for each occasion that a successful response is not observed. The procedure should be continued until three consecutive successful responses are observed. The level of the input signal should then be recorded.

e) The unwanted input signals should then be increased by 1 dB and the new value recorded. The wanted signal should then be continuously repeated. In each case if a response is not obtained the level of the unwanted signals should be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signals should not be changed until three consecutive successful responses have been obtained. In this case the unwanted signals should be increased by 1 dB and the new value recorded. No levels of the unwanted signals should be recorded unless preceded by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

f) The intermodulation immunity for messages should be recorded as the ratio in dB of the average of the levels of the unwanted signals recorded in steps d) and e) to the level of the wanted input signal.

g) The measurements should be repeated with the unwanted signal generator B at the frequency 50 kHz below that of the wanted signal and the frequency of the unwanted signal generator C at the frequency 100 kHz below that of the wanted signal.

8.1.6 Blocking immunity or desensitization

8.1.6.1 Blocking immunity or desensitization for analogue speech

8.1.6.1.1 Definition

Blocking immunity or desensitization for analogue speech is a measure of the capability of the receiver to receive the wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of an unwanted unmodulated high input signal.

It is specified as the ratio in decibels of the level of the unwanted signal to a specified level of the wanted signal at the receiver input, which produces through a *psophometric weighting network* either a SINAD ratio of 14 dB (blocking immunity) or a power reduction of 3 dB in the receiver audio output power (desensitization).

8.1.6.1.2 Method of measurement

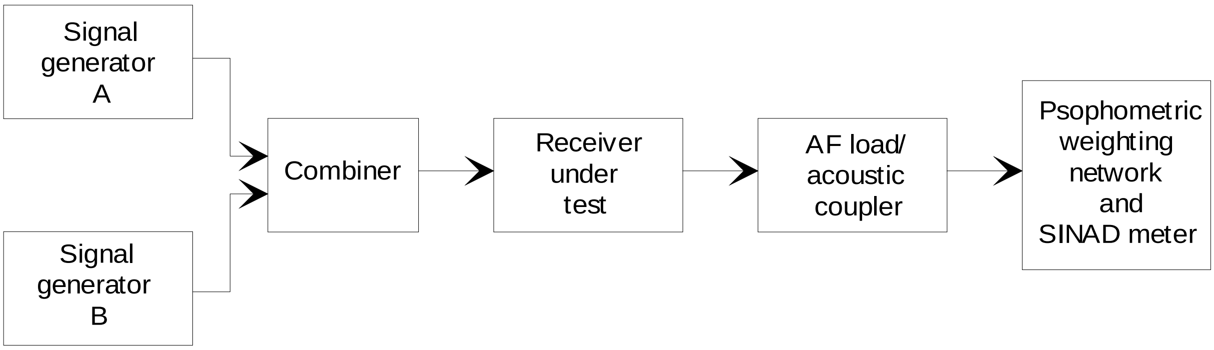


Figure 68: Measurement Arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network*. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation A-M1*.

b) Initially the unwanted signal, represented by signal generator B, should be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The unwanted signal should be unmodulated. Its frequency should be placed at least 1 MHz away of the carrier frequency and its level should be increased until a reduction in the receiver output power or a reduction of the SINAD ratio at the receiver output is observed.

d) Maintaining this level constant the frequency of the unwanted signal should be varied between +1 MHz and +10 MHz, also between -1 MHz and -10 MHz relative to the nominal *frequency* of the receiver. However for practical reasons the measurements should be carried out at certain frequencies of the unwanted signal at approximately ±1 MHz, ±2 MHz, ±5 MHz and ±10 MHz relative to the nominal frequency of the receiver. The frequency at which the greatest degradation occurs should be noted taking care to be sure that it is not a spurious response.

e) The level of the unwanted signal should then be adjusted to give:

   a) a reduction of 3 dB in the receiver audio output power; or

   b) a reduction to 14 dB of the SINAD ratio at the receiver output;

   whichever occurs first. This level should be recorded.

f) The blocking ratio for analogue speech should be recorded as the ratio in dB between the level of the unwanted signal to the level of the wanted signal, at the receiver input.

8.1.6.2 Blocking immunity for bit stream

8.1.6.2.1 Definition

Blocking immunity for bit stream is a measure of the capability of the receiver to receive the wanted modulated signal at the *nominal frequency* without exceeding a given degradation due to the presence of an unwanted unmodulated high input signal.

It is specified as the ratio in decibels of the level of the unwanted signal to a specified level of the wanted signal at the receiver input for which the bit error ratio is 10^{-2}.

8.1.6.2.2 Method of measurement

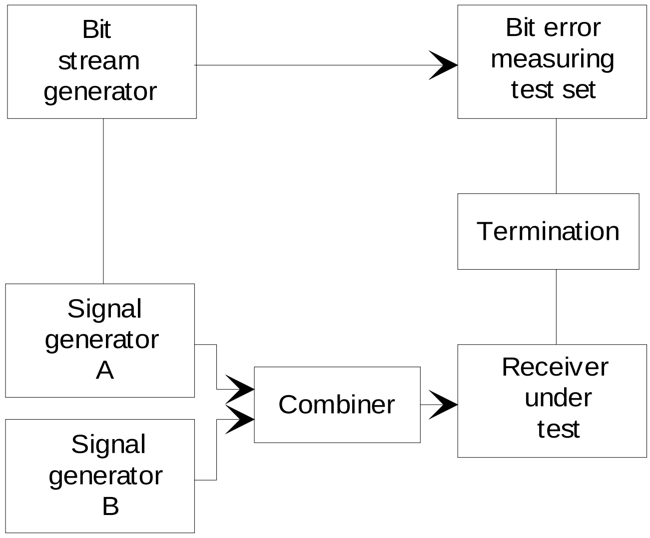


Figure 69: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*.

b) Initially the unwanted signal, represented by the signal generator B, should be switched off and the amplitude of signal generator A should be adjusted to the *wanted signal level* when measured at the receiver input.

c) The unwanted signal should be unmodulated and its frequency should be varied between +1 MHz and +10 MHz, also between -1 MHz and -10 MHz relative to the nominal frequency of the receiver. However for practical reasons the measurements should be carried out at certain frequencies of the unwanted signal at approximately ±1 MHz, ±2 MHz, ±5 MHz and ±10 MHz. Any of these frequencies should be one at which no spurious response has been detected. The level of the unwanted signal should be adjusted until a bit error ratio of less then 10^{-1} is obtained.

d) The wanted signal should then be transmitted whilst observing the bit error ratio. The level of the unwanted signal should be reduced in steps of 1 dB until a bit error ratio of $10-^{2}$ or better is obtained. The level of the unwanted signal should then be recorded in each case.

e) The blocking level for bit stream is recorded as the lower value of the ratios in dB, of each measurement above, of the level of the unwanted signal to the level of the wanted signal, at the receiver input.

8.1.6.3 Blocking immunity for messages

8.1.6.3.1 Definition

Blocking immunity for messages is a measure of the capability of the receiver to receive the wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted unmodulated high input signal.

It is specified as the ratio in decibels of the level of the unwanted signal to a specified level of the wanted signal at the receiver input for which the message acceptance ratio is 80 %.

8.1.6.3.2 Method of measurement

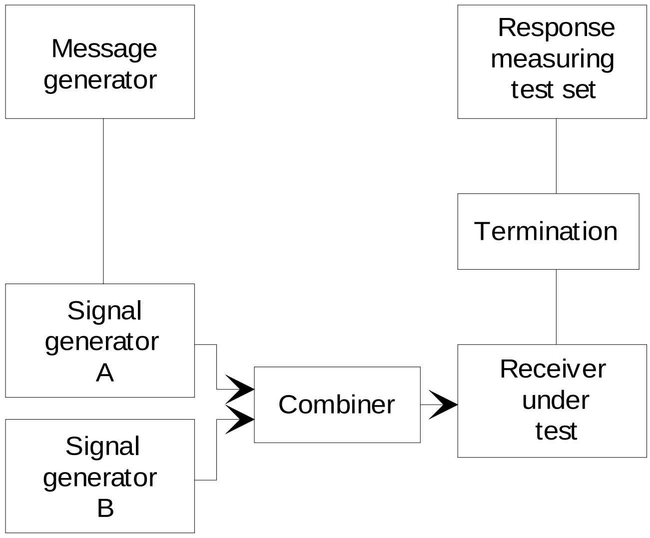


Figure 70: Measurement arrangement

a) Two signal generators A and B should be connected to the receiver input via a *combining network.* The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M3.*

b) Initially the unwanted signal, represented by the signal generator B, should be switched off and the amplitude of signal generator A should be adjusted to the wanted signal level when measured at the receiver input.

c) The wanted signal should then be transmitted repeatedly and the signal generator B should be switched on. The unwanted signal should be unmodulated and its frequency should be selected in the range +1 MHz ±10 % relative to the nominal frequency of the receiver. This frequency should be one at which no spurious response has been detected. The level of the unwanted signal should be adjusted until a successful message ratio of less than 10 % is obtained.

d) The level of the unwanted signal should be reduced by 2 dB for each occasion that a successful response is not observed. The procedure should be continued until three consecutive successful responses are observed. The level of the input signal should then be recorded.

e) The unwanted input signal should then be increased by 1 dB and the new value recorded. The wanted signal should then be continuously repeated. In each case if a response is not obtained the level of the unwanted signal should be reduced by 1 dB and the new value recorded. If a successful response is obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal should be increased by 1 dB and the new value recorded. No levels of the unwanted signal should be recorded unless preceded by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

f) Repeat the measurements for frequency of the unwanted signal selected in the range -1 MHz ±10 % relative to the *nominal frequency* of the receiver.

g) The blocking level for messages is recorded as the lower value of the ratios in dB, of the two measurements above, of the average of the levels of the unwanted signal recorded in steps d) and e) to the level of the wanted signal.

8.1.7 Conducted spurious components

8.1.7.1 Definition

Conducted spurious components are discrete radio frequency signals conveyed from the antenna socket by conduction to the *test load*.

They are specified as the power level of any discrete signal delivered into a *test load* within the specified frequency range.

8.1.7.2 Method of measurement

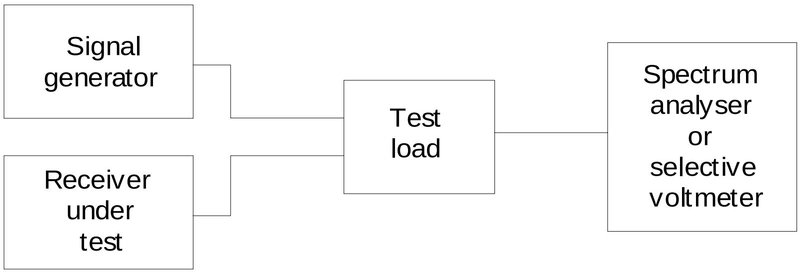


Figure 71: Measurement arrangement

A *test load* may be used to protect the spectrum analyser or selective voltmeter against damage when testing a receiver combined in one unit with a transmitter.

The spectrum analyser or selective voltmeter used should have sufficient dynamic range and sensitivity to achieve the required measurement accuracy at the specified limit.

a) The receiver input terminals should be connected to a spectrum analyser or selective voltmeter having an input impedance of 50 Ω and the receiver is switched on.

b) The frequency of the spectrum analyser or selective voltmeter should be adjusted over the specified frequency range. The frequency and the absolute power level of each of the spurious components found should be recorded.

c) If the detecting device is not calibrated in terms of power input, the level of any detected components should be determined by replacing the receiver by the signal generator and adjusting it to reproduce the frequency and level of every spurious component recorded in step b). The absolute power level of each spurious component should be recorded.

8.1.8 Amplitude characteristic for analogue speech

8.1.8.1 Definition

The amplitude characteristic for analogue speech of the receiver is the relationship between the radio frequency input level and the audio frequency level at the receiver output.

8.1.8.2 Method of measurement

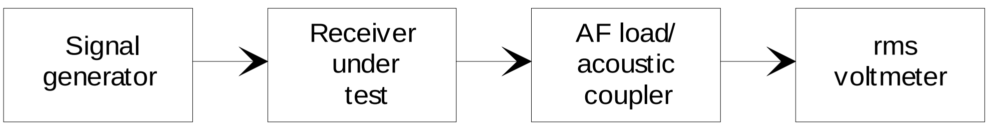


Figure 72: Measurement arrangement

a) A signal generator should be connected to the receiver input. The signal generator should be at the *nominal frequency* of the receiver and should be modulated by *test modulation A-M1* and should be adjusted to the *wanted signal level*. The audio output should be adjusted to give a level of approximately 25 % of the *rated audio output power.* The level should be recorded.

b) The input signal should be increased to an emf of +100 dBµV and the level of the audio output should be recorded.

c) The amplitude characteristics of the receiver is recorded as the change of level of the audio output measured in steps a) and b) above expressed in dB.

8.1.9 Audio frequency response for analogue speech

8.1.9.1 Definition

The audio frequency response for analogue speech is the variation of the level of the audio frequency output of the receiver as a function of change of the frequency of the modulation.

8.1.9.2 Method of measurement

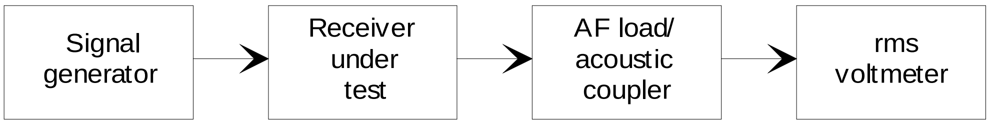


Figure 73: Measurement arrangement

a) An *audio frequency load* and an rms voltmeter should be connected to the receiver output terminals. A signal generator at the *nominal frequency* of the receiver and with *test modulation A-M1* should be connected to the receiver input.

b) The signal generator output should be adjusted to a level of +60 dBµV emf. Where possible, the receiver volume control should be adjusted to give at least 50 % of the *rated audio output power* and, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the *rated audio output power*.

c) The frequency deviation at 1 000 Hz should be reduced to 20 % of the *maximum permissible frequency deviation*. The deviation should remain constant while the modulating frequency is varied between 300 Hz and its *upper audio frequency limit*.

d) The variation of the receiver output should be recorded at suitable intervals of modulation frequency.

e) The measurement should be repeated with the carrier frequency offset by plus and minus half the absolute limit value of the frequency tolerance for the corresponding transmitter.

8.1.10 Harmonic distortion for analogue speech

8.1.10.1 Definition

The harmonic distortion for analogue speech of a receiver output is the ratio, expressed as a percentage, of the rms voltage of all the harmonic components of the fundamental audio frequency to the total rms voltage at the output.

8.1.10.2 Method of measurement

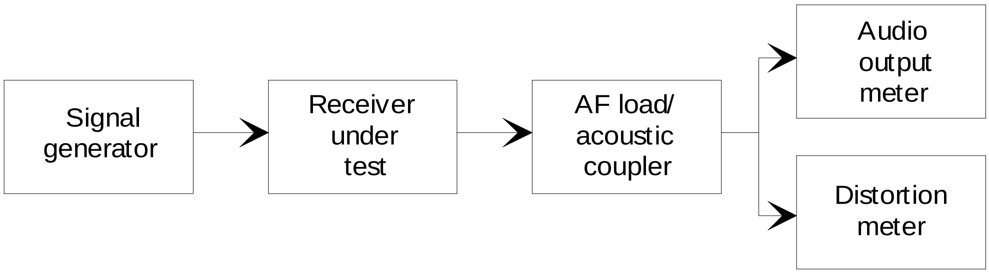


Figure 74: Measurement arrangement

a) An *audio frequency load*, audio power meter and a distortion meter should be connected to the receiver output terminal. A signal generator at the *nominal frequency* of the receiver and with *test modulation A-M1* should be connected to the receiver input.

b) The signal generator level should be adjusted to a level of +60 dBμV emf and the receiver volume control should be adjusted to the manufacturers *rated audio output power* into the stated resistive load. In the case of a stepped power control it should be the first position which gives a power level not less than the *rated audio output power*.

c)

- Phase modulation: The test signal should be modulated successively at frequencies of 300 Hz, 500 Hz and 1 000 Hz maintaining a constant modulation index (i.e. keeping the ratio of frequency deviation to the modulating frequency constant. This is the index which produces 60 % of the *maximum permissible frequency deviation* when modulated at 1 000 Hz.

- Frequency modulation: The test signal should be modulated successively at frequencies of 300 Hz, 500 Hz and 1 000 Hz with a frequency deviation equal to 60 % of the *maximum permissible frequency deviation.*

d) The harmonic distortion should be measured and recorded at each of the frequencies.

e) The tests b) to d) above should be repeated with the signal generator output at a level of +100 dBμV emf.

f) The measurement should be repeated under *extreme test conditions* with the modulating signal at 1 000 Hz and the frequency deviation equal to 70 % of the *maximum permissible frequency deviation* at the *nominal frequency* and also with the carrier frequency offset by plus and minus half the limit value of the frequency tolerance for the corresponding transmitter.

8.1.11 Hum and noise for analogue speech

8.1.11.1 Definition

The "hum and noise" of a receiver for analogue speech is the ratio, expressed in decibels, of the audio frequency power output produced by a radio frequency test signal without modulation to the audio frequency power output produced by a signal with specified test modulation.

8.1.11.2 Method of measurement

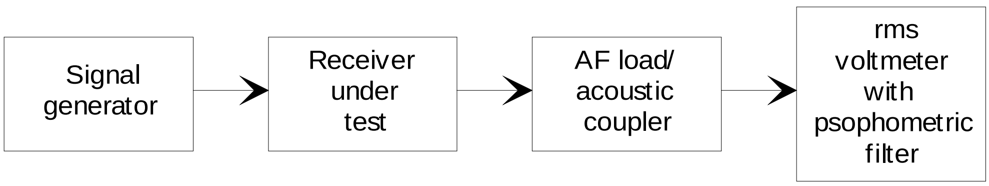


Figure 75: Measurement arrangement

a) An *audio frequency load* and an rms voltmeter with *psophometric weighting network* should be connected to the receiver output terminals.

b) A signal generator should be connected to the receiver input. The signal generator should be at the *nominal frequency* of the receiver and should have *test modulation A-M1*. The signal generator output should be adjusted to a level of +30 dBµV emf.

c) The receiver volume control should be adjusted to the manufacturers *rated audio output power* into the stated resistive load. In the case of a stepped power control it should be the first position which gives a power level not less than the *rated audio output power*.

d) The output level should be recorded.

e) The modulation should be removed and the new level recorded.

f) The "hum and noise" for analogue speech should be recorded as is the ratio of the values recorded in steps e) and d) expressed in dB.

8.1.12 Multipath sensitivity

8.1.12.1 Multipath sensitivity for bit stream

8.1.12.1.1 Definition

The multipath sensitivity for bit stream of the receiver is the rms value of the level of a Rayleigh fading signal, at the receiver input, at the nominal frequency of the receiver with test modulation D-M2 signal which produces a bit error ratio of 10^{-2}.

8.1.12.1.2 Method of measurements

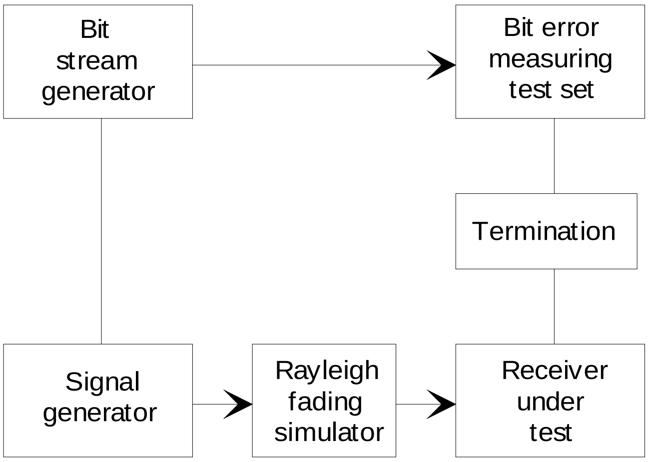


Figure 76: Measuring arrangement

The Rayleigh fading simulator may consist of two uncorrelated digital pseudorandom generators with third order digital filters to shape the noise power spectra. The bandwidth corresponds to the Doppler shift of the simulated speed. The two noise sources modulate two RF signals 90 degrees out of phase. The combined signal has a Rayleigh distributed amplitude. Diversity reception Rayleigh fading simulators should have a cross-correlation coefficient less than 0,1.

a) The signal generator should be connected to the receiver input via a Rayleigh fading simulator, adjusted for a 10 km/h simulated vehicle speed. The signal generator should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*.

b) The method of measurement of measured usable sensitivity for bit stream should then be applied, except that the minimum length of the bit pattern should be 2 500 bits or:

$$\frac{43\ 200 \times (\text{bit rate})}{(\text{vehicle speed in km/h}) \times (\text{operating frequency in MHz})}$$

which ever is the greater.

c) If an error correcting code is used the measurement should be repeated for the other specified values for the vehicle speed.

d) The amplitude of the signal at the input of the receiver should be adjusted until a bit error ratio of 10^{-2} is obtained.

e) The rms value of the level applied at the input of the receiver should be recorded (in dBV emf) as being the multipath sensitivity.

f) Whenever needed, the degradation factor of the measured usable sensitivity for bit stream due to the effect of fading should be obtained by the difference between the value recorded in step e) and the corresponding value recorded previously (as defined in subclause 8.1.1.2 step c).

g) Return to step a), apply a 50 km/h simulated vehicle speed and repeat steps b) to f).

h) Return to step a), apply a 90 km/h simulated vehicle speed and repeat steps b) to f).

8.1.12.2 Multipath sensitivity for messages

8.1.12.2.1 Definition

The multipath sensitivity for messages of the receiver is the rms value of the level of a Rayleigh fading signal, at the receiver input, at the nominal frequency of the receiver with test modulation D-M3 signal which produces a specified successful message ratio of 80 %.

8.1.12.2.2 Method of measurements

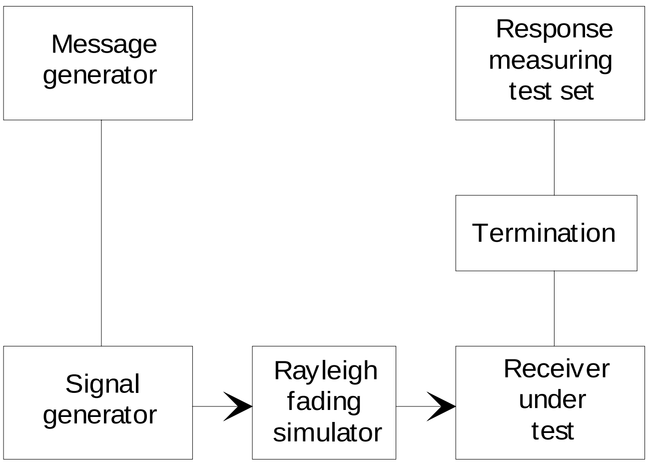


Figure 77: Measuring arrangement

The Rayleigh fading simulator may consist of two uncorrelated digital pseudorandom generators with third order digital filters to shape the noise power spectra. The bandwidth corresponds to the doppler shift of the simulated speed. The two noise sources modulate two RF signals 90 degrees out of phase. It can be shown that the combined signal has a Rayleigh distributed amplitude. Diversity reception Rayleigh fading simulators should have a cross-correlation coefficient less than O.1.

a) The signal generator should be connected to the receiver input via a Rayleigh fading simulator, adjusted for a 90 km/h simulated vehicle speed. The signal generator should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*.

b) The method of measurement of measured usable sensitivity for messages steps b) to d) should then be used.

c) The multipath sensitivity for messages is the average of the values recorded in step b).

d) Whenever needed, the degradation factor of the measured usable sensitivity for messages due to the effect of fading should be obtained by the difference between the value recorded in step c) and the corresponding value recorded previously (as defined in subclause 8.1.1.3 step e).

e) Return to step a), apply a 50 km/h simulated vehicle speed and repeat steps b) to d).

f) Return to step a), apply a 90 km/h simulated vehicle speed and repeat steps b) to d).

8.1.13 Bit error ratio at high input levels

8.1.13.1 Definition

The bit error ratio is the ratio of the number of bits incorrectly received to the total number of bits received.

8.1.13.2 Method of measurement

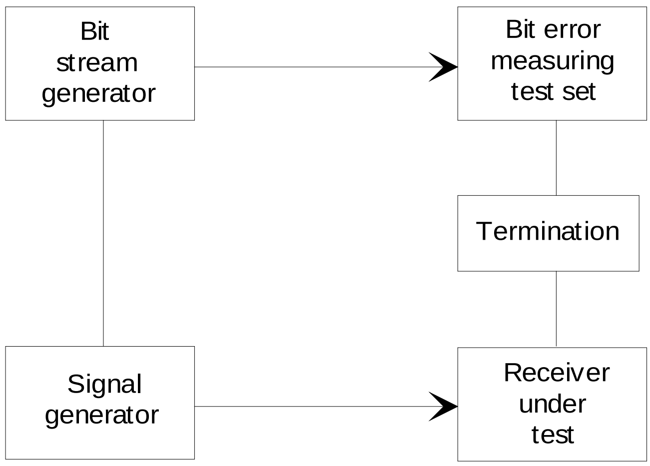


Figure 78: Measurement arrangement

a) A signal generator should be connected to the receiver input. The signal generator should be, at the *nominal frequency* and should have *test modulation D-M2.*

b) The amplitude at the signal generator should be adjusted to a level at 30 dB above the level of the *wanted signal level.*

c) The number of errors that occur at the receiver output, during a period of 3 minutes, is counted.

d) The bit error ratio should be recorded as the ratio of the number of bits incorrectly received to the total number of bits received.

e) The measurement should be repeated with the input signal of the receiver at a level of 100 dB above the level of the *wanted signal level.*

8.1.14 Opening delay for data

8.1.14.1 Definition

The receiver opening delay is the time which elapses between the application of a test signal to the receiver and the establishment of the receiving condition.

8.1.14.2 Method of measurement

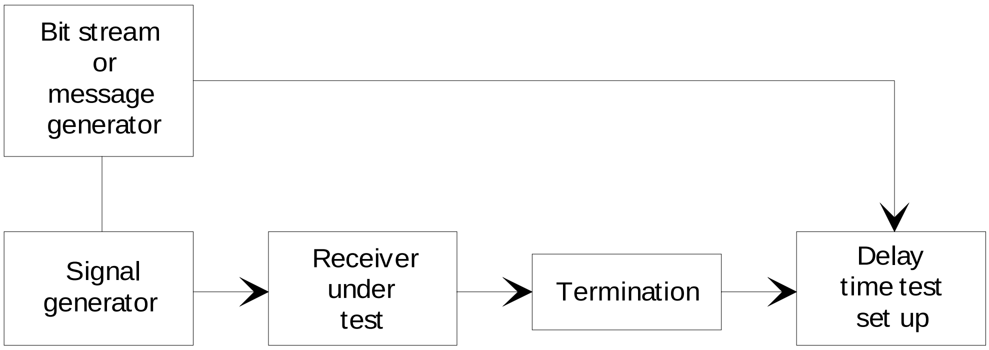


Figure 79: Measuring arrangement

a) A signal generator should be connected to the receiver input. The signal generator should be at the *nominal frequency* and should be adjusted to give a signal level at the receiver input 20 dB above the *wanted signal level*.

b) The signal generator should have *test modulation D-M2* or *D-M3*.

c) When the *D-M3* is used, the measurement is repeated three times.

d) The delay between the application of the test signal to the receiver and the establishment of the receiving condition is measured.

8.2 Radiated tests

The tests carried out on receivers can be divided into two categories, namely sensitivity and immunity.

Sensitivity tests determine how well a receiver can accept wanted signals in the absence of interference, whereas immunity tests, by involving 2 or 3 signal generators, determine the ability of a receiver to accept a wanted signal in the presence of different types of interference. The latter tests should, strictly speaking, contain the word "immunity" in their titles but, in the present document, historically well-established test names such as co-channel rejection and adjacent channel selectivity have been retained.

8.2.1 Sensitivity tests (30 MHz to 1 000 MHz)

The test method for measuring the maximum or average usable sensitivity of a receiver is in two parts. In the first part, a Transform Factor for the test site (i.e. the relationship in decibels between the output power level (in dBm) from the signal generator to the resulting electric field strength (in dBμV/m) at the point of test) is determined. In the second part, the sensitivity of the EUT is measured by finding the lowest output level from the signal generator which produces the required response at each of 8 angles in the horizontal plane.

The receiver output depends on the type of information the receiver has been designed to demodulate. There are principally 3 different types of information: analogue speech, bit stream and messages.

Definition

For analogue speech:

The ***maximum usable sensitivity*** expressed as field strength is the minimum of 8 field strength (in μV/m) measurements (at 45° increments in the horizontal plane) at the nominal frequency of the receiver and with specified test modulation, which produces a SINAD ratio of 20 dB measured at the receiver input through a telephone psophometric weighting network. The starting horizontal angle is the reference orientation as stated by the manufacturer.

The ***average usable sensitivity*** expressed as field strength is the average of 8 field strength (in µV/m) measurements (at 45° increments in the horizontal plane) at the nominal frequency of the receiver and with specified test modulation, which produces a SINAD ratio of 20 dB measured at the receiver input through a telephone psophometric weighting network. The starting horizontal angle is the reference orientation as stated by the manufacturer.

For bit stream:

The ***maximum usable sensitivity*** expressed as field strength is the minimum of 8 field strength (in µV/m) measurements (at 45° increments in the horizontal plane) at the nominal frequency of the receiver and with specified test modulation, which produces, after demodulation, a data signal with a bit error ratio of 10^{-2} measured at the receiver input. The starting horizontal angle is the reference orientation as stated by the manufacturer.

The ***average usable sensitivity*** expressed as field strength is the average of 8 field strength (in µV/m) measurements (at 45° increments in the horizontal plane) at the nominal frequency of the receiver and with specified test modulation, which produces, after demodulation, a data signal with a bit error ratio of 10^{-2} measured at the receiver input. The starting horizontal angle is the reference orientation as stated by the manufacturer.

For messages:

The ***maximum usable sensitivity*** expressed as field strength is the minimum of 8 field strength (in µV/m) measurements (at 45° increments in the horizontal plane) at the nominal frequency of the receiver, and with specified test modulation, which produces, after demodulation, a message acceptance ratio of 80 % measured at the receiver input. The starting horizontal angle is the reference orientation as stated by the manufacturer.

The ***average usable sensitivity*** expressed as field strength is the average of 8 field strength (in µV/m) measurements (at 45° increments in the horizontal plane) at the nominal frequency of the receiver and with specified test modulation, which produces, after demodulation, a message acceptance ratio of 80 % measured at the receiver input. The starting horizontal angle is the reference orientation as stated by the manufacturer.

8.2.1.1 Anechoic Chamber

8.2.1.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Anechoic Chamber;
- Test antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Measuring antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- RF Signal generator;
- Receiving device (measuring receiver or spectrum analyser).

Additional requirements for analogue speech:

- AF source;
- SINAD Meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 29).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

8.2.1.1.2 Method of measurement

Determination of the Transform Factor for the Anechoic Chamber

1 For this part of the test, it is necessary to position the measuring antenna within the chamber such that its phase centre is at the same point that the phase centre of the EUT will occupy in the second part of the test (the EUT being mounted in an orientation which matches that of its normal usage as declared by the manufacturer). The precise point should always be on the axis of rotation of the turntable, and either on the central axis of the chamber or at a convenient height within the quiet zone. The vertical offset of the phase centre of the EUT from the central axis (if any) should be either measured remotely or determined by sitting the EUT on the turntable. The vertical offset should be recorded on page 2 of the log book results sheet (table 29).

NOTE 1: If the position of the phase centre within the EUT is unknown but the antenna is visible, then the vertical offset from the central axis of the point at which the antenna meets the case of the EUT should be used. If the phase centre is unknown and there is no visible antenna the volume centre of the EUT should be used instead.

2 The measuring antenna (in the recommended scheme: a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) should be adjusted to correspond to the nominal frequency of the EUT and positioned with its phase centre on the axis of rotation of the turntable and at the same vertical offset from the central axis of the chamber (if any) as determined for the EUT in step 1. The measuring antenna should be oriented for vertical polarization.

NOTE 2: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

NOTE 3: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 The measuring antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber, to the receiving device.

4 The test antenna (identical to the measuring antenna) should be tuned to the nominal frequency of the EUT and mounted with the height of its phase centre at the same vertical offset from the central axis of the chamber (if any) as the measuring antenna, so that the measurement axis is parallel to the central axis of the chamber. The test antenna should be oriented to the same polarization as the measuring antenna.

NOTE 4: The measurement axis is the straight line joining the phase centres of the transmitting and receiving devices.

5 The test antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber, to the signal generator whose output should be unmodulated. See figure 80. The signal generator should be tuned to the nominal frequency of the EUT.

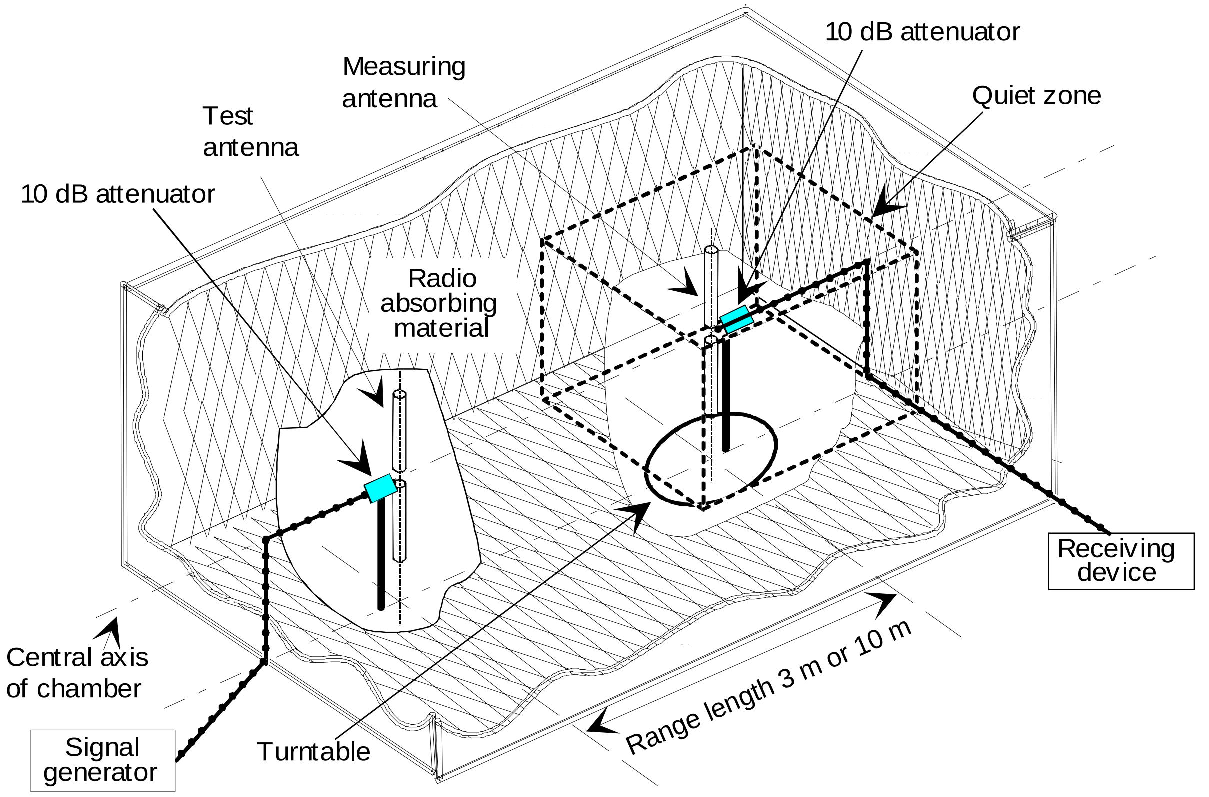


Figure 80: Equipment layout for determining the Transfer Factor during Sensitivity tests in an Anechoic Chamber

6 The output level of the signal generator should be adjusted until a received signal level at least 20 dB above the noise floor is observed on the receiving device.

7 The received signal level (dBµV) appearing on the receiving device along with the output level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 29). The Transform Factor for the chamber (i.e. the factor relating the output power level from the signal generator (dBm) to the resulting field strength (dBµV/m) at the point of measurement) should then be calculated according to the following formula:

*Transform Factor (*dB*)* = *received signal level (*dBµV*)*

+ *measuring antenna cable loss*

+ *measuring antenna attenuator loss*

+ *measuring antenna balun loss*

+ *mutual coupling and mismatch loss correction factor (if applicable)*

+ *antenna factor of the measuring antenna*

- *signal generator output level (dBm)*

NOTE 5: Guidance for deriving/calculating/finding the unknown values in the above formula for Transform Factor are given in table 28. The resulting values should be entered on page 2 of the log book results sheet (table 29).

The resulting value for the Transform Factor should be entered on page 2 of the log book results sheet (table 29).

Table 28: Guidance for deriving Transform Factor

Values in the formula for Transform Factor
Measuring antenna cable loss: Obtained directly from the calibration data.
Measuring antenna attenuator loss: Obtained from calibration data.
Measuring antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss correction factors between the test antenna and the measuring antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A.19. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Antenna factor of the measuring antenna: For ANSI dipoles: Antenna factor = 20 $\log_{10}$ (f) - 31,4 dB dB/m (where f is the frequency in MHz) For other types the value can be obtained from calibration data.

Sensitivity measurement on the EUT

8 The measuring antenna should be replaced on the turntable by the EUT. The EUT should be positioned on the turntable such that its phase centre is in the same place as formerly occupied by the phase centre of the measuring antenna.

NOTE 6: If the position of the phase centre within the EUT is unknown but the antenna is a single rod which is visible and vertical in normal usage, the axis of the antenna should be aligned with the axis of rotation of the turntable. If the phase centre is not known and there is no visible antenna the volume centre of the EUT should be aligned with the axis of rotation of the turntable.

9 The EUT should be mounted in an orientation which matches that of its normal usage as declared by the manufacturer. The normal to its reference face should point directly towards the antenna mast. This is the 0° reference angle for this test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 29).

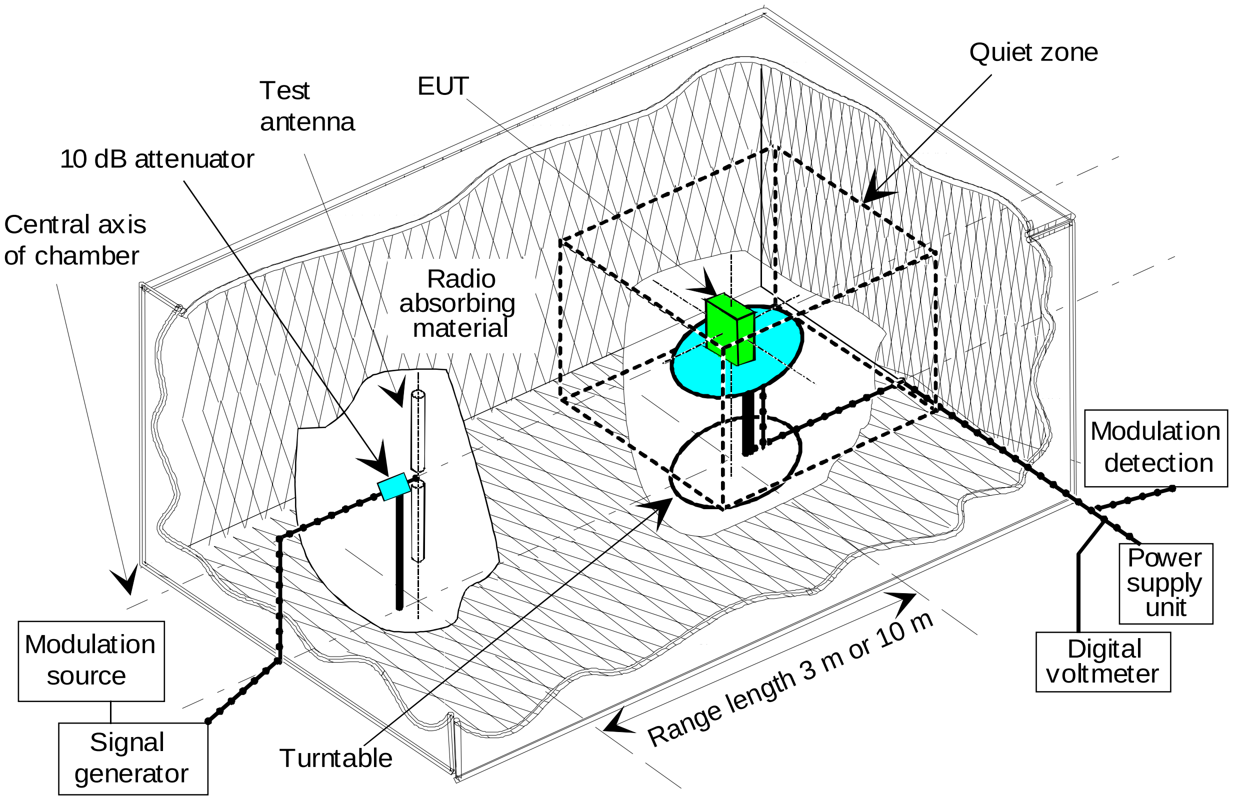


Figure 81: Anechoic Chamber set-up for Sensitivity tests on the EUT

For analogue speech:

10a The EUT should be connected to the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) through an AF load or by an acoustic coupler which is made from low dielectric constant (i.e. less than 1,5) material(s) for EUTs not fitted with a direct connection. See figure 81.

10b The signal generator output should be modulated with test modulation AM-1 (produced by the AF source) and its output level should be adjusted until a psophometrically weighted SINAD ratio of 20 dB is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 29).

10c The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle step 10b should be repeated.

10d The 8 values of signal generator output power level resulting from steps 10b and 10c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBµV/m and then secondly converting dBµV/m to µV/m i.e.:

1) field strength (dBµV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (µV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$

The resulting values in µV/m should be entered on page 2 of the log book results sheet (table 29).

10e The test procedure should now continue with step 11.

For bit stream:

10a The EUT should be connected to the modulation detector (a bit error measuring test set, which should also receive a direct input from the bit stream generator) by a direct connection. See figure 81.

10b The signal generator output should be modulated with test modulation DM-2 (produced by the bit stream generator) and its output level should be adjusted until a bit error ratio of 10^{-2} is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 29).

10c The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle step 10b should be repeated.

10d The 8 values of signal generator output power level resulting from steps 10b and 10c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBµV/m and then secondly converting dBµV/m to µV/m i.e.:

1) field strength (dBµV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (µV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$

The resulting values in µV/m should be entered on page 2 of the log book results sheet (table 29).

10e The test procedure should now continue with step 11.

For messages:

10a The EUT should be connected to the modulation detector (a response measuring test set) via an acoustic coupler (pipe) which is made from low dielectric constant (i.e. less than 1,5) material(s). See figure 81.

10b The signal generator output should be modulated with test modulation DM-3 (produced by the message generator) and its output level should be adjusted until a message acceptance ratio of < 10 % is obtained from the EUT.

10c The test message should be transmitted repeatedly from the test antenna, whilst observing for each message whether a successful response is obtained. The output level of the signal generator should be increased by 2 dB for each occasion that a successful response is NOT obtained.

10d Step 10c should be repeated until three consecutive successful responses are observed at the same output level from the signal generator. The output level from the signal generator should be recorded on page 2 of the log book results sheet (table 29).

10e The output signal level from the signal generator should be reduced by 1 dB. The new signal level should be recorded on page 2 of the log book results sheet (table 29) and the response of the EUT observed.

10f If a successful response is NOT obtained, the output signal level should be increased by 1 dB and the new level recorded in the results sheet. If a successful response IS obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the output signal level from the signal generator should be reduced by 1 dB and the new level recorded in the results sheet. No signal levels should be recorded unless preceded by a change of level.

10g Step 10f should be repeated until a total of 10 recorded values for the signal generator output level have been entered on page 2 of the log book results sheet (table 29).

10h The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle steps 10b to 10g should be repeated.

10i For each angle, the 10 recorded values of the signal generator output level (dBm) should be converted to field strength (µV/m) by firstly adding the Transform Factor to produce the field strength in dBµV/m and then secondly converting dBµV/m to µV/m i.e.:

1) field strength (dBµV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (µV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$

The resulting values in µV/m should be entered on page 2 of the log book results sheet (table 32).

10j For each angle, the 10 new recorded values of field strength in μV/m should be averaged according to the following formula:

$$\text{Average field strength } (\mu V/m) = \sqrt{\left(\frac{10}{\sum_{i=1}^{i=10} \frac{1}{field\ strength\ (\mu V/m)_i^{\ 2}}} \right)}$$

The resulting 8 average values should also be entered on page 2 of the log book results sheet (table 29).

10k The procedure should continue with step 11.

11 For the maximum sensitivity test only, the lowest of the 8 values of field strength (μV/m) calculated during the multiple-stage step 10 represents the minimum field strength to which the EUT responds. This minimum value of field strength (μV/m) should be entered on page 2 of the log book results sheet (table 29) as the maximum sensitivity.

12 For the average sensitivity test only, the average of the 8 values of field strength (μV/m) calculated during the multiple-stage step 10 represents the average field strength to which the EUT responds. This average value of field strength in μV/m should now be calculated by the following:

$$\text{Average field strength } (\mu V/m) = \sqrt{\left(\frac{8}{\sum_{i=1}^{i=8} \frac{1}{field\ strength\ (\mu V/m)_i^{\ 2}}} \right)}$$

This average value of field strength (μV/m) should be entered on page 2 of the log book results sheet (table 29) as the average sensitivity.

13 Steps 2 to 12 should be repeated with both the test and measuring antennas oriented for horizontal polarization.

8.2.1.1.3 Procedure for completion of the results sheets

All the necessary processing of the measured results is carried out during the course of the test procedure. The only calculation that remains to be performed is the determination of the expanded uncertainty of the measurement. This should be performed as given in TR 100 028-2 [7], subclause 8.2.1.1 and the resulting value should be entered in the overall results sheet (table 30).

8.2.1.1.4 Log book entries

Table 29: Log book results sheet

RECEIVER SENSITIVITY		**Date:**			**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**		**Humidity:..............%** **Type No:.............**			**Frequency:............MHz** **Serial No:.................**
Range length:......................					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Measuring antenna				N/A	
Measuring antenna attenuator					N/A
Measuring antenna cable					N/A
Ferrite beads			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
AF source (if applicable)			N/A	N/A	N/A
SINAD meter (if applicable)			N/A	N/A	N/A
AF load (if applicable)			N/A	N/A	N/A
Bit stream generator (if applicable)			N/A	N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A	N/A
Message generator (if applicable)			N/A	N/A	N/A
Response measuring test set (if applicable)			N/A	N/A	N/A
Mounting configuration of EUT					

RECEIVER SENSITIVITY (analogue speech)									**Date:**								**PAGE 2 of 2**
Vertical polarization									**Horizontal polarization**								
Vertical offset from the central axis								m	Vertical offset from the central axis								m
Received signal level								dBμV	Received signal level								dBμV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle for 20 dB SINAD									**Signal generator level (dBm) against angle for 20 dB SINAD**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
Conversion to μV/m									**Conversion to μV/m**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
MAXIMUM Sensitivity								μV/m	MAXIMUM Sensitivity								μV/m
AVERAGE Sensitivity								μV/m	AVERAGE Sensitivity								μV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

RECEIVER SENSITIVITY (bit stream)									**Date:**								**PAGE 2 of 2**
Vertical polarization									**Horizontal polarization**								
Vertical offset from the central axis								m	Vertical offset from the central axis								m
Received signal level								dBμV	Received signal level								dBμV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle for 10^{-2} BER									**Signal generator level (dBm) against angle for 10^{-2} BER**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
Conversion to μV/m									**Conversion to μV/m**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
MAXIMUM Sensitivity								μV/m	MAXIMUM Sensitivity								μV/m
AVERAGE Sensitivity								μV/m	AVERAGE Sensitivity								μV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

RECEIVER SENSITIVITY (messages)									Date:							PAGE 2 of 2	
Vertical polarization									Horizontal polarization								
Vertical offset from the central axis								m	Vertical offset from the central axis								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle									**Signal generator level (dBm) against angle**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Conversion to µV/m									**Conversion to µV/m**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Ave.									**Ave.**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

8.2.1.1.5 Statement of results

The results should be presented in tabular form as shown in table 30.

Table 30: Overall results sheet

RECEIVER SENSITIVITY		Date:	PAGE 1 of 1
Vertical polarization		**Horizontal polarization**	
MAXIMUM Usable Sensitivity	µV/m	MAXIMUM Usable Sensitivity	µV/m
AVERAGE Usable Sensitivity	µV/m	AVERAGE Usable Sensitivity	µV/m
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)	dB

8.2.1.2 Anechoic Chamber with a ground plane

For Sensitivity testing in an Anechoic Chamber with a ground plane reference should be made to the Open Area Test Site test method (subclause 8.2.1.3), since the procedures are identical.

The test equipment set-up for the derivation of the Transfer Factor is shown in figure 82 whilst the set-up for the sensitivity measurement is shown in figure 83.

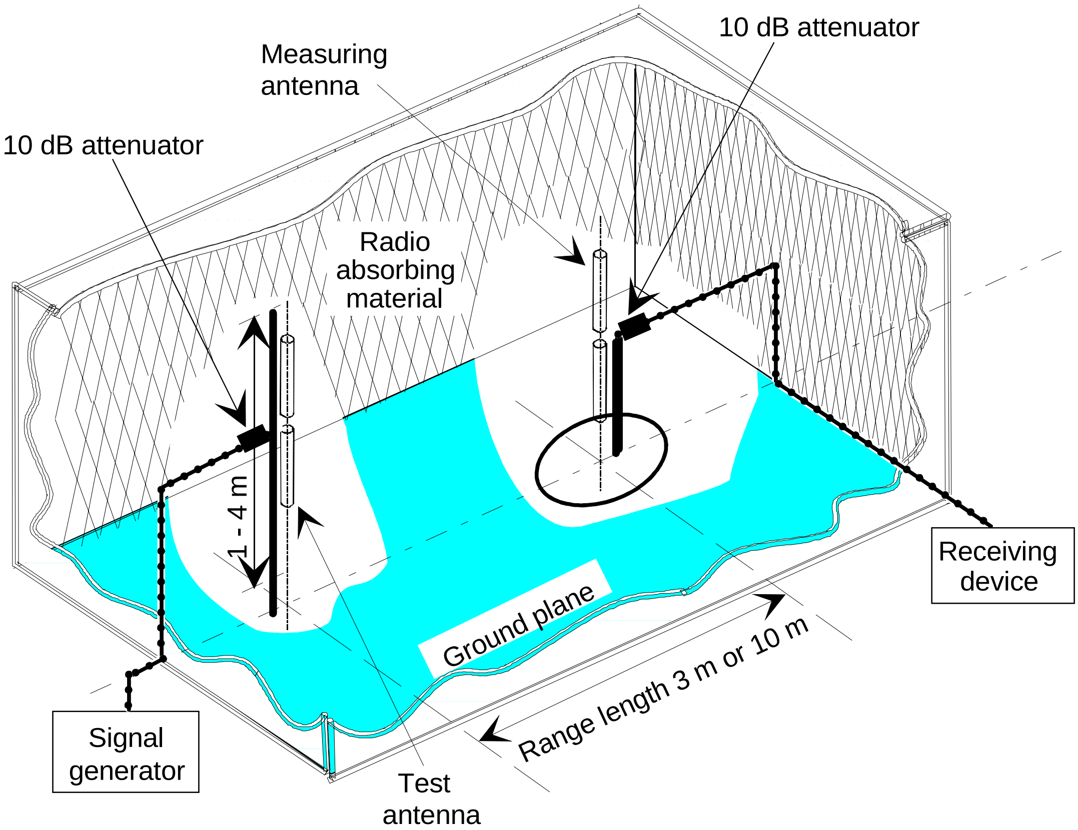


Figure 82: Equipment layout for the derivation of the Transform Factor during Sensitivity tests in an Anechoic Chamber with a ground plane

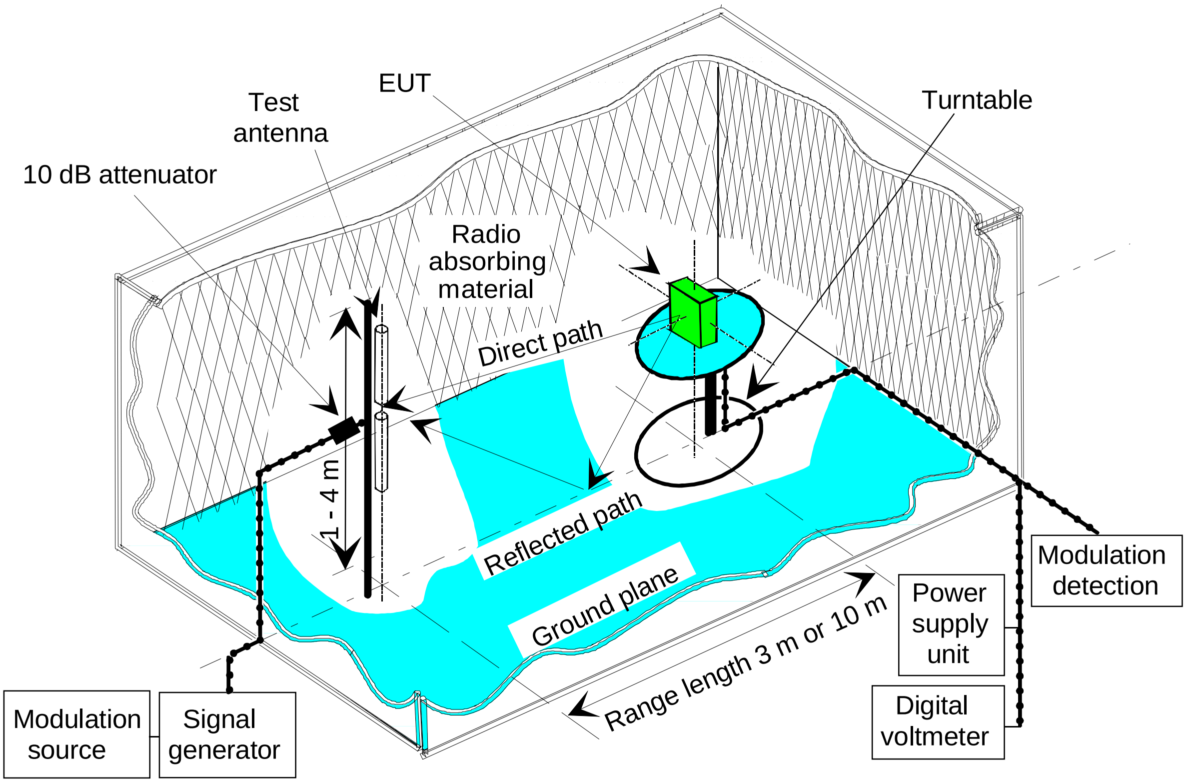


Figure 83: Anechoic chamber with a ground plane set-up for Sensitivity tests on the EUT

To complete the overall results sheet for this test, the value for expanded measurement uncertainty should be calculated according to TR 100 028-2 [7], subclause 8.2.1.2.

8.2.1.3 Open Area Test Site

8.2.1.3.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Open Area Test Site;
- Test antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Measuring antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- RF Signal generator;
- Receiving device (measuring receiver or spectrum analyser).

Additional requirements for analogue speech:

- AF source;
- SINAD Meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 32).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

8.2.1.3.2 Method of measurement

Determination of the Transform Factor for the test site

1 For this part of the test, it is necessary to position the measuring antenna such that its phase centre is at the same height above the ground plane as the phase centre of the EUT in the second part of the test. The height of the phase centre of the EUT should be either measured remotely or determined by sitting the EUT on the turntable. The height above the turntable (whose mounting surface should be at the height above the ground plane as specified in the relevant Standard) should be recorded on page 2 of the log book results sheet (table 32).

NOTE 1: If the position of the phase centre within the EUT is unknown, but the antenna is visible, then the height above the ground plane of the point at which the antenna meets the case of the EUT should be used. If the phase centre is unknown and there is no visible antenna, the volume centre of the EUT should be used instead.

2 The measuring antenna (in the recommended scheme: a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) should be adjusted to correspond to the nominal frequency of the EUT and positioned with its phase centre on the axis of rotation of the turntable and at the height above it as recorded in step 1. It should be oriented for vertical polarization.

NOTE 2: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

NOTE 3: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 The measuring antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site, to the receiving device.

4 The test antenna (identical to the measuring antenna) should be mounted on the antenna mast, tuned to the nominal frequency of the EUT and oriented for vertical polarization.

5 The test antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site, to the signal generator whose output is unmodulated. See figure 84. The signal generator should be tuned to the nominal frequency of the EUT.

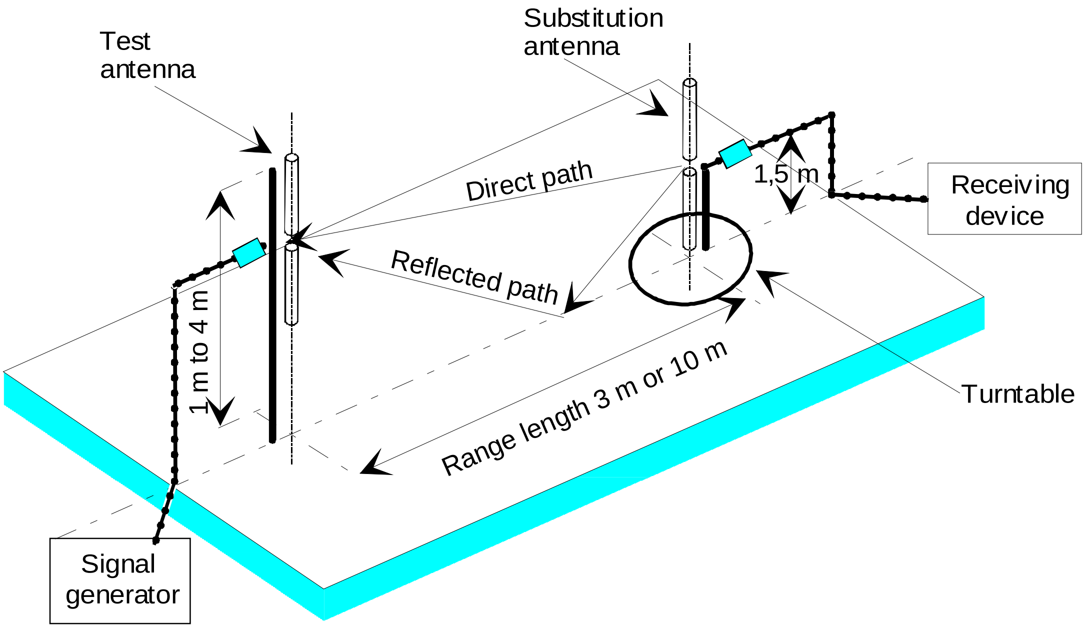


Figure 84: Equipment layout for the derivation of the Transfer Factor during Sensitivity tests on an Open Area Test Site

6 The output level of the signal generator should be adjusted until a received signal level at least 20 dB above the noise floor is observed on the receiving device.

7 The test antenna should be raised and lowered through the specified range of heights whilst monitoring the received signal level on the receiving device. The test antenna should be positioned at the height corresponding to the maximum received signal. This height should be recorded on page 2 of the log book results sheet (table 32).

NOTE 4: The true maximum may lie beyond the top of the mast, in which case the maximum receivable level should be at the top of the height range.

8 The measuring antenna should be rotated in the horizontal plane until the maximum level is detected on the receiving device.

NOTE 5: This is to correct for possible misalignment of a directional beam i.e. dipoles used in horizontally polarized tests. This step can be omitted when dipoles are used in vertically polarized tests.

9 The maximum received signal level (dBμV) appearing on the receiving device along with the output level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 32). The Transform Factor for the test site (i.e. the factor relating the output power level from the signal generator (dBm) to the resulting field strength (dBμV/m) at the point of measurement) should be calculated according to the following formula:

Transform Factor = maximum received signal level (dBμV)

+ *measuring antenna cable loss*

+ *measuring antenna attenuator loss*

+ *measuring antenna balun loss*

+ *mutual coupling and mismatch loss correction factor (if applicable)*

+ *antenna factor of the measuring antenna*

- signal generator output level (dBm)

NOTE 6: Guidance for deriving/calculating/finding the values for all of the unknown factors in the above are given in table 31. These values should be entered on page 2 of the log book results sheet (table 32).

The resulting value for the Transform Factor should be entered on page 2 of the log book results sheet (table 32).

Table 31: Guidance for deriving Transform Factor

Values in the formula for Transform Factor
Measuring antenna cable loss: Obtained directly from the calibration data.
Measuring antenna attenuator loss: Obtained directly from the calibration data.
Measuring antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss correction factors between the test antenna and the measuring antenna: For ANSI dipoles (30 MHz to 180 MHz), values can be obtained from annex A: table A20. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Antenna factor of the measuring antenna: For ANSI dipoles: Antenna factor = 20 $\log_{10}(f)$ - 31,4 dB/m (where f is the frequency in MHz) For other types the value can be obtained from calibration data.

Sensitivity measurement on the EUT

10 The measuring antenna should be replaced on the turntable by the EUT. The EUT should be positioned on the turntable such that its phase centre is in the same place as formerly occupied by the phase centre of the measuring antenna.

NOTE 7: If the position of the phase centre within the EUT is unknown but the antenna is a single rod which is visible and vertical in normal usage, the axis of the antenna should be aligned with the axis of rotation of the turntable. If the phase centre is not known and there is no visible antenna the volume centre of the EUT should be aligned with the axis of rotation of the turntable.

11 The EUT should be mounted in an orientation which matches that of its normal usage as declared by the manufacturer. The normal to its reference face should point directly towards the antenna mast. This is the 0° reference angle for this test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 32).

For analogue speech

12a The EUT should be connected to the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) through an AF load or by an acoustic coupler which is made from low dielectric constant (i.e. less than 1,5) material(s) for EUTs not fitted with a direct connection. See figure 85.

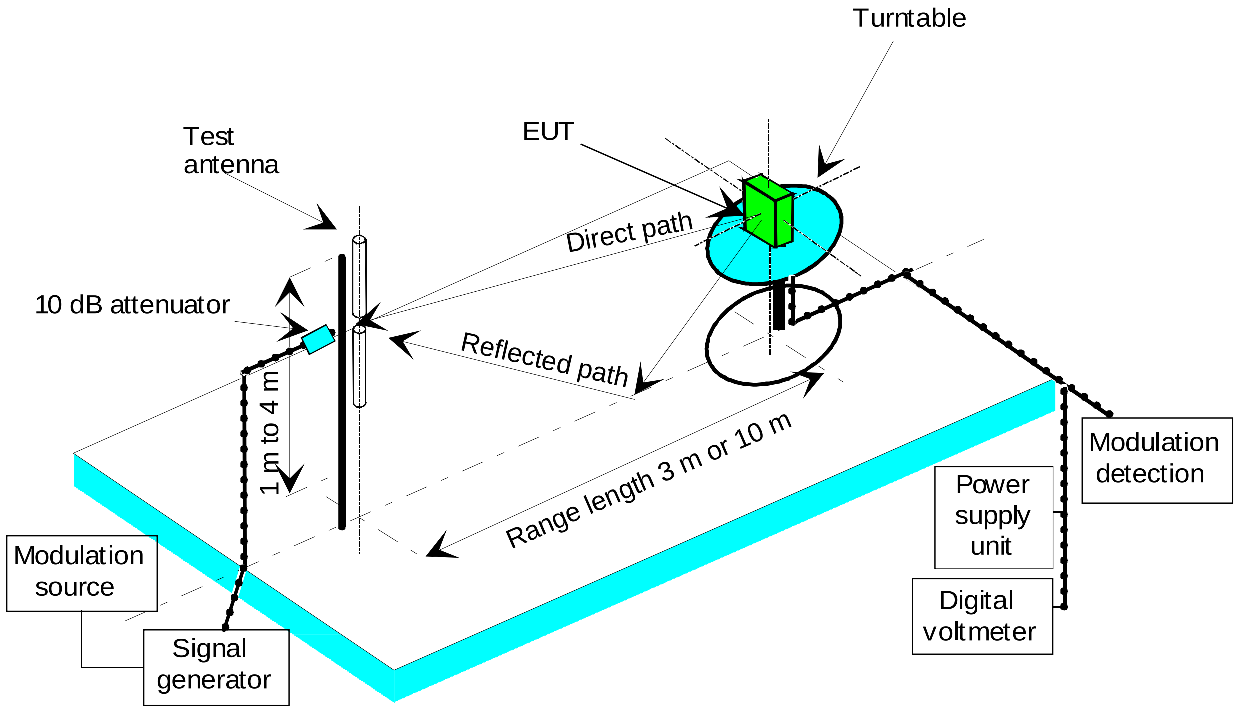


Figure 85: Open Area Test Site set-up for Sensitivity tests on the EUT

12b The signal generator output should be modulated with test modulation AM-1 (produced by the AF source) and its output level should be adjusted until a psophometrically weighted SINAD ratio of 20 dB is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 32).

12c The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle step 12b should be repeated.

12d The 8 values of signal generator output power level resulting from steps 12b and 12c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBµV/m and then secondly converting dBµV/m to µV/m i.e.:

1) field strength (dBµV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (µV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$

The resulting values in µV/m should be entered on page 2 of the log book results sheet (table 32).

12e The test procedure should now continue with step 13.

For bit stream

12a The EUT should be connected to the modulation detector (a bit error measuring test set, which should also receive a direct input from the bit stream generator) by a direct connection. See figure 85.

12b The signal generator output should be modulated with test modulation DM-2 (produced by the bit stream generator) and its output level should be adjusted until a bit error ratio of 10^{-2} is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 32).

12c The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle step 12b should be repeated.

12d The 8 values of signal generator output power level resulting from steps 12b and 12c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBμV/m and then secondly converting dBμV/m to μV/m i.e.:

1) field strength (dBμV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (μV/m) = 10^(field strength(dBμV/m)/20)

The resulting values in μV/m should be also entered on page 2 of the log book results sheet (table 32).

12e The test procedure should now continue with step 13.

For messages

12a The EUT should be connected to the modulation detector (a response measuring test set) via an acoustic coupler (pipe) which is made from low dielectric constant (i.e. less than 1,5) material(s). See figure 85.

12b The signal generator output should be modulated with test modulation DM-3 (produced by the message generator) and its output level should be adjusted until a message acceptance ratio of < 10 % is obtained from the EUT.

12c The test message should be transmitted repeatedly from the test antenna, whilst observing for each message whether a successful response is obtained. The output level of the signal generator should be increased by 2 dB for each occasion that a successful response is NOT obtained.

12d Step 12c should be repeated until three consecutive successful responses are observed at the same output level from the signal generator. The output level from the signal generator should be recorded on page 2 of the log book results sheet (table 32).

12e The output signal level from the signal generator should be reduced by 1 dB. The new signal level should be recorded on page 2 of the log book results sheet (table 32) and the response of the EUT observed.

12f If a successful response is NOT obtained, the output signal level should be increased by 1 dB and the new level recorded in the results sheet. If a successful response IS obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the output signal level from the signal generator should be reduced by 1 dB and the new level recorded in the results sheet. No signal levels should be recorded unless preceded by a change of level.

12g Step 12f should be repeated until a total of 10 recorded values for the signal generator output level have been entered on page 2 of the log book results sheet (table 32).

12h The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle steps 12b to 12g should be repeated.

12i For each angle, the 10 recorded values of the signal generator output level (dBm) should be converted to field strength (μV/m) by firstly adding the Transform Factor to produce the field strength in dBμV/m and then secondly converting dBμV/m to μV/m i.e.:

1) field strength (dBμV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (μV/m) = 10^(field strength(dBμV/m)/20)

The resulting values in μV/m should be entered on page 2 of the log book results sheet (table 32).

12j For each angle, the 10 new recorded values of field strength in μV/m should be averaged according to the following formula:

$$\text{Average field strength } (\mu V/m) = \sqrt{\left(\frac{10}{\sum_{i=1}^{i=10} \frac{1}{field\ strength\ (\mu V/m)_i^2}} \right)}$$

The resulting 8 average values should also be entered on page 2 of the log book results sheet (table 32).

12k The procedure should continue with step 13.

13 For the maximum sensitivity test only, the lowest of the 8 values of field strength (μV/m) calculated during the multiple-stage step 12 represents the minimum field strength to which the EUT responds. This minimum value of field strength in μV/m should be entered on page 2 of the log book results sheet (table 32) as the maximum sensitivity.

14 For the average sensitivity test only, the average of the 8 values of field strength (μV/m) calculated during the multiple-stage step 12 represents the average field strength to which the EUT responds. This average value of field strength in μV/m should now be calculated by the following:

$$\text{Average field strength } (\mu\text{V/m}) = \sqrt{\left(\frac{8}{\sum_{i=1}^{i=8} \frac{1}{\textit{field strength } (\mu V/m)_i^{\,2}}}\right)}$$

This value of average field strength (μV/m) should be entered on both page 2 of the log book results sheet (table 32) as the average sensitivity.

15 Steps 3 to 14 should be repeated with both the test and measuring antennas oriented for horizontal polarization.

8.2.1.3.3 Procedure for completion of the results sheets

All the necessary processing of the measured results is carried out during the course of the test procedure. The only calculation that remains to be performed before the overall results sheet (table 33) can be completed is the determination of expanded uncertainty of the measurement. This should be carried out in accordance with ETR 028 [7], subclause 8.2.1.3 and the resulting value entered in the overall results sheet (table 33).

8.2.1.3.4 Log book entries

Table 32: Log book results sheet

RECEIVER SENSITIVITY		**Date:**			**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**		**Humidity:..............%** **Type No:.............**		**Frequency:............MHz** **Serial No:.................**	
Range length:......................					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Measuring antenna				N/A	
Measuring antenna attenuator					N/A
Measuring antenna cable					N/A
Ferrite beads			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
AF source (if applicable)			N/A	N/A	N/A
SINAD meter (if applicable)			N/A	N/A	N/A
Audio load (if applicable)			N/A	N/A	N/A
Bit stream generator (if applicable)			N/A	N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A	N/A
Message generator (if applicable)			N/A	N/A	N/A
Response measuring test set (if applicable)			N/A	N/A	N/A
Mounting configuration of EUT					

<table>
<tr><td colspan="9">RECEIVER SENSITIVITY (analogue speech)</td><td colspan="9">Date: PAGE 2 of 2</td></tr>
<tr><td colspan="9">Vertical polarization</td><td colspan="9">Horizontal polarization</td></tr>
<tr><td colspan="6">Height above the turntable</td><td colspan="3">m</td><td colspan="6">Height above the turntable</td><td colspan="3">m</td></tr>
<tr><td colspan="6">Height of the test antenna</td><td colspan="3">m</td><td colspan="6">Height of the test antenna</td><td colspan="3">m</td></tr>
<tr><td colspan="6">Received signal level</td><td colspan="3">dBμV</td><td colspan="6">Received signal level</td><td colspan="3">dBμV</td></tr>
<tr><td colspan="6">Output level from signal generator</td><td colspan="3">dBm</td><td colspan="6">Output level from signal generator</td><td colspan="3">dBm</td></tr>
<tr><td colspan="6">Transform Factor</td><td colspan="3">dB</td><td colspan="6">Transform Factor</td><td colspan="3">dB</td></tr>
<tr><td colspan="9">Signal generator level (dBm) against angle for 20 dB SINAD</td><td colspan="9">Signal generator level (dBm) against angle for 20 dB SINAD</td></tr>
<tr><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td></tr>
<tr><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Conversion to μV/m</td><td colspan="9">Conversion to μV/m</td></tr>
<tr><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td></tr>
<tr><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">MAXIMUM Sensitivity</td><td colspan="3">μV/m</td><td colspan="6">MAXIMUM Sensitivity</td><td colspan="3">μV/m</td></tr>
<tr><td colspan="6">AVERAGE Sensitivity</td><td colspan="3">μV/m</td><td colspan="6">AVERAGE Sensitivity</td><td colspan="3">μV/m</td></tr>
<tr><td colspan="18">Values in the formula for Transform Factor</td></tr>
<tr><td colspan="6">Measuring antenna cable loss</td><td colspan="3"></td><td colspan="6">Measuring antenna cable loss</td><td colspan="3"></td></tr>
<tr><td colspan="6">Measuring antenna attenuator loss</td><td colspan="3"></td><td colspan="6">Measuring antenna attenuator loss</td><td colspan="3"></td></tr>
<tr><td colspan="6">Measuring antenna balun loss</td><td colspan="3"></td><td colspan="6">Measuring antenna balun loss</td><td colspan="3"></td></tr>
<tr><td colspan="6">Mutual coupling and mismatch loss (30 MHz - 180 MHz)</td><td colspan="3"></td><td colspan="6">Mutual coupling and mismatch loss (30 MHz - 180 MHz)</td><td colspan="3"></td></tr>
<tr><td colspan="6">Antenna factor of the measuring antenna</td><td colspan="3"></td><td colspan="6">Antenna factor of the measuring antenna</td><td colspan="3"></td></tr>
</table>

<table>
<tr><td colspan="9">RECEIVER SENSITIVITY (bit stream)</td><td colspan="9">Date: PAGE 2 of 2</td></tr>
<tr><td colspan="9">Vertical polarization</td><td colspan="9">Horizontal polarization</td></tr>
<tr><td colspan="6">Height above the turntable</td><td colspan="3">m</td><td colspan="6">Height above the turntable</td><td colspan="3">m</td></tr>
<tr><td colspan="6">Height of the test antenna</td><td colspan="3">m</td><td colspan="6">Height of the test antenna</td><td colspan="3">m</td></tr>
<tr><td colspan="6">Received signal level</td><td colspan="3">dBμV</td><td colspan="6">Received signal level</td><td colspan="3">dBμV</td></tr>
<tr><td colspan="6">Output level from signal generator</td><td colspan="3">dBm</td><td colspan="6">Output level from signal generator</td><td colspan="3">dBm</td></tr>
<tr><td colspan="6">Transform Factor</td><td colspan="3">dB</td><td colspan="6">Transform Factor</td><td colspan="3">dB</td></tr>
<tr><td colspan="9">Signal generator level (dBm) against angle for 10^{-2} BER</td><td colspan="9">Signal generator level (dBm) against angle for 10^{-2} BER</td></tr>
<tr><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td></tr>
<tr><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Conversion to μV/m</td><td colspan="9">Conversion to μV/m</td></tr>
<tr><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td><td></td><td>0°</td><td>45°</td><td>90°</td><td>135°</td><td>180°</td><td>225°</td><td>270°</td><td>325°</td></tr>
<tr><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">MAXIMUM Sensitivity</td><td colspan="3">μV/m</td><td colspan="6">MAXIMUM Sensitivity</td><td colspan="3">μV/m</td></tr>
<tr><td colspan="6">AVERAGE Sensitivity</td><td colspan="3">μV/m</td><td colspan="6">AVERAGE Sensitivity</td><td colspan="3">μV/m</td></tr>
<tr><td colspan="18">Values in the formula for Transform Factor</td></tr>
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<tr><td colspan="6">Measuring antenna attenuator loss</td><td colspan="3"></td><td colspan="6">Measuring antenna attenuator loss</td><td colspan="3"></td></tr>
<tr><td colspan="6">Measuring antenna balun loss</td><td colspan="3"></td><td colspan="6">Measuring antenna balun loss</td><td colspan="3"></td></tr>
<tr><td colspan="6">Mutual coupling and mismatch loss (30 MHz - 180 MHz)</td><td colspan="3"></td><td colspan="6">Mutual coupling and mismatch loss (30 MHz - 180 MHz)</td><td colspan="3"></td></tr>
<tr><td colspan="6">Antenna factor of the measuring antenna</td><td colspan="3"></td><td colspan="6">Antenna factor of the measuring antenna</td><td colspan="3"></td></tr>
</table>

RECEIVER SENSITIVITY (messages)									Date:								PAGE 2 of 2
Vertical polarization									Horizontal polarization								
Height above the turntable								m	Height above the turntable								m
Height of the test antenna								m	Height of the test antenna								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle									**Signal generator level (dBm) against angle**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Conversion to µV/m									**Conversion to µV/m**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Ave.									**Ave.**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

8.2.1.3.5 Statement of results

The results should be presented in tabular form as shown in table 33.

Table 33: Overall results sheet

RECEIVER SENSITIVITY		Date:	PAGE 1 of 1
Vertical polarization		**Horizontal polarization**	
MAXIMUM Usable Sensitivity	µV/m	MAXIMUM Usable Sensitivity	µV/m
AVERAGE Usable Sensitivity	µV/m	AVERAGE Usable Sensitivity	µV/m
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)	dB

8.2.1.4 Striplines

8.2.1.4.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Stripline test facility;
- RF Signal generator;
- Receiving device (measuring receiver or spectrum analyser).
- Monopole or 3-axis probe.

NOTE: The receiving device and Monopole (or 3-axis probe) are only required if the results of the verification procedure are not used to determine the field strength within the Stripline.

Additional requirements for analogue speech:

- AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 36).

8.2.1.4.2 Method of measurement

1 The EUT should be placed on a non-conducting support constructed from low dielectric constant (i.e. less than 1,5) material(s) so that its volume centre lies midway between the plates and directly above the central hole drilled (for the purposes of the verification procedure) in the bottom plate. It should be mounted in the position closest to its normal use as declared by the manufacturer (consistent with the polarization within the Stripline) with its reference face oriented towards the input (source end) of the Stripline (this is the 0° reference angle for the test). This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 36).

2 The electrical supply and monitoring cables should be routed straight down towards the bottom plate and out through the central hole.

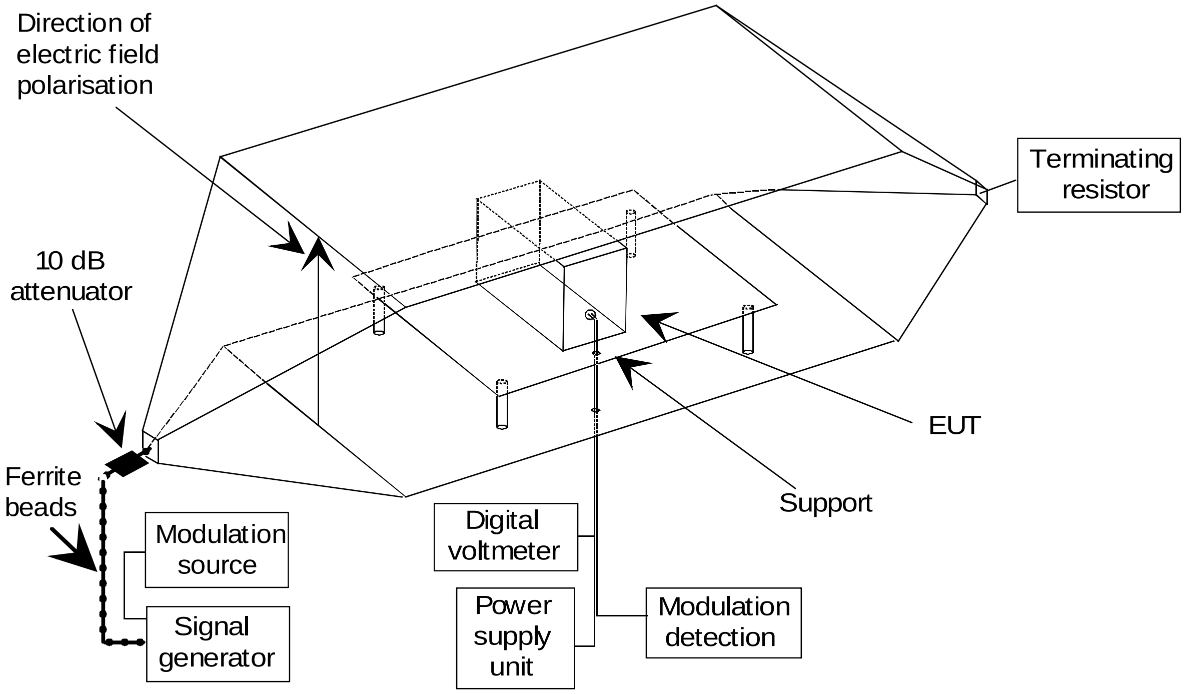

Figure 86: Test equipment layout for maximum and average usable sensitivity tests

For analogue speech

3a The signal generator should be connected to the input of the Stripline via a 10 dB attenuator and a calibrated, ferrited coaxial cable. Its output should be modulated by test modulation AM-1 (produced by the AF source). The signal generator should be tuned to the nominal frequency of the EUT.

3b The EUT should be connected to the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) through an AF load or by an acoustic coupler for equipment not fitted with a direct connection. See figure 86.

3c The output level of the signal generator should be adjusted until a psophometrically weighted SINAD ratio of 20 dB is obtained from the EUT. The corresponding output power level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 36).

3d The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270° and 315° (thereby covering the entire 360° in 8 measurements). At each angle, step 3c should be repeated.

3e For the maximum sensitivity test only, after the final measurement, the 8 values of signal generator output power level should be compared and the lowest value entered on page 2 of the log book results sheet (table 36).

3f For the average sensitivity test only, after the final measurement, the 8 values of signal generator output power level should be averaged and the resulting value entered on page 2 of the log book results sheet (table 36).

NOTE 1: Each of the output power levels in dBm should be converted into µV before averaging. Having found the average value in µV, this should then be converted back into dBm. These conversions should be calculated as follows:

a: dBm into µV: $\mu V_i = 10^{\left(\frac{107 - dBm_i}{20}\right)}$;

b: Average voltage (µV) = $\frac{\sum_{i=1}^{i=8} \mu V_i}{8}$;

c: Average output power level (dBm) = 20 $\log_{10}$ (Average voltage µV) - 107.

3g The procedure should now resume with the field measurement (step 4).

For bit stream

3a The signal generator should be connected to the input of the Stripline via a 10 dB attenuator and a calibrated, ferrited coaxial cable. Its output should be modulated by test modulation DM-2 (produced by the bit stream generator). The signal generator should be tuned to the nominal frequency of the EUT.

3b The EUT should be directly connected to the modulation detector (a bit error measuring test set, which should also receive a direct input from the bit stream generator). See figure 86.

3c The output level of the signal generator should be adjusted until a bit error ratio of 10^{-2} is obtained from the EUT. The corresponding output power level (dBm) from the signal generator should be recorded on page 2 of the log book results sheet (table 36).

3d The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270° and 315° (thereby covering the entire 360° in 8 measurements). At each angle, step 3c should be repeated.

3e For the maximum sensitivity test only, after the final measurement, the 8 values of signal generator output power level should be compared and the lowest value entered on page 2 of the log book results sheet (table 36).

3f For the average sensitivity test only, after the final measurement, the 8 values of signal generator output power level should be averaged and the resulting value entered on page 2 of the log book results sheet (table 36).

NOTE 2: Each of the output power levels in dBm should be converted into µV before averaging. Having found the average value in µV, this should then be converted back into dBm. These conversions should be calculated as follows:

a: dBm into µV: $\mu V_i = 10^{\left(\frac{107 - dBm_i}{20}\right)}$;

b: Average voltage (µV) = $\frac{\sum_{i=1}^{i=8} \mu V_i}{8}$;

c: Average output power level (dBm) = 20 $\log_{10}$ (Average voltage µV) - 107.

3g The procedure should now resume with the field measurement (step 4).

For messages

3a The signal generator should be connected to the input of the Stripline via a 10 dB attenuator and a calibrated, ferrited coaxial cable. Its output should be modulated by test modulation DM-3 (produced by the message generator). The signal generator should be tuned to the nominal frequency of the EUT.

3b The EUT should be connected to the modulation detector (a response measuring test set) via an acoustic coupler (pipe) which is made from low dielectric constant (i.e. less than 1,5) material(s). See figure 86.

3c The output level of the signal generator should be adjusted until a message acceptance ratio of < 10 % is obtained from the EUT.

3d The test message should be transmitted repeatedly, whilst observing for each message whether a successful response is obtained. The output level of the signal generator should be increased by 2 dB for each occasion that a successful response is NOT obtained.

3e Step 3d should be repeated until three consecutive successful responses are observed at the same output level from the signal generator. The output power level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 36).

3f The output signal level from the signal generator should be reduced by 1 dB. The new signal power level (dBm) should be recorded on page 2 of the log book results sheet (table 36) and the response of the EUT observed.

3g If a successful response is NOT obtained, the output signal level should be increased by 1 dB and the new level recorded in the results sheet. If a successful response IS obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the output signal level from the signal generator should be reduced by 1 dB and the new level recorded in the results sheet. No signal levels should be recorded unless preceded by a change of level.

3h Step 3g should be repeated until a total of 10 recorded values for the signal generator output power level (dBm) have been entered on page 2 of the log book results sheet (table 36).

3i The EUT should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle steps 3c to 3h should be repeated.

3j For each angle, the 10 recorded values of the signal generator output power level should be averaged, by firstly converting them into μV, secondly averaging in μV(and recording the 8 average values on page 2 of the log book results sheet (table 8)) and finally converting the 8 values back into dBm, again recording these values on page 2 of the log book results sheet (table 36).

NOTE 3: The various conversions should be carried out according to the following formulae:

a: dBm into μV: $\mu V_i = 10^{\left(\frac{107 - dBm_i}{20}\right)}$;

b: Average voltage (μV) = $\dfrac{\sum_{i=1}^{i=10} \mu V_i}{10}$;

c: Average output power level (dBm) = 20 $\log_{10}$ (Average voltage μV) - 107.

3k For the maximum sensitivity test only, the 8 average values derived in step 3j should be compared and the lowest value entered on page 2 of the log book results sheet (table 36).

3l For the average sensitivity test only, the 8 average values in μV derived in step 3j should themselves be averaged, the new average value converted into dBm and the resulting value entered on page 2 of the log book results sheet (table 36).

NOTE 4: The conversion should be calculated as follows:

Power level (dBm) = 20 $\log_{10}$ (Average voltage μV) - 107.

3m The procedure should now continue with the field measurement (step 4).

Field measurement: For Stripline test facilities which, since the verification was carried out:

- show no visual sign of change (i.e. no damaged components or plates);
- and have not been moved;
- and have not had their surrounding environment (i.e. the layout of the absorbing panels and test equipment) changed;

the test is concluded at this point since the Transform Factors determined during the verification procedure can be used for determining the field strength.

If any, or all of these conditions are not satisfied, the field strength should be measured directly by using either a Monopole or a 3-axis probe (isotropic monitor). Performing steps 6 to 9 for the Monopole or steps 10 and 11 for the 3-axis probe gives measured values of field strength at the precise frequency of test - thereby eliminating the need for interpolation of the Transform Factor (and its associated uncertainty) between the frequencies at which the verification procedure was carried out, if the results of that procedure are used.

4 The modulation source should be removed from the signal generator, leaving an unmodulated carrier.

5 The output power level of the signal generator should be set as follows:

For the maximum sensitivity test:

at the lowest value recorded on page 2 of the log book results sheet (table 36) for the relevant modulation.

For the average sensitivity test:

at the average value recorded on page 2 of the log book results sheet (table 36) for the relevant modulation.

Monopole Only: Steps 6 to 9

6 The EUT and non-conducting support plate should be removed from the Stripline and replaced by the Monopole. The Monopole should be mounted through the central hole in the bottom plate. When installed, the Monopole should have a length of 0,2 ± 0,002 m above the bottom plate. Its diameter should be a maximum of 0,002 m and it should be straight to within ±0,002 m.

7 The Monopole should be connected via any adapters that are necessary, through a 10 dB attenuator and a calibrated, ferrited coaxial cable to the receiving device.

8 The received level appearing on the receiving device should be recorded (dBμV) on page 2 of the log book results sheet (table 36).

9 The Monopole should be removed from the Stripline and replaced by the EUT which should again be mounted on a non-conducting support with its volume centre directly over the central hole in the bottom plate. Whilst the EUT should again have its reference face oriented towards the input, it should, for this part of the procedure, be placed on its side so that the polarization of the Stripline is orthogonal to it. This mounting configuration should be recorded on page 1 of the log book results sheet (table 8) and steps 2 to 8 repeated.

NOTE 5: In step 3d for analogue speech and bit stream modulations (step 3i for messages) the rotation should now be in the vertical plane i.e. about a horizontal axis.

3-Axis Probe Only: Steps 10 and 11

10 The 3-axis probe should be oriented as shown in figure 16 with the centre of its cubic head at the intersection of the centre lines of the Stripline. A mounting block of low dielectric constant (i.e. less than 1,5) material e.g. expanded polystyrene, balsawood, etc., should be used to position the probe accurately. The electric field strength value for the vertical direction only (i.e. the z direction in figure 87) should be recorded (dBμV/m) on page 2 of the log book results sheet (table 8).

11 The 3-axis probe should be removed from the Stripline and replaced by the EUT which should again be mounted on a non-conducting support with its volume centre directly over the central hole drilled in the bottom plate. Whilst the EUT should again have its reference face oriented towards the source end, it should, for this part of the procedure, be placed on its side so that the polarization of the Stripline is orthogonal to it. This mounting configuration should be recorded on page 1 of the log book results sheet (table 36) and steps 2 to 5 and 10 repeated.

NOTE 6: In step 3d for analogue speech and bit stream modulations (step 3i for messages) the rotation should now be in the vertical plane i.e. about a horizontal axis.

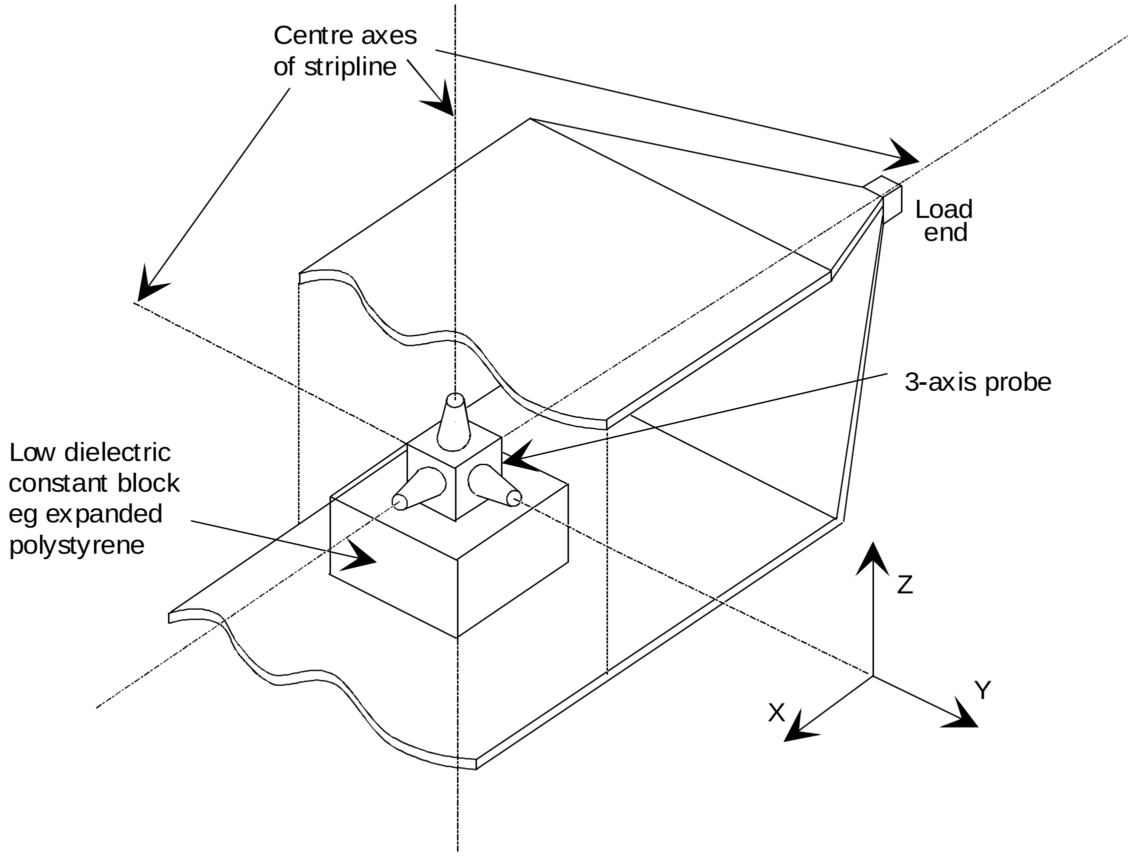

Figure 87: Location of the 3-axis probe at the intersection of the Stripline's centre axes

8.2.1.4.3 Procedure for completion of the results sheets

There are two values that need to be derived before the overall results sheet (table 37) can be completed. These are the values for the maximum (or average) usable sensitivity of the EUT and the expanded measurement uncertainty.

NOTE: Guidance for deriving the values of the various parameters used in the following calculations is given in table 34.

For field measurement using the results of the verification procedure only

The verification procedure provides values for the Transform Factor of the Stripline i.e. the relationship between the input power (in dBm) and the resulting electric field strength (in dBµV/m) between the plates. To relate the field strength to a particular setting of the signal generator, the following calculation is performed:

*Field strength (*dBµV/m*) = Signal generator output power (*dBm*)*

*- signal generator cable loss (*dB*) - signal generator attenuator loss (*dB*) + Transform Factor (*dB*)*

The value of field strength resulting from the minimum (or average) output from the signal generator, should be entered on page 2 of the log book results sheet (table 36).

This value of field strength needs to be corrected for the systematic offsets involved. The overall correction factor for this value of field strength concerns only one term, namely that for the size of the EUT. Various values for different sizes of EUT are given in table 34 and the relevant value should be recorded on page 2 of the log book results sheet (table 36).

The maximum or average sensitivity for the EUT should be derived as follows:

*Maximum or average usable sensitivity (*dBµV/m*) = Field strength (*dBµV/m*)*

*+ overall correction factor (*dB*)*

and finally, the resulting sensitivity value should be converted into µV/m and recorded in the overall results sheet (table 37). To complete the overall results sheet, the expanded uncertainty for the measurement should be calculated in accordance with TR 100 028-2 [7], subclause 8.2.1.4.

Table 34: Guidance for deriving correction factors

Figures for correction factors
Signal generator cable loss: Obtained directly from the calibration data.
Signal generator attenuator loss: Obtained from manufacturer's data.
Monopole cable loss: Obtained directly from the calibration data.
Monopole attenuator loss: Obtained from manufacturer's data.
Transform Factor of Stripline: (at the nominal frequency of test): If the verification procedure results were used, the value should be interpolated between the closest set values (unless the test coincides with a set frequency). If a Monopole was used during the sensitivity test then the value is as calculated. If a 3-axis probe was used during the sensitivity test then the value is zero.
Correction factor for size of the EUT: (for the height in the E-plane) (EN 55020 [12]): height ≤ 0,2 m, correction factor is 1,6 dB 0,2 m < height ≤ 0,4 m, correction factor is 4,6 dB 0,4 m < height ≤ 0,7 m, correction factor is 6,0 dB

For field measurement using the Monopole only:

The Monopole is only used if the results of the verification procedure cannot be relied on (i.e. the Stripline has been moved, damaged, modified, etc., or has had its surroundings changed). In this case, it is necessary to calculate the field strength using the values of received signal level and Monopole antenna factor (given in table 35). This is achieved by using the following formula:

Field strength (dBµV/m) = Received signal level (dBµV) + Monopole cable loss (dB)

+ Monopole attenuator loss (dB) + Antenna factor (dB/m)

Where the frequency of test does not coincide with a spot value in table 35, the antenna factor should be deduced by linear interpolation between the closest two frequencies.

Table 35: Antenna factor of the Monopole

Frequency (MHz)	**Antenna factor (dB/m)**
30	50,3
35	49,7
40	49,0
45	48,4
50	47,8
60	46,5
70	45,2
80	43,9
90	42,7
100	41,4
120	38,8
140	36,3
150	35,0

This value of field strength needs to be corrected for the systematic offsets involved. The overall correction factor for this value of field strength concerns only one term (for the size of the EUT) since all other systematic offsets are included in the calculation of field strength. Various values for different sizes of EUT are given in table 34 and the relevant value should be recorded on page 2 of the log book results sheet (table 36).

The maximum or average sensitivity for the EUT should be derived as follows:

*Maximum or average usable sensitivity (*dBµV/m*) = Field strength (*dBµV/m*)+ overall correction factor (*dB*)*

and finally, the sensitivity value should be converted into µV/m and recorded in the overall results sheet (table 37). To complete the overall results sheet, the expanded uncertainty for the measurement should be calculated in accordance with TR 100 028-2 [7], subclause 8.2.1.4.

For field measurement using the 3-axis probe only:

In a similar manner to the Monopole, the 3-axis probe is only used when the results of the Stripline verification procedure cannot be relied upon or reduced uncertainty is required.

The 3-axis probe directly measures the electric field strength in dBµV/m, so the only processing of the measured value is to correct for the size of the EUT. Various values for different sizes of EUT are given in table 34 and the relevant value should be recorded on page 2 of the log book results sheet (table 36).

The maximum or average sensitivity for the EUT should be derived as follows:

Maximum or average usable sensitivity (dBµV/m) = Field strength (dBµV/m) + overall correction factor (dB)

and finally, the sensitivity value should be converted into µV/m and recorded in the overall results sheet (table 37). To complete the overall results sheet, the expanded uncertainty for the measurement should be calculated in accordance with TR 100 028-2 [7], subclause 8.2.1.4.

8.2.1.4.4 Log book results sheet

Table 36: Log book results sheet

RECEIVER SENSITIVITY		**Date:**		**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**		**Humidity:...............%** **Type No:.............**	**Frequency:.............MHz** **Serial No:.................**	
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Signal generator cable				
Signal generator attenuator				
Monopole cable (if applicable)				
Monopole attenuator (if applicable)				
Ferrite beads			N/A	N/A
Receiving device				N/A
Signal generator				N/A
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)			N/A	N/A
Audio load (if applicable)			N/A	N/A
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)			N/A	N/A
Monopole (if applicable)				N/A
3-axis probe (if applicable)			N/A	N/A
Vertical polarization Mounting configuration of EUT		**Horizontal polarization** Mounting configuration of EUT		

RECEIVER SENSITIVITY (analogue speech)									Date:							PAGE 2 of 2
Vertical polarization									**Horizontal polarization**							
Signal generator level (dBm) against angle for 20 dB SINAD									**Signal generator level (dBm) against angle for 20 dB SINAD**							
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
LOWEST of the 8 levels above						dBm			LOWEST of the 8 levels above						dBm		
AVERAGE of the 8 levels above						dBm			AVERAGE of the 8 levels above						dBm		
For Monopole: Received sig. level on receiving device:..........dBµV									**For Monopole:** Received sig. level on receiving device:..........dBµV								
For 3-axis probe: Field strength in vertical plane:...................dBµV/m									**For 3-axis probe:** Field strength in vertical plane:...................dBµV/m								
Calculated field strength:………………….….dBµV/m									Calculated field strength:………………….….dBµV/m								
Correction factors																	
Signal generator cable loss									Signal generator cable loss								
Signal generator attenuator loss									Signal generator attenuator loss								
Monopole cable loss									Monopole cable loss								
Monopole attenuator loss									Monopole attenuator loss								
Transform Factor of Stripline									Transform Factor of Stripline								
Correction factor for size of the EUT									Correction factor for size of the EUT								
Overall measurement correction						dB			Overall measurement correction						dB		

RECEIVER SENSITIVITY (bit stream)									Date:							PAGE 2 of 2
Vertical polarization									**Horizontal polarization**							
Signal generator level (dBm) against angle for 10^{-2} BER									**Signal generator level (dBm) against angle for 10^{-2} BER**							
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
LOWEST of the 8 levels above						dBm			LOWEST of the 8 levels above						dBm		
AVERAGE of the 8 levels above						dBm			AVERAGE of the 8 levels above						dBm		
For Monopole: Received sig. level on receiving device:..........dBµV									**For Monopole:** Received sig. level on receiving device:..........dBµV								
For 3-axis probe: Field strength in vertical plane:...................dBµV/m									**For 3-axis probe:** Field strength in vertical plane:...................dBµV/m								
Calculated field strength:………………….….dBµV/m									Calculated field strength:………………….….dBµV/m								
Correction factors																	
Signal generator cable loss									Signal generator cable loss								
Signal generator attenuator loss									Signal generator attenuator loss								
Monopole cable loss									Monopole cable loss								
Monopole attenuator loss									Monopole attenuator loss								
Transform Factor of Stripline									Transform Factor of Stripline								
Correction factor for size of the EUT									Correction factor for size of the EUT								
Overall measurement correction						dB			Overall measurement correction						dB		

RECEIVER SENSITIVITY (messages)									Date:						PAGE 2 of 2		
Vertical polarization									**Horizontal polarization**								
Signal generator level (dBm) against angle									**Signal generator level (dBm) against angle**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Ave. µV									**Ave. µV**								
Ave. dBm									**Ave. dBm**								
LOWEST of the 8 values of dBm above								dBm	LOWEST of the 8 values of dBm above								dBm
AVERAGE of the 8 values of dBm above								dBm	AVERAGE of the 8 values of dBm above								dBm
For Monopole: Received sig. level on receiving device:..........dBµV									**For Monopole:** Received sig. level on receiving device:..........dBµV								
For 3-axis probe: Field strength in vertical plane:..................dBµV/m									**For 3-axis probe:** Field strength in vertical plane:..................dBµV/m								
Calculated field strength:………….……….…dBµV/m									Calculated field strength:………….……….…dBµV/m								
Correction factors																	
Signal generator cable loss									Signal generator cable loss								
Signal generator attenuator loss									Signal generator attenuator loss								
Monopole cable loss									Monopole cable loss								
Monopole attenuator loss									Monopole attenuator loss								
Transform Factor of Stripline									Transform Factor of Stripline								
Correction factor for size of the EUT									Correction factor for size of the EUT								
Overall measurement correction								dB	Overall measurement correction								dB

8.2.1.4.5 Statement of results

The results should be presented in tabular form as shown in table 37.

Table 37: Overall results sheet

RECEIVER SENSITIVITY		Date:	PAGE 1 of 1
Vertical polarization		**Horizontal polarization**	
MAXIMUM Usable Sensitivity	µV/m	MAXIMUM Usable Sensitivity	µV/m
AVERAGE Usable Sensitivity	µV/m	AVERAGE Usable Sensitivity	µV/m
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)	dB

8.2.1.5 Test Fixture

NOTE: For a Test Fixture, no facility is usually incorporated into its structure to allow for rotation in 45° increments as called for in the definitions. Strictly speaking therefore this test should not be termed either maximum or average usable sensitivity. However, since the changes in performance caused by extreme conditions are determined for the same orientation of the EUT in the Test Fixture and further, that its performance in that orientation under normal conditions is related to a true maximum usable sensitivity test on an accredited test site, the results are regarded as being fully representative of a maximum usable sensitivity test.

8.2.1.5.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site.

Additional requirements for analogue speech:

- AF source;
- SINAD Meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 38).

8.2.1.5.2 Method of measurement

1 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of maximum usable sensitivity (for the particular modulation type) should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

   a) the EUT by itself on the accredited Free-Field Test Site;

   b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

   c) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

   d) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

   The value recorded for configuration b) during the verification procedure should be entered on page 1 of the log book results sheet (table 38).

2 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This configuration should be noted on page 1 of the log book results sheet (table 38).

3 Normal conditions (as stated in the relevant standard) should exist within the climatic facility.

For analogue speech:

4a The EUT should be connected to the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) through an AF load or by an acoustic coupler which is made from low dielectric constant (i.e. less than 1,5) material(s) for EUTs not fitted with a direct connection. See figure 88.

4b The signal generator output should be modulated with test modulation AM-1 (produced by the AF source) and its output level should be adjusted until a psophometrically weighted SINAD ratio of 20 dB is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 38).

4c The procedure should now resume with step 5.

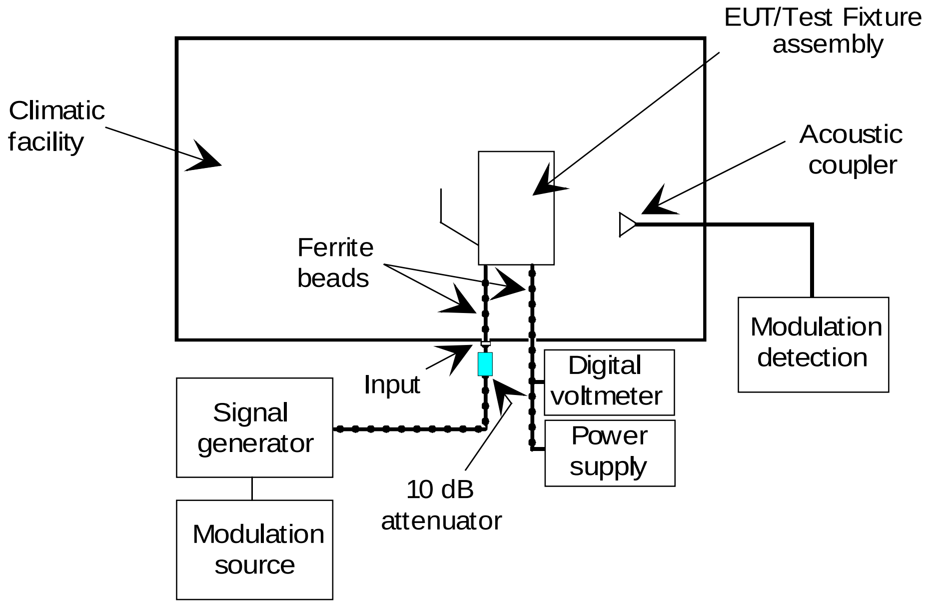

Figure 88: Maximum usable sensitivity using a Test Fixture (shown with acoustic coupler)

For bit stream:

4a The EUT should be connected to the modulation detector (a bit error measuring test set, which should also receive a direct input from the bit stream generator) by a direct connection. See figure 88.

4b The signal generator output should be modulated with test modulation DM-2 (produced by the bit stream generator) and its output level should be adjusted until a bit error ratio of 10^{-2} is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 38).

4c The procedure should now resume with step 5.

For messages:

4a The EUT should be connected to the modulation detector (a response measuring test set) via an acoustic coupler (pipe) which is made from low dielectric constant (i.e. less than 1,5) material(s). See figure 88.

4b The signal generator output should be modulated with test modulation DM-3 (produced by the message generator) and its output level should be adjusted until a message acceptance ratio of < 10 % is obtained from the EUT.

4c The test message should be transmitted repeatedly from the test antenna, whilst observing for each message whether a successful response is obtained. The output level of the signal generator should be increased by 2 dB for each occasion that a successful response is NOT obtained.

4d Step 4c should be repeated until three consecutive successful responses are observed at the same output level from the signal generator. The output level from the signal generator should be recorded on page 2 of the log book results sheet (table 38).

4e The output signal level from the signal generator should be reduced by 1 dB. The new signal level should be recorded on page 2 of the log book results sheet (table 38) and the response of the EUT observed.

4f If a successful response is NOT obtained, the output signal level should be increased by 1 dB and the new level recorded in the results sheet. If a successful response IS obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the output signal level from the signal generator should be reduced by 1 dB and the new level recorded in the results sheet. No signal levels should be recorded unless preceded by a change of level.

4g Step 4f should be repeated until a total of 10 recorded values for the signal generator output level have been entered on page 2 of the log book results sheet (table 38).

4h The 10 recorded values of the signal generator output level (dBm) should be converted into field strength values µV/m by the following equation:

$$\textit{field strength} = \sqrt{10^{\frac{(dBm)}{10}}}$$

The resulting values should be also entered on page 2 of the log book results sheet (table 38).

4i The 10 new recorded values of field strength should then be averaged and finally converted back to dBm according to the following formula:

$$\textit{Average output level} = 20\log\left(\frac{\sum_{i=1}^{10}\sqrt{10^{\frac{(dBmi)}{10}}}}{10}\right)^2 \text{ dBm}$$

4j The resulting value for average signal generator output power level should be entered on page 2 of the log book results sheet (table 38).

4k The procedure should now continue with step 5.

5 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

6 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required.

NOTE 1: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 2: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

7 The supply voltage to the EUT should be set to the upper extreme as given in the relevant Standard. The multi-stage step 4 should then be repeated.

8 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant Standard. The multi-stage step 4 should then be repeated.

9 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

10 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 3: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 4: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

11 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant Standard. The multi-stage step 4 should then be repeated.

12 The supply voltage to the EUT should be set to the upper extreme as given in the relevant Standard. The multi-stage step 4 should then be repeated.

13 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

8.2.1.5.3 Procedure for completion of the results sheets

The results taken during the above test method should be processed as follows. Firstly, all the recorded values for the signal generator output power levels (the average level for the case of messages) should be normalized to the value corresponding to normal conditions of temperature and voltage by simple subtraction of the dBm values. The normalized values should then entered in the log book results sheet (table 38) and subsequently converted into numerical factors according to the following formula:

$$\text{Normalized numerical factor} = 10^{\left(\frac{normalised\ signal\ generator\ level\ in\ dB}{20}\right)}$$

All five resulting values of the numerical factor should be entered in the log book results sheet (table 38).

The value of maximum usable sensitivity (µV/m) recorded on the accredited Free-Field Test Site should then be multiplied by the normalized numerical factor and the resulting values recorded in the overall results sheet (table 39).

Finally, to complete the overall results sheet, the expanded uncertainty should calculated in accordance with TR 100 028-2 [7], subclause 8.2.1.5.

8.2.1.5.4 Log book results sheet

Table 38: Log book results sheet

MAXIMUM USABLE SENSITIVITY	**Date:**			**PAGE 1 of 1**
Temperature:.........°C	**Humidity:...............%**		**Frequency:.............MHz**	
Bandwidth of Receiving Device...................Hz				
Manufacturer of EUT:.....................	**Type No:..............**		**Serial No:..................**	
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
Signal generator				N/A
Signal generator cable				
RF cable within climatic facility				
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)			N/A	N/A
Audio load (if applicable)			N/A	N/A
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)			N/A	N/A
Result of measurement on accredited Free-Field Test Site: Type of site:.. Maximum usable sensitivity (μV/m).................................				
Mounting configuration of EUT				

MAXIMUM USABLE SENSITIVITY (analogue speech)	**Date:**			**PAGE 2 of 2**
Temperature, °C	**Voltage, Volts (V)**	**Signal generator level, dBm, for 20 dB SINAD**	**Normalized signal generator level**	
			dB	**Numerical**
T (normal)	V (normal)		0,0	1,0
T (high)	V (high)			
	V (low)			
T (low)	V (high)			
	V (low)			

MAXIMUM USABLE SENSITIVITY (bit stream)	Date:		PAGE 2 of 2	
Temperature, °C	**Voltage, Volts (V)**	**Signal generator level, dBm, for 10^{-2} BER**	**Normalized signal generator level**	
			dB	**Numerical**
T (normal)	V (normal)		0,0	1,0
T (high)	V (high)			
	V (low)			
T (low)	V (high)			
	V (low)			

MAXIMUM USABLE SENSITIVITY (messages)	Date:			PAGE 2 of 2
	T(normal)	T(high)		T(low)	
	V(normal)	V(high)	V(low)	V(high)	V(low)
Signal generator output level 1					
Signal generator output level 2					
Signal generator output level 3					
Signal generator output level 4					
Signal generator output level 5					
Signal generator output level 6					
Signal generator output level 7					
Signal generator output level 8					
Signal generator output level 9					
Signal generator output level 10					
Converting to linear value					
linear value for sig gen level 1					
linear value for sig gen level 2					
linear value for sig gen level 3					
linear value for sig gen level 4					
linear value for sig gen level 5					
linear value for sig gen level 6					
linear value for sig gen level 7					
linear value for sig gen level 8					
linear value for sig gen level 9					
linear value for sig gen level 10					
Average of the 10 values					
Normalized signal generator level dB					
Normalized signal generator level Numerical value					

8.2.1.5.5 Statement of results

The results should be presented in tabular form as shown in table 39.

Table 39: Overall results sheet

MAXIMUM USABLE SENSITIVITY	Date:			PAGE 1 of 1	
	T(normal)	T(high)		T(low)	
	V(normal)	V(high)	V(low)	V(high)	V(low)
Maximum usable sensitivity in the Test Fixture µV/m					
Expanded uncertainty (95 %)	dB				

8.2.1.6 Salty man/salty-lite

8.2.1.6.1 Anechoic Chamber

8.2.1.6.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Anechoic Chamber;
- Salty man or Salty-lite;
- Test antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Measuring antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- RF Signal generator;
- Receiving device (measuring receiver or spectrum analyser).

Additional requirements for analogue speech:

- AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 41).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz inclusive.

8.2.1.6.1.2 Method of measurement

1 The EUT should be mounted on the Salty man/Salty-lite at the height stated in the relevant standard. It should be mounted in an orientation which matches that of its normal usage as declared by the manufacturer.

Determination of the Transform Factor for the test site

2 For this part of the test, it is necessary to position the measuring antenna within the chamber such that its phase centre is at the same point that the phase centre of the EUT (mounted on the Salty man/Salty-lite) will occupy in the second part of the test. The precise point should always be, where possible, on the axis of rotation of the turntable but at a height either on the central axis of the chamber or at a convenient height within the quiet zone. The vertical offset of the phase centre from the central axis (if any) should be either measured remotely or determined by sitting the complete assembly of Salty man/Salty-lite plus EUT on the turntable. The vertical offset from the central axis should be recorded on page 2 of the log book results sheet (table 41).

NOTE 1: If the position of the phase centre within the EUT is unknown, but its antenna is a single rod which is visible and vertical in normal usage, the axis of its antenna should be aligned with the axis of rotation of the turntable. The base of the antenna should be used for determining the height. If the phase centre is not known and there is no visible antenna, the volume centre of the EUT should be aligned with the axis of rotation of the turntable instead.

NOTE 2: The bulk of the Salty man/Salty-lite may offer little flexibility in positioning within the chamber and some offset of the phase centre of the EUT from the axis of rotation might be unavoidable (see figure 89). Where an offset is unavoidable, its value should be entered on page 2 of the log book results sheet (table 41). If the overall positioning of the phase centre cannot be achieved without the dipole either falling outside the quiet zone of the chamber or approaching closer than 1 m to the absorbing panels at any angle of rotation, the test should not be carried out.

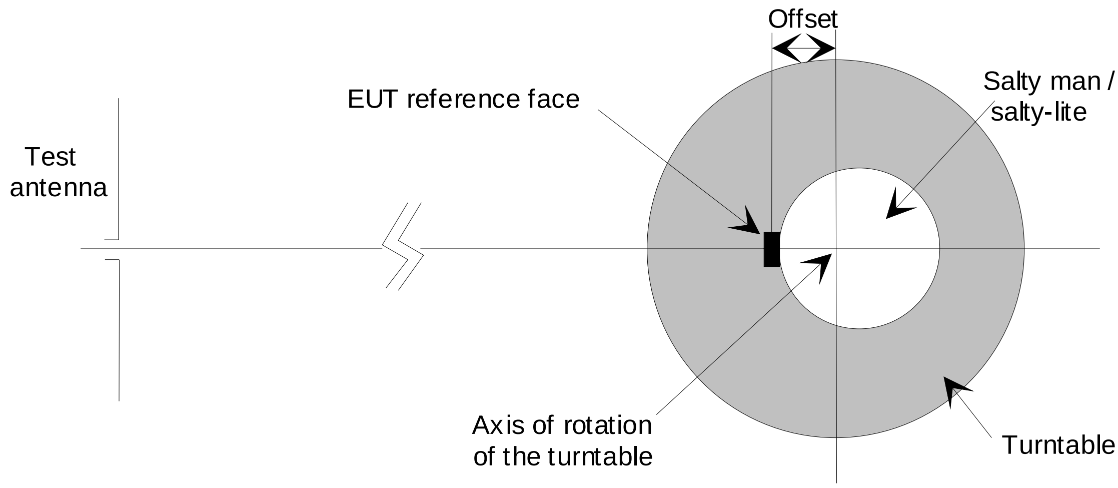

Figure 89: Illustration of offset from the axis of rotation

3 The measuring antenna (in the recommended scheme: a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) should be adjusted to correspond to the nominal frequency of the EUT and positioned with its phase centre at the point identified in step 2. It should be oriented for vertical polarization.

NOTE 3: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

4 The measuring antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber, to the receiving device.

5 The test antenna (identical to the measuring antenna) should be tuned to the nominal frequency of the EUT and mounted with the height of its phase centre at the same vertical offset from the central axis of the chamber (if any) as the measuring antenna, so that the measurement axis is parallel to the central axis of the chamber. The test antenna should be oriented to the same polarization as the measuring antenna.

NOTE 4: The measurement axis is the straight line joining the phase centres of the transmitting and receiving devices.

6 The test antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber to the signal generator whose output should be unmodulated. See figure 90. The signal generator should be tuned to the nominal frequency of the EUT.

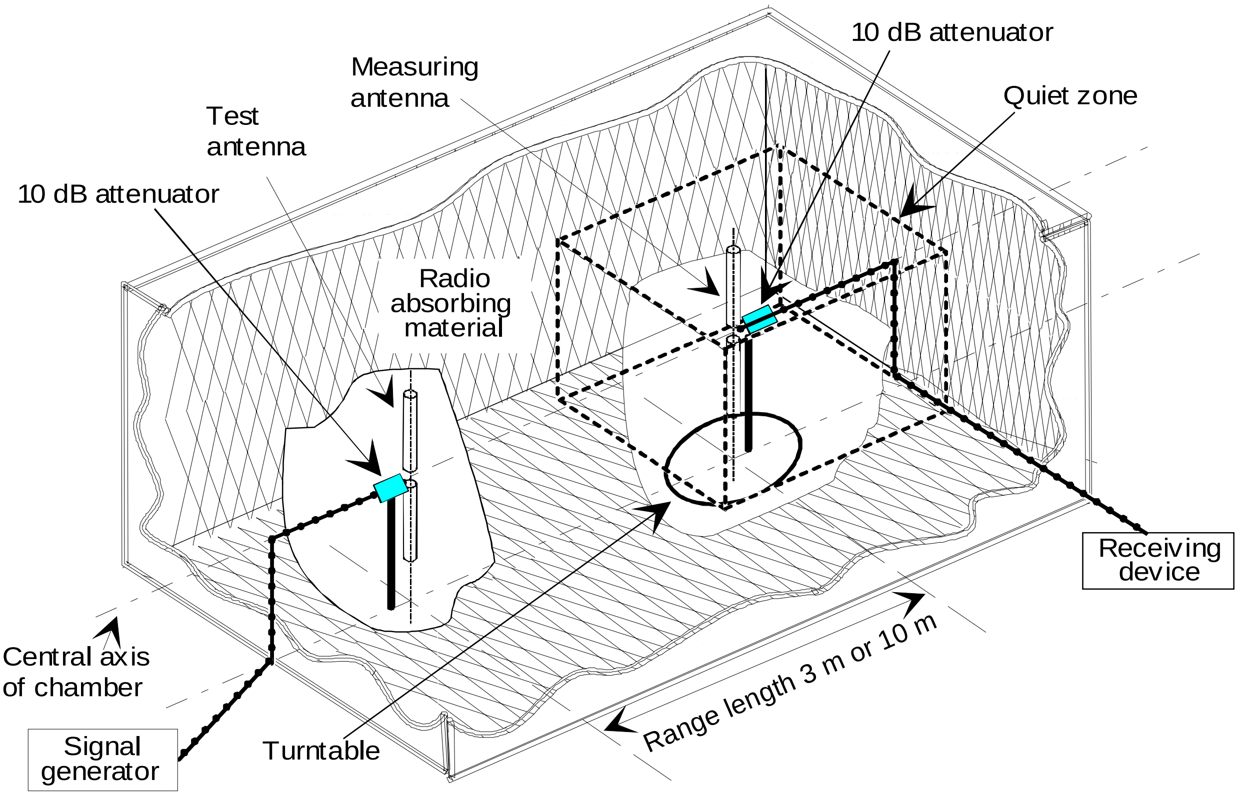

Figure 90: Equipment layout for the derivation of the Transform Factor during Sensitivity tests in an Anechoic Chamber

7 The output level of the signal generator should be adjusted until a received signal level at least 20 dB above the noise floor is observed on the receiving device.

8 The received signal level (dBμV) appearing on the receiving device along with the output level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 41). The Transform Factor for the chamber (i.e. the factor relating the output power level from the signal generator (dBm) to the resulting field strength (dBμV/m) at the point of measurement) should then be calculated according to the following formula:

*Transform Factor (*dB*) = received signal level (*dBμV*)*

+ *measuring antenna cable loss*

+ *measuring antenna attenuator loss*

+ *measuring antenna balun loss*

+ *mutual coupling and mismatch loss correction factor (if applicable)*

+ *antenna factor of the measuring antenna*

- signal generator output level (dBm)

NOTE 5: Guidance for deriving/calculating/finding the unknown values in the above formula for Transform Factor are given in table 40. These values should be entered on page 2 of the log book results sheet (table 41).

The resulting value for the Transform Factor should be entered on page 2 of the log book results sheet (table 41).

Table 40: Guidance for deriving Transform Factor

Values in the formula for Transform Factor
Measuring antenna cable loss: Obtained directly from the calibration data.
Measuring antenna attenuator loss: Obtained from calibration data.
Measuring antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss correction factor between the test antenna and the measuring antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A19. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Antenna factor of the measuring antenna: For ANSI dipoles: Antenna factor = 20 $\log_{10}$ (*f*) - 31,4 dB dB/m (where *f* is the frequency in MHz) For other types the value can be obtained from calibration data.

Sensitivity measurement on the EUT

9 The measuring antenna should be replaced on the turntable by the complete assembly of Salty man/Salty-lite plus EUT. The EUT should be positioned on the turntable such that its phase centre is in the same place as formerly occupied by the phase centre of the measuring antenna.

10 The normal to the reference face of the EUT should point directly towards the test antenna. This is the 0° reference angle for this test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 41).

For analogue speech:

11a The EUT should be connected to the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) through an AF load or by an acoustic coupler which is made from low relative dielectric constant (i.e. less than 1,5) material(s) for EUTs not fitted with a direct connection. See figure 91.

11b The signal generator output should be modulated with test modulation A-M1 (produced by the AF source) and its output level should be adjusted until a psophometrically weighted SINAD ratio of 20 dB is obtained from the EUT. The corresponding signal generator output power level (dBm) should be recorded on page 2 of the log book results sheet (table 41).

11c The Salty man/Salty-lite plus EUT complete assembly should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle, step 11b should be repeated.

11d The 8 values of signal generator output power level resulting from steps 11b and 11c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBμV/m and then secondly converting dBμV/m to μV/m i.e.:

1) field strength (dBμV/m) = signal generator level (dBm) + Transform Factor (dB)

2) field strength (μV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$

The resulting values in μV/m should be recorded on page 2 of the log book results sheet (table 41).

11e The procedure should now resume with step 12.

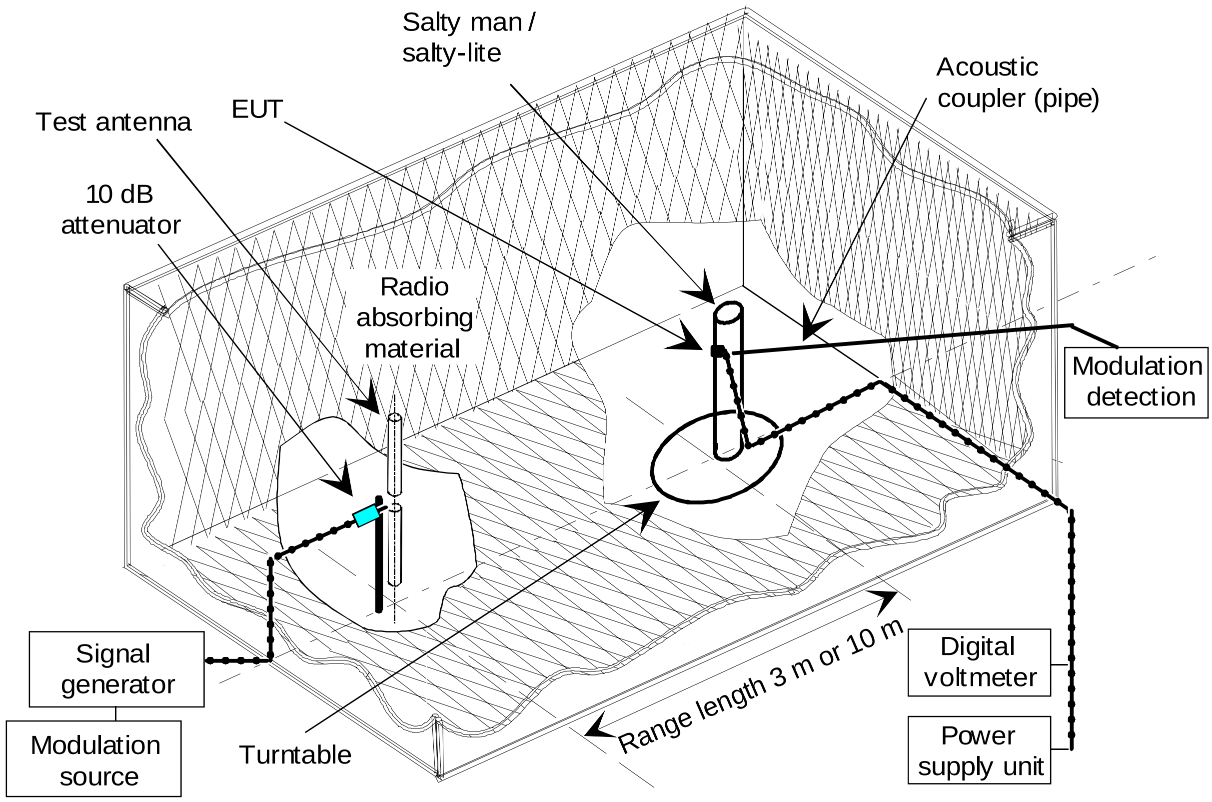

Figure 91: Anechoic Chamber set-up for Sensitivity tests on the EUT

For bit stream:

11a The EUT should be connected to the modulation detector (a bit error measuring test set, which should also receive a direct input from the bit stream generator) by a direct connection. See figure 91.

11b The signal generator output should be modulated by the test modulation D-M2 (produced by the bit stream generator) and its output level should be adjusted until a bit error ratio of 10^{-2} is obtained from the EUT. The corresponding signal generator output power level (dBm) should be recorded on page 2 of the log book results sheet (table 41).

11c The Salty man/Salty-lite plus EUT complete assembly should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle, step 11b should be repeated.

11d The 8 values of signal generator output power level resulting from steps 11b and 11c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBμV/m and then secondly converting dBμV/m to μV/m i.e.:

1) field strength (dBμV/m) = signal generator level (dBm) + Transform Factor (dB);

2) field strength (μV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20})}$.

The resulting values in μV/m should be recorded on page 2 of the log book results sheet (table 41).

11e The procedure should now resume with step 12.

For messages

11a The EUT should be connected to the modulation detector (a response measuring test set) via an acoustic coupler (pipe) which is made from low relative dielectric constant (i.e. less than 1,5) material(s). See figure 91.

11b The signal generator output should be modulated with test modulation DM-3 (produced by the message generator) and its output level should be adjusted until a message acceptance ratio of < 10 % is obtained from the EUT.

11c The test message should be transmitted repeatedly from the test antenna, whilst observing for each message whether a successful response is obtained. The output level of the signal generator should be increased by 2 dB for each occasion that a successful response is NOT obtained.

11d Step 11c should be repeated until three consecutive successful responses are observed at the same output level from the signal generator. The output level from the signal generator should be recorded on page 2 of the log book results sheet (table 41).

11e The output signal level from the signal generator should be reduced by 1 dB. The new signal level should be recorded on page 2 of the log book results sheet (table 41) and the response of the EUT observed.

11f If a successful response is NOT obtained, the output signal level should be increased by 1 dB and the new level recorded in the results sheet. If a successful response IS obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the output signal level from the signal generator should be reduced by 1 dB and the new level recorded in the results sheet. No signal levels should be recorded unless preceded by a change of level.

11g Step 11f should be repeated until a total of 10 recorded values for the signal generator output level have been entered on page 2 of the log book results sheet (table 41).

11h The Salty man/Salty-lite plus EUT complete assembly should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle steps 11b to 11g should be repeated.

11i For each angle, the 10 recorded values of the signal generator output level (dBm) should be converted to field strength (µV/m) by firstly adding the Transform Factor to produce the field strength in dBµV/m and then secondly converting dBµV/m to µV/m i.e.:

1) field strength (dBµV/m) = signal generator level (dBm) + Transform Factor (dB);

2) field strength (µV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m})/20)}$.

The resulting values in µV/m should be entered on page 2 of the log book results sheet (table 41).

11j For each angle, the 10 new recorded values of field strength in µV/m should be averaged according to the following formula:

$$\text{average field strength } (\mu\text{V/m}) = \sqrt{\left(\frac{10}{\sum_{i=1}^{i=10} \frac{1}{\textit{field strength } (\mu V/m)_i^2}} \right)}$$

The resulting 8 average values should also be entered on page 2 of the log book results sheet (table 41).

11k The procedure should continue with step 12.

12 For the maximum sensitivity test only, the lowest of the 8 values of field strength (µV/m) calculated during the multiple-stage step 11 represents the minimum field strength to which the EUT responds. This lowest value of field strength (µV/m) should be entered on page 2 of the log book results sheet (table 41) as the maximum sensitivity.

13 For the average sensitivity test only, the average of the 8 values of field strength (μV/m) calculated during the multiple-stage step 11 represents the average field strength to which the EUT responds. This average value of field strength in μV/m should now be calculated by the following:

$$\text{average field strength } (\mu\text{V/m}) = \sqrt{\left(\frac{8}{\sum_{i=1}^{i=8} \frac{1}{\textit{field strength } (\mu V/m)_i^{\,2}}} \right)}$$

This value of average field strength (μV/m) should be entered on page 2 of the log book results sheet (table 41) as the average sensitivity.

14 Steps 2 to 13 should be repeated with both the test and measuring antennas oriented for horizontal polarization.

8.2.1.6.1.3 Procedure for completion of the results sheets

All the necessary processing of the measured results is carried out during the course of the test procedure. The only calculation that remains to be performed is the determination of the expanded uncertainty of the measurement. This should be carried out in accordance with TR 100 028-2 [7], subclause 8.2.1.6.1 and the resulting value entered in the overall results sheet (table 42).

8.2.1.6.1.4 Log book entries

Table 41: Log book results sheet

RECEIVER SENSITIVITY			**Date:**		**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**			**Humidity:..............%** **Type No:.............**		**Frequency:.............MHz** **Serial No:.................**
Range length:......................					
Salty: Type:……………….			**Serial No:………….**		
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Measuring antenna				N/A	
Measuring antenna attenuator					N/A
Measuring antenna cable					N/A
Ferrite beads			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
AF source (if applicable)			N/A	N/A	N/A
SINAD meter (if applicable)			N/A	N/A	N/A
AF load (if applicable)			N/A	N/A	N/A
Bit stream generator (if applicable)			N/A	N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A	N/A
Message generator (if applicable)			N/A	N/A	N/A
Response measuring test set (if applicable)			N/A	N/A	N/A
Mounting configuration of EUT					

RECEIVER SENSITIVITY (analogue speech)									Date:								PAGE 2 of 2
Vertical Polarization									**Horizontal Polarization**								
Vertical offset from the central axis								m	Vertical offset from the central axis								m
Offset from axis of rotation								m	Offset from axis of rotation								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle for 20 dB SINAD									**Signal generator level (dBm) against angle for 20 dB SINAD**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
Conversion to µV/m									**Conversion to µV/m**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

RECEIVER SENSITIVITY (bit stream)									Date:								PAGE 2 of 2
Vertical Polarization									**Horizontal Polarization**								
Vertical offset from the central axis								m	Vertical offset from the central axis								m
Offset from axis of rotation								m	Offset from axis of rotation								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle for 10^{-2} BER									**Signal generator level (dBm) against angle for 10^{-2} BER**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
Conversion to µV/m									**Conversion to µV/m**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

RECEIVER SENSITIVITY (messages)				Date:												PAGE 2 of 2	
Vertical Polarization									Horizontal Polarization								
Vertical offset from the central axis								m	Vertical offset from the central axis								m
Offset from axis of rotation								m	Offset from axis of rotation								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle									Signal generator level (dBm) against angle								
level	0°	45°	90°	135°	180°	225°	270°	325°	level	0°	45°	90°	135°	180°	225°	270°	325°
1									1								
2									2								
3									3								
4									4								
5									5								
6									6								
7									7								
8									8								
9									9								
10									10								
Conversion to µV/m									Conversion to µV/m								
level	0°	45°	90°	135°	180°	225°	270°	325°	level	0°	45°	90°	135°	180°	225°	270°	325°
1									1								
2									2								
3									3								
4									4								
5									5								
6									6								
7									7								
8									8								
9									9								
10									10								
Ave.									Ave.								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

8.2.1.6.1.5 Statement of results

The results should be presented in tabular form as shown in table 42.

Table 42: Overall results sheet

RECEIVER SENSITIVITY		Date:		PAGE 1 of 1
Vertical Polarization		Horizontal Polarization		
MAXIMUM Usable Sensitivity	µV/m	MAXIMUM Usable Sensitivity		µV/m
AVERAGE Usable Sensitivity	µV/m	AVERAGE Usable Sensitivity		µV/m
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)		dB

8.2.1.6.2 Anechoic Chamber with a ground plane

For Sensitivity testing in an Anechoic Chamber with a ground plane reference should be made to the Open Area Test Site test method (subclause 8.2.1.6.3), since the procedures are identical.

The test equipment set-up for the derivation of the Transfer Factor is shown in figure 92 whilst the set-up for the sensitivity measurement is shown in figure 93.

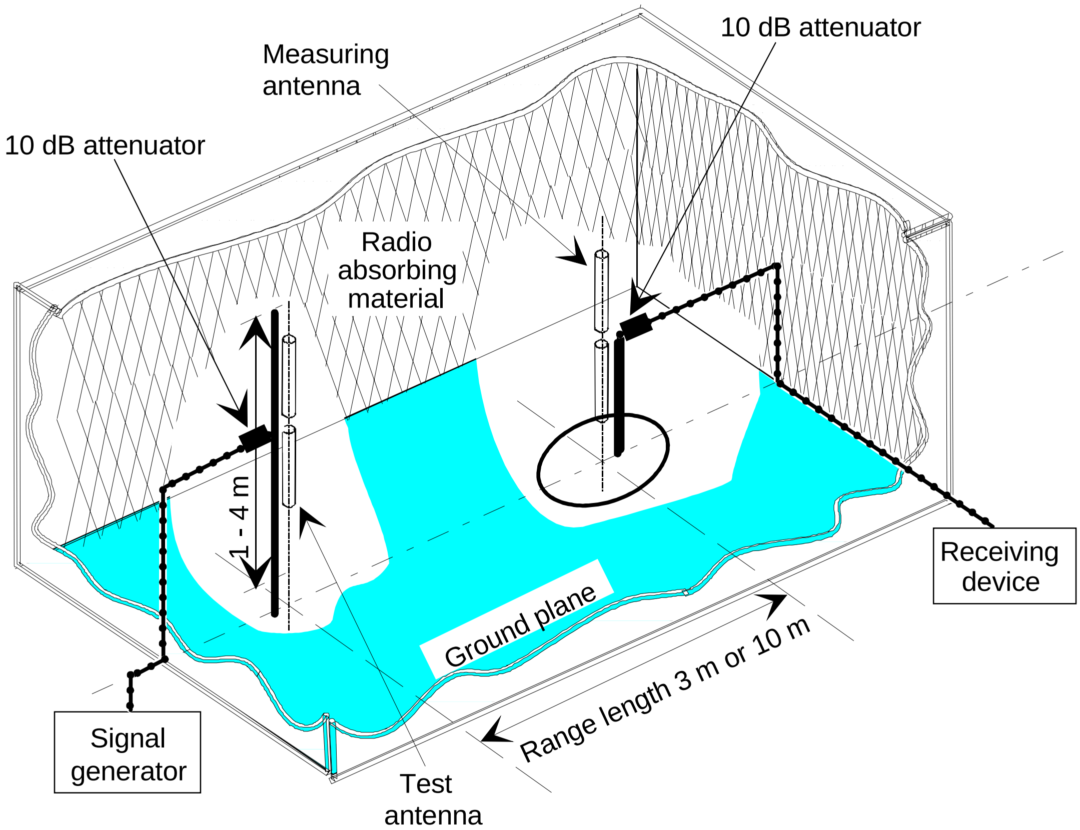

Figure 92: Equipment layout for the derivation of the Transform Factor during Receiver Sensitivity tests in an Anechoic Chamber with a ground plane

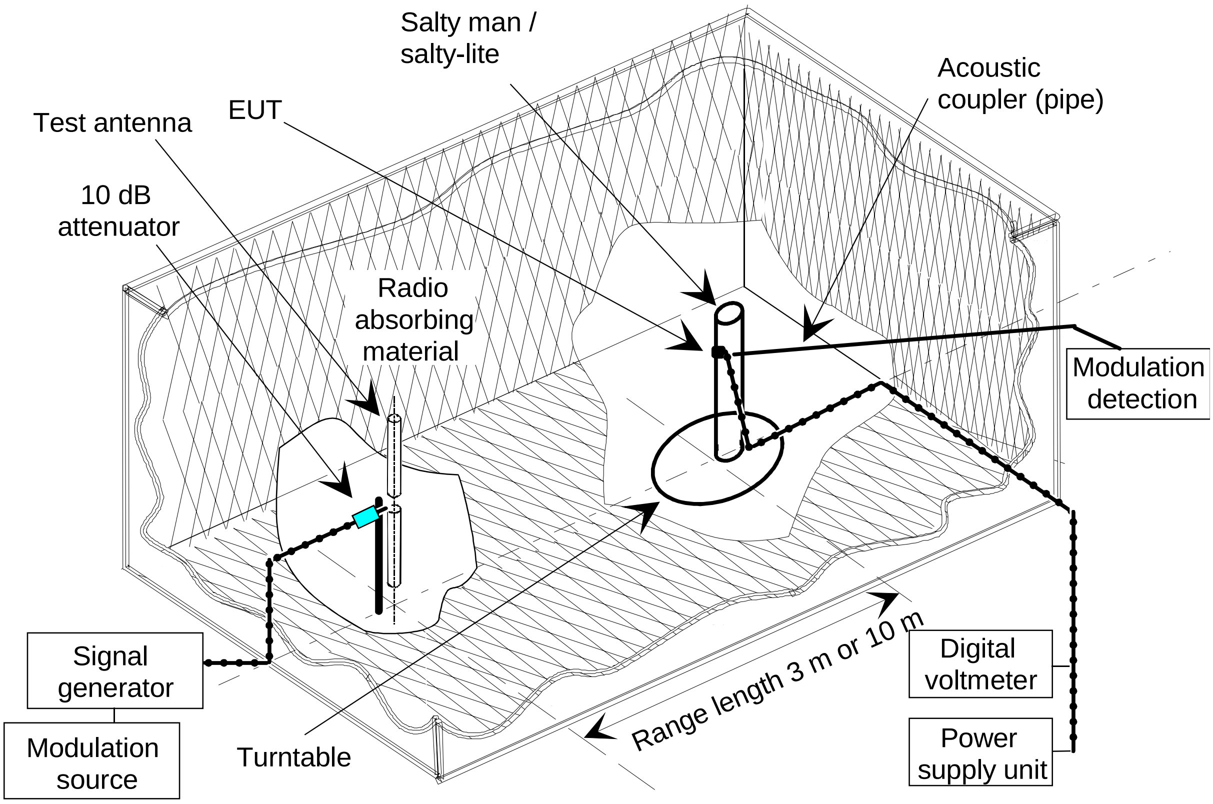

Figure 93: Anechoic Chamber with a ground plane set-up for sensitivity tests on the EUT

To complete the overall results sheet for this test, the value for expanded measurement uncertainty should be calculated according to TR 100 028-2 [7], subclause 8.2.1.6.2.

8.2.1.6.3 Open Area Test Site

8.2.1.6.3.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Open Area Test Site;
- Salty man or Salty-lite;
- Test antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- Measuring antenna (half wavelength dipole as detailed in ANSI C63.5 (1988) [11] recommended);
- RF Signal generator;
- Receiving device (measuring receiver or spectrum analyser).

Additional requirements for analogue speech:

- AF source;

- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 44).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

8.2.1.6.3.2 Method of measurement

1 The EUT should be mounted on the Salty man/Salty-lite at the height stated in the relevant Standard. It should be mounted in an orientation which matches that of its normal usage as declared by the manufacturer.

Determination of the Transform Factor for the test site

2 For this part of the test, it is necessary to position the measuring antenna such that its phase centre is at the same point that the phase centre of the EUT (mounted on the Salty man/Salty-lite) will occupy in the second part of the test. The precise point should always be, where possible, on the axis of rotation of the turntable but at a height above its mounting surface that should either be measured remotely or determined by sitting the complete assembly of Salty man/Salty-lite plus EUT on the turntable. The height above the turntable should be recorded on page 2 of the log book results sheet (table 44).

NOTE 1: If the position of the phase centre within the EUT is unknown, but its antenna is a single rod which is visible and vertical in normal usage, the axis of its antenna should be used for alignment with the axis of rotation of the turntable. The base of the antenna should be used for determining the height. If the phase centre is unknown and there is no visible antenna, the volume centre of the EUT should be used instead.

NOTE 2: The bulk of the Salty man/Salty-lite may offer little flexibility in positioning on the test site and some offset of the phase centre of the EUT from the axis of rotation might be necessary (see figure 94). Where an offset is unavoidable, its value should be entered on page 2 of the log book results sheet (table 44). If the overall positioning of the phase centre cannot be achieved without the dipole approaching closer than 0,25 m to the ground plane, the test should not be carried out.

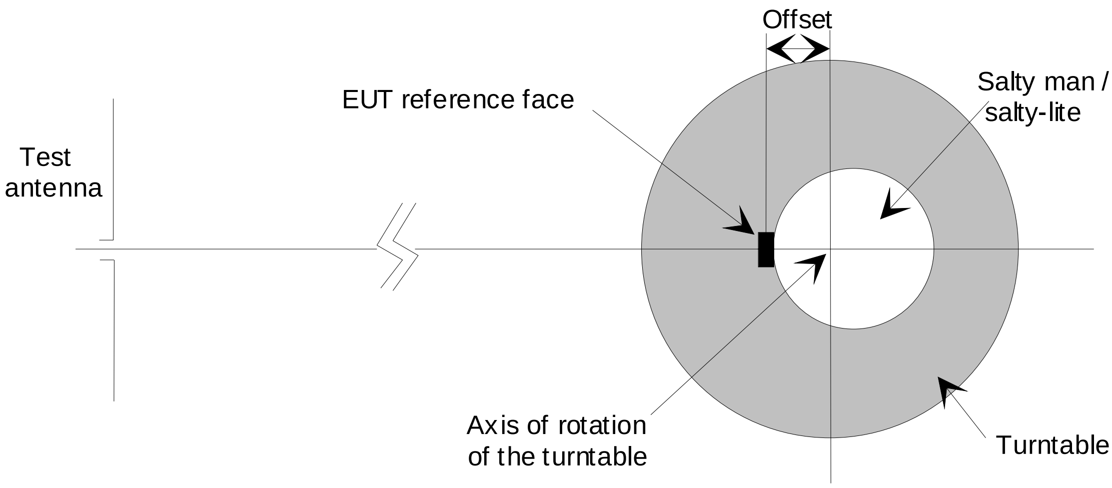

Figure 94: Illustration of offset from the axis of rotation

3 The measuring antenna (in the recommended scheme: a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) should be adjusted to correspond to the nominal frequency of the EUT and positioned with its phase centre at the point identified in step 2. It should be oriented for vertical polarization.

NOTE 3: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

4 The measuring antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site, to the receiving device.

5 The test antenna (identical to the measuring antenna) should be mounted on the antenna mast, tuned to the nominal frequency of the EUT and oriented for vertical polarization.

6 The test antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the test site, to the signal generator whose output is unmodulated. See figure 95. The signal generator should be tuned to the nominal frequency of the EUT.

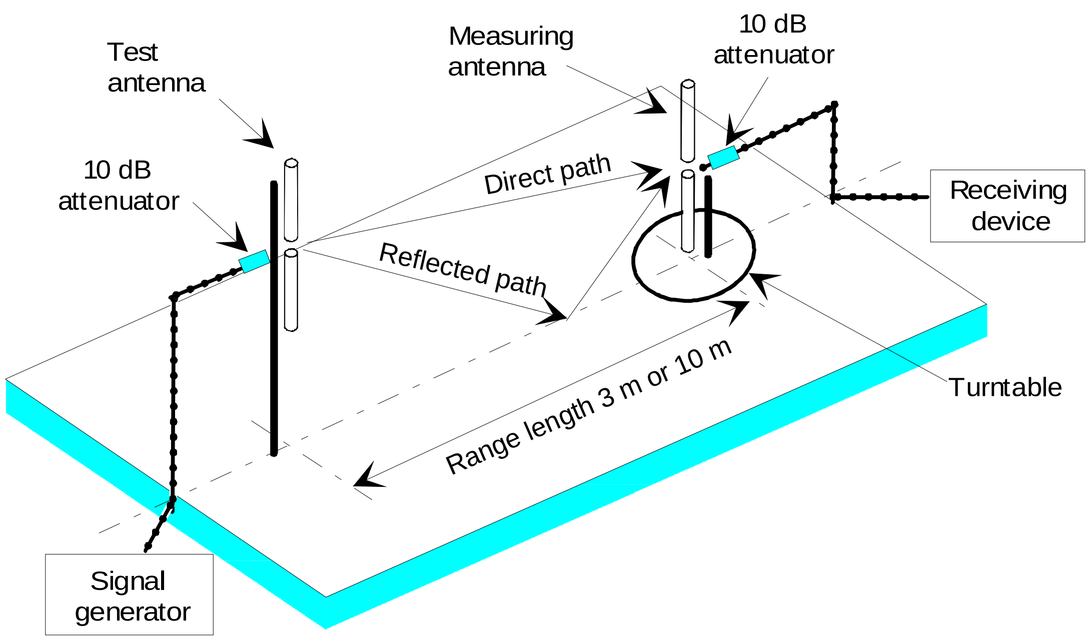

Figure 95: Equipment layout for the derivation of the Transfer Factor during Sensitivity tests on an Open Area Test Site

7 The output level of the signal generator should be adjusted until a received signal level at least 20 dB above the noise floor is observed on the receiving device.

8 The test antenna should be raised and lowered through the specified range of heights whilst monitoring the received signal level on the receiving device. The test antenna should be positioned at the height corresponding to the maximum received signal. This height should be recorded on page 2 of the log book results sheet (table 44).

NOTE 4: The true maximum may lie beyond the top of the mast, in which case the maximum receivable level should be at the top of the height range.

9 The measuring antenna should be rotated in the horizontal plane until the maximum level is detected on the receiving device.

NOTE 5: This is to correct for possible misalignment of a directional beam i.e. dipoles used in horizontally polarized tests. This step can be omitted when dipoles are used in vertically polarized tests.

10 The maximum received signal level (dBμV) appearing on the receiving device along with the output level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 44). A Transform Factor for the test site (i.e. a factor relating the output power level from the signal generator (dBm) to the resulting field strength (dBμV/m) at the point of measurement) should be calculated according to the following formula:

Transform Factor (dB) = *received signal level (dBμV)*

+ *measuring antenna cable loss*

+ *measuring antenna attenuator loss*

+ *measuring antenna balun loss*

+ *mutual coupling and mismatch loss correction factor (if applicable)*

+ *antenna factor of the measuring antenna*

- *signal generator output level (dBm)*

NOTE 6: Guidance for deriving/calculating/finding the unknown values in the above formula for Transform Factor are given in table 43. These values should be entered on page 2 of the log book results sheet (table 44).

The resulting value for the Transform Factor should be entered on page 2 of the log book results sheet (table 44).

Table 43: Guidance for deriving Transform Factor

Values in the formula for Transform Factor
Measuring antenna cable loss: Obtained directly from the calibration data.
Measuring antenna attenuator loss: Obtained from calibration data.
Measuring antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss correction factor between the test antenna and the measuring antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A20. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Antenna factor of the measuring antenna: For ANSI dipoles: Antenna factor = 20 $\log_{10}$ (*f*) - 31,4 dB dB/m (where *f* is the frequency in MHz) For other types the value can be obtained from calibration data.

Sensitivity measurement on the EUT

11 The measuring antenna should be replaced on the turntable by the complete assembly of Salty man/Salty-lite plus EUT. The EUT should be positioned such that its phase centre is in the same place as formerly occupied by the phase centre of the measuring antenna.

12 The normal to the reference face of the EUT should point directly towards the test antenna. This is the 0° reference angle for this test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 44).

For analogue speech:

13a The EUT should be connected to the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) through an AF load or by an acoustic coupler which is made from low dielectric constant (i.e. less than 1,5) material(s) for EUTs not fitted with a direct connection. See figure 96.

13b The signal generator output should be modulated with test modulation AM-1 (produced by the AF source) and its output level should be adjusted until a psophometrically weighted SINAD ratio of 20 dB is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 44).

13c The Salty man/Salty-lite plus EUT complete assembly should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle step 13b should be repeated.

13d The 8 values of signal generator output power level resulting from steps 13b and 13c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBμV/m and then secondly converting dBμV/m to μV/m i.e.:

1) field strength (dBμV/m) = signal generator level (dBm) + Transform Factor (dB);

2) field strength (μV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$.

The resulting values in μV/m should be also entered on page 2 of the log book results sheet (table 44).

13e The procedure should now resume with step 14.

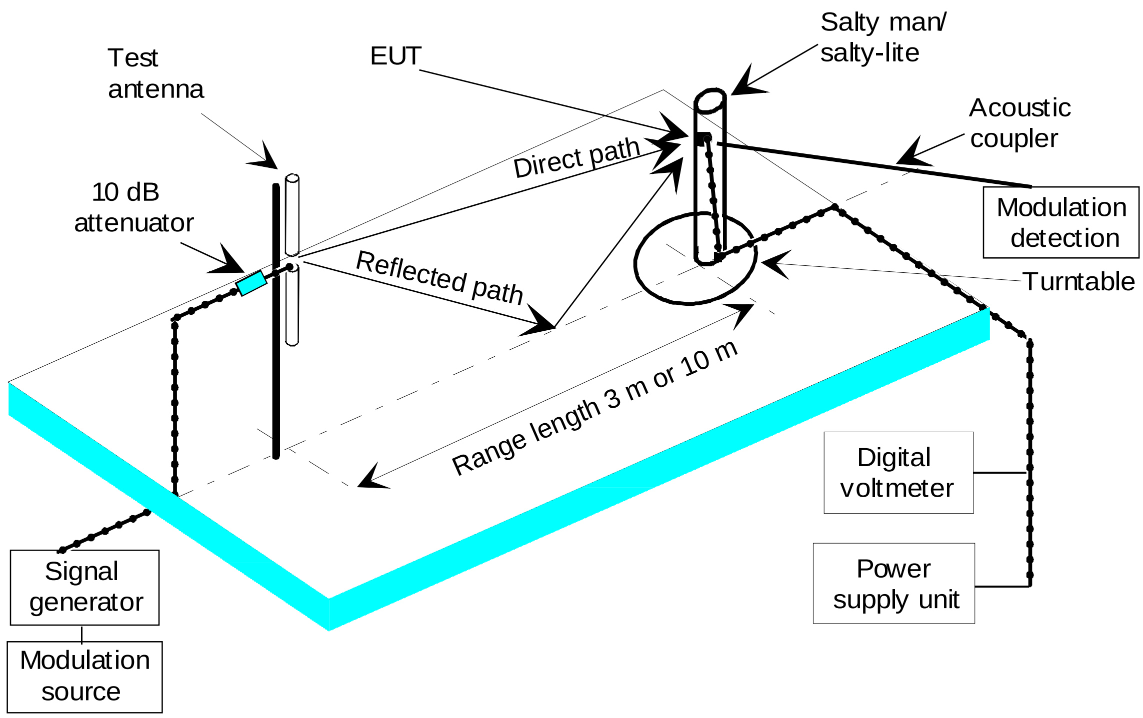

Figure 96: Open Area Test Site set-up for sensitivity tests on the EUT

For bit stream:

13a The EUT should be connected to the modulation detector (a bit error measuring test set, which should also receive a direct input from the bit stream generator) by a direct connection. See figure 96.

13b The signal generator output should be modulated with test modulation DM-2 (produced by the bit stream generator) and its output level should be adjusted until a bit error ratio of 10^{-2} is obtained from the EUT. The corresponding signal generator output power level should be recorded on page 2 of the log book results sheet (table 44).

13c The Salty man/Salty-lite plus EUT complete assembly should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle step 13b should be repeated.

13d The 8 values of signal generator output power level resulting from steps 13b and 13c should be converted into field strength values by firstly adding the Transform Factor to produce the field strength in dBµV/m and then secondly converting dBµV/m to µV/m i.e.:

1) field strength (dBµV/m) = signal generator level (dBm) + Transform Factor (dB);

2) field strength (µV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$.

The resulting values in µV/m should be also entered on page 2 of the log book results sheet (table 44).

13e The procedure should now resume with step 14.

For messages

13a The EUT should be connected to the modulation detector (a response measuring test set) via an acoustic coupler (pipe) which is made from low dielectric constant (i.e. less than 1,5) material(s). See figure 96.

13b The signal generator output should be modulated with test modulation DM-3 (produced by the message generator) and its output level should be adjusted until a message acceptance ratio of < 10 % is obtained from the EUT.

13c The test message should be transmitted repeatedly from the test antenna, whilst observing for each message whether a successful response is obtained. The output level of the signal generator should be increased by 2 dB for each occasion that a successful response is NOT obtained.

13d Step 13c should be repeated until three consecutive successful responses are observed at the same output level from the signal generator. The output level from the signal generator should be recorded on page 2 of the log book results sheet (table 44).

13e The output signal level from the signal generator should be reduced by 1 dB. The new signal level should be recorded on page 2 of the log book results sheet (table 44) and the response of the EUT observed.

13f If a successful response is NOT obtained, the output signal level should be increased by 1 dB and the new level recorded in the results sheet. If a successful response IS obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the output signal level from the signal generator should be reduced by 1 dB and the new level recorded in the results sheet. No signal levels should be recorded unless preceded by a change of level.

13g Step 13f should be repeated until a total of 10 recorded values for the signal generator output level have been entered on page 2 of the log book results sheet (table 44).

13h The Salty man/Salty-lite plus EUT complete assembly should be successively rotated through 45° in the horizontal plane to new testing angles of 45°, 90°, 135°, 180°, 225°, 270°, 315° (thereby covering the entire 360° in 8 measurements). At each angle steps 13b to 13g should be repeated.

13i For each angle, the 10 recorded values of the signal generator output level (dBm) should be converted to field strength (μV/m) by firstly adding the Transform Factor to produce the field strength in dBμV/m and then secondly converting dBμV/m to μV/m i.e.:

1) field strength (dBμV/m) = signal generator level (dBm) + Transform Factor (dB);

2) field strength (μV/m) = $10^{\wedge(\text{field strength(dB}\mu\text{V/m)/20)}}$.

The resulting values in μV/m should be also entered on page 2 of the log book results sheet (table 44).

13j For each angle, the 10 new recorded values of field strength in μV/m should be averaged according to the following formula:

$$\text{average field strength } (\mu\text{V/m}) = \sqrt{\left(\frac{10}{\sum_{i=1}^{i=10} \frac{1}{\textit{field strength } (\mu V/m)_i^{\,2}}}\right)}$$

The resulting 8 average values should also be entered on page 2 of the log book results sheet (table 44).

13k The procedure should continue with step 14.

14 For the maximum sensitivity test only, the lowest of the 8 values of field strength (dBμV/m) calculated during the multiple-stage step 13 represents the minimum field strength to which the EUT responds. This lowest value of field strength (μV/m) should be entered on page 2 of the log book results sheet (table 44) as the maximum sensitivity.

15 For the average sensitivity test only, the average of the 8 values of field strength (μV/m) calculated during the multiple-stage step 13 represents the average field strength to which the EUT responds. This average value of field strength in μV/m should now be calculated by the following:

$$\text{average field strength } (\mu\text{V/m}) = \sqrt{\left(\frac{8}{\sum_{i=1}^{i=8} \frac{1}{\textit{field strength } (\mu V/m)_i^{\,2}}}\right)}$$

This average value of field strength (μV/m) should be entered on page 2 of the log book results sheet (table 44) as the average sensitivity.

16 Steps 2 to 15 should be repeated with both the test and measuring antennas oriented for horizontal polarization.

8.2.1.6.3.3 Procedure for completion of the results sheets

All the necessary processing of the measured results is carried out during the course of the test procedure. The only calculation that remains to be performed before the overall results sheet (table 45) can be completed is the determination of the expanded uncertainty of the measurement. This should be carried out in accordance with TR 100 028-2 [7], subclause 8.2.1.6.3 and the resulting value entered in the overall results sheet (table 45).

8.2.1.6.3.4 Log book entries

Table 44: Log book results sheet

RECEIVER SENSITIVITY		**Date:**			**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**		**Humidity:..............%** **Type No:.............**		**Frequency:............MHz** **Serial No:.................**	
Range length:......................					
Salty: Type:……………….		**Serial No:………….**			
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Measuring antenna				N/A	
Measuring antenna attenuator					N/A
Measuring antenna cable					N/A
Ferrite beads			N/A	N/A	N/A
Receiving device				N/A	N/A
Signal generator				N/A	N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Audio frequency source (if applicable)			N/A	N/A	N/A
SINAD meter (if applicable)			N/A	N/A	N/A
Audio frequency load (if applicable)			N/A	N/A	N/A
Bit stream generator (if applicable)			N/A	N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A	N/A
Message generator (if applicable)			N/A	N/A	N/A
Response measuring test set (if applicable)			N/A	N/A	N/A
Mounting configuration of EUT					

RECEIVER SENSITIVITY (analogue speech)									**Date:**								**PAGE 2 of 2**
Vertical polarization									**Horizontal polarization**								
Height of the test antenna								m	Height of the test antenna								m
Offset from the axis of rotation								m	Offset from the axis of rotation								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle for 20 dB SINAD									**Signal generator level (dBm) against angle for 20 dB SINAD**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
Conversion to µV/m									**Conversion to µV/m**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

RECEIVER SENSITIVITY (bit stream)									**Date:**								**PAGE 2 of 2**
Vertical polarization									**Horizontal polarization**								
Height of the test antenna								m	Height of the test antenna								m
Offset from the axis of rotation								m	Offset from the axis of rotation								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle for 10^{-2} BER									**Signal generator level (dBm) against angle for 10^{-2} BER**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
Conversion to µV/m									**Conversion to µV/m**								
	0°	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**		**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
level									**level**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

RECEIVER SENSITIVITY (messages)									Date:						PAGE 2 of 2		
Vertical polarization									**Horizontal polarization**								
Height of the test antenna								m	Height of the test antenna								m
Offset from the axis of rotation								m	Offset from the axis of rotation								m
Received signal level								dBµV	Received signal level								dBµV
Output level from signal generator								dBm	Output level from signal generator								dBm
Transform Factor								dB	Transform Factor								dB
Signal generator level (dBm) against angle									**Signal generator level (dBm) against angle**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Conversion to µV/m									**Conversion to µV/m**								
level	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**	**level**	**0°**	**45°**	**90°**	**135°**	**180°**	**225°**	**270°**	**325°**
1									**1**								
2									**2**								
3									**3**								
4									**4**								
5									**5**								
6									**6**								
7									**7**								
8									**8**								
9									**9**								
10									**10**								
Ave.									**Ave.**								
MAXIMUM Sensitivity								µV/m	MAXIMUM Sensitivity								µV/m
AVERAGE Sensitivity								µV/m	AVERAGE Sensitivity								µV/m
Values in the formula for Transform Factor																	
Measuring antenna cable loss									Measuring antenna cable loss								
Measuring antenna attenuator loss									Measuring antenna attenuator loss								
Measuring antenna balun loss									Measuring antenna balun loss								
Mutual coupling and mismatch loss (30 MHz - 180 MHz)									Mutual coupling and mismatch loss (30 MHz - 180 MHz)								
Antenna factor of the measuring antenna									Antenna factor of the measuring antenna								

8.2.1.6.3.5 Statement of results

The results should be presented in tabular form as shown in table 45.

Table 45: Overall results sheet

RECEIVER SENSITIVITY		Date:	PAGE 1 of 1
Vertical polarization		**Horizontal polarization**	
MAXIMUM Usable Sensitivity	µV/m	MAXIMUM Usable Sensitivity	µV/m
AVERAGE Usable Sensitivity	µV/m	AVERAGE Usable Sensitivity	µV/m
Expanded uncertainty (95 %)	dB	Expanded uncertainty (95 %)	dB

8.2.2 Co-channel rejection

NOTE: This test is only usually carried out using a Test Fixture.

Definition

The ***co-channel rejection*** is a measure of the capability of the receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted modulated signal also at the nominal frequency.

For analogue speech:

it is specified as the ratio in decibels of the level of the unwanted signal to the specified wanted signal level at the receiver input which produces, through a telephone psophometric weighting network, a SINAD ratio of 14 dB.

For bit stream:

it is specified as the ratio in decibels of the level of the unwanted signal to the specified wanted signal level at the receiver input for which the bit error ratio is 10^{-2}.

For messages:

it is specified as the ratio in decibels of the level of the unwanted signal to the specified wanted signal level at the receiver input for which the message acceptance ratio is 80 %.

8.2.2.1 Test Fixture

8.2.2.1.1 Apparatus required

- Digital voltmeter;
- Power supply;
- Connecting cables;
- Ferrite beads;
- 10 dB attenuator;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;
- 2 RF signal generators;
- 50 Ω load;
- AF source.

Additional requirements for analogue speech:

- 2nd AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;

- Response measuring test set.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 46).

8.2.2.1.2 Method of measurement

1 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of maximum usable sensitivity (for the particular type of data modulation i.e. analogue speech, bit stream or messages) should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

   a) the EUT by itself on the accredited Free-Field Test Site;

   b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

   c) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

   d) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

   The value recorded for configuration b) during the verification procedure should be entered on page 2 of the log book results sheet (table 46). This value should be converted to dBμV/m (from μV/m) before entering it in the log book results sheet.

   For all modulation types, the maximum usable sensitivity limit (as stated in the relevant standard) as well as the calculated difference between this value and the b) value recorded during the verification procedure should both be entered on page 2 of the log book results sheet (table 46).

2 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This configuration should be noted on page 1 of the log book results sheet (table 46).

3 The assembly should be connected to the test equipment as shown in figure 97 where acoustic coupling to the EUT is illustrated.

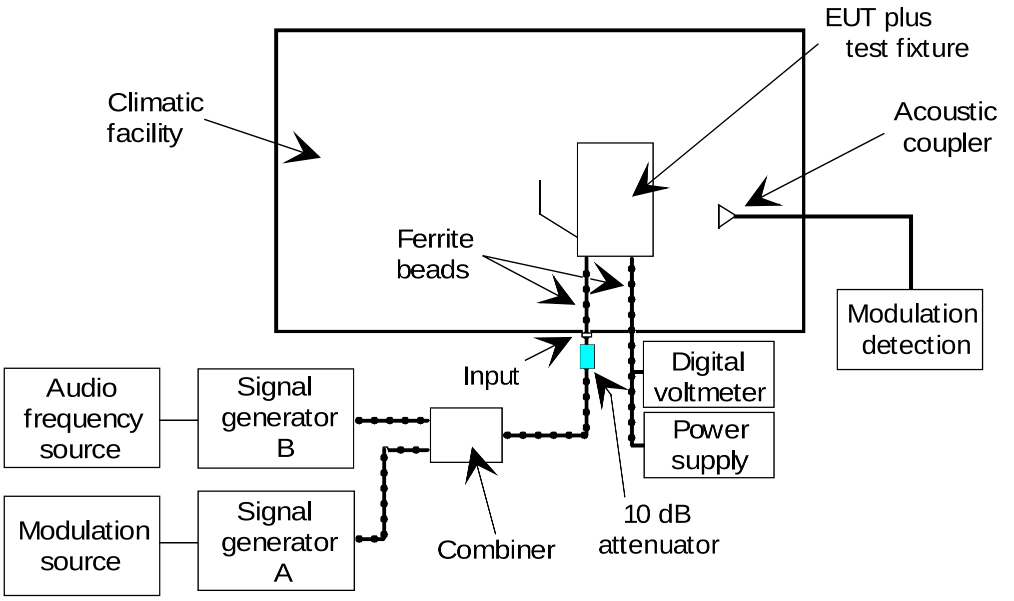

Figure 97: Co-channel rejection using a Test Fixture (shown with acoustic coupler)

4 Normal conditions (as stated in the relevant standard) should exist within the climatic facility.

5 The output from signal generator B should be tuned to the nominal frequency of the EUT. It should be modulated with test modulation A-M3 produced by the AF generator. This is the unwanted signal as far as the test is concerned.

For analogue speech:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation A-M1 produced by the modulation source (an AF generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The output signal level of signal generator A should be adjusted until the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) indicates a 20 dB SINAD ratio has been obtained. The signal generator level should be increased by the difference between the limit of the maximum usable sensitivity - the Free-Field Test Site measured maximum usable sensitivity. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 46).

NOTE 1: The output level increase is the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6d The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6e The output of signal generator B should then be switched on and its level adjusted until the SINAD ratio (again as measured through a telephone psophometric weighting network) is reduced to 14 dB. The corresponding output power level of signal generator B should be recorded on page 2 of the log book results sheet (table 46).

6f Retaining its modulation A-M3, signal generator B should then be tuned, in succession, to frequencies 1 500 Hz and 3 000 Hz above and below the nominal frequency. For each frequency, step 6e should be repeated keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6c.

6g The procedure should now resume with step 7.

For bit stream:

6a The output from signal generator A should be tuned to the nominal frequency of the receiver. It should be modulated by test modulation D-M2 produced by the modulation source (a bit stream generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The EUT should be directly connected to the modulation detector (a bit error measuring test set which should also receive a direct input from the bit stream generator) and the output signal level of signal generator A should be adjusted until a bit error ratio of 10^{-2} is obtained. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 46).

6d The output signal level of signal generator A should then be increased above the level noted in step 6c by the difference in the two values recorded in step 1. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 46).

NOTE 2: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6e The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6f The output of signal generator B should then be switched on and its level adjusted until a bit error ratio of about 10^{-1} is obtained.

6g The wanted signal should be transmitted at the level set in step 6d whilst the level of signal generator B (the unwanted signal) is reduced in 1 dB steps until a bit error ratio of 10^{-2} or better is obtained. The corresponding output power level of signal generator B should be recorded on page 2 of the log book results sheet (table 46).

6h Retaining its modulation A-M3, signal generator B should then be tuned, in succession, to frequencies 1 500 Hz and 3 000 Hz above and below the nominal frequency. For each frequency, steps 6f and 6g should be repeated keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6d.

6i The procedure should now resume with step 7.

For messages:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation D-M3. This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The output signal level of signal generator A should be adjusted until the modulation detector (a response measuring test set) indicates that a successful message response ratio of less than 10 % has been obtained.

6d The output signal level of signal generator A should then be successively increased in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level should be recorded on page 2 of the log book results sheet (table 46).

6e The output signal level of signal generator A should then be decreased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 46). The message should then be continuously repeated. In each case, if a successful response **is not** obtained, the input level should be increased by 1 dB and the new value recorded. If a successful response **is** obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the input level should be reduced by 1 dB and the new value recorded in the log book results sheet. No input signal levels should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded in the log book results sheet (table 46).

6f The 10 values of signal generator output level recorded should then be averaged and the resulting value should be entered on page 2 of the log book results sheet (table 46).

6g The output signal level of signal generator A should then be increased above the calculated average level recorded in step 6f by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 46).

NOTE 3: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6h The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6i Whilst repeatedly transmitting the message from signal generator A, the output of signal generator B should then be switched on and its output level adjusted until a successful message acceptance ratio of less than 10 % is obtained.

6j The output signal level of signal generator B should then be successively reduced in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level from signal generator B should be recorded on page 2 of the log book results sheet (table 46).

6k The output signal level of signal generator B should then be increased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 46). The wanted signal (signal generator A) should then be repeatedly transmitted. In each case, if a successful response **is not** obtained, the level of the unwanted signal (signal generator B) should be continuously reduced by 1 dB and the new value recorded. If a successful response **is** obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been observed. In this case, the unwanted signal level should be reduced by 1 dB and the new value recorded in the log book results sheet. No levels of the unwanted signal should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded in the log book results sheet (table 46).

6l The 10 values of signal level recorded should then be averaged and the resulting value should be entered on page 2 of the log book results sheet (table 46).

6m Retaining its modulation A-M3, signal generator B should then be tuned, in succession, to frequencies of 1 500 Hz and 3 000 Hz above and below the nominal frequency. For each frequency, steps 6i to 6l should be repeated keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6g.

6n The procedure should now continue with step 7

7 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

8 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required.

NOTE 4: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 5: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

9 The supply voltage to the EUT should be set to the upper extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should then be repeated.

10 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should again be repeated.

11 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

12 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 6: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 7: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

13 The supply voltage to the EUT should be set to the lower extreme as given in the relevant standard. Step 5 and the multi-stage step 6 should then be repeated.

14 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant standard. Step 5 and the multi-stage step 6 should again be repeated.

15 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

8.2.2.1.3 Procedure for completion of the results sheets

Some final calculations need to be made before the overall results sheet (table 47) can be completed. The first of these calculations derives the difference in levels between the wanted signal and the unwanted signal for the stipulated reception (i.e. 14 dB SINAD for analogue speech, 10^{-2} bit error ratio for bit stream or 80 % message acceptance ratio for messages). In all cases, the relevant values can be found on page 2 of the log book results sheet (table 46) and the resulting level differences are co-channel rejection ratios.

For analogue speech: For each frequency, the difference (in dB) between the signal generator A level and the level of signal generator B (for 14 dB SINAD) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 46). The actual calculation is:

signal generator B level (for 14 dB *SINAD) - signal generator A increased (step 6c) level* dB

For bit stream: For each frequency, the difference (in dB) between the increased level (step 6d) of signal generator A and the level of signal generator B (for 10^{-2} BER) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 46). The actual calculation is:

signal generator B level (for 10^{-2} *BER) - signal generator A increased (step 6d) level* dB

For messages: For each frequency, the difference (in dB) between the increased level (step 6g) of signal generator A and the average level of signal generator B for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 46). The actual calculation is:

average signal generator B level - signal generator A increased (step 6g) level dB

For all types of data modulation, the co-channel rejection ratio for the EUT is the lowest of all the level differences between generators A and B. This value should be entered in the overall results sheet (table 47).

The final value needed to complete the overall results sheet (table 47) is the overall measurement uncertainty. This should be calculated in accordance with TR 100 028-2 [7], subclause 8.2.2.1.

8.2.2.1.4 Log book entries

Table 46: Log book results sheet

CO-CHANNEL REJECTION		**Date:**		**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**		**Humidity:...............%** **Type No:.............**		**Frequency:.............MHz** **Serial No:.................**
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
Signal generator A				N/A
Signal generator B				N/A
RF cable within climatic facility				
RF cable, climatic facility output to combiner				
RF cable, combiner to sig gen A				
RF cable, combiner to sig gen B				
RF Combiner				
50 Ω load				N/A
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
AF source A			N/A	N/A
2nd AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)			N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A
Audio load (if applicable)			N/A	N/A
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)			N/A	N/A
Mounting configuration of EUT				

CO-CHANNEL REJECTION (analogue speech)		**Date:**				**PAGE 2 of 2**
Result of measurement on accredited Free-Field Test Site: Type of test site:... 'b)' value of maximum usable sensitivity (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m).................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m).................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
f_0	Sig gen A (for 20 dB SINAD):					
	Increased level of sig gen A:					
	Sig gen B (for 14 dB SINAD):					
f_0 + 1 500	Sig gen B (for 14 dB SINAD):					
f_0 + 3 000	Sig gen B (for 14 dB SINAD):					
f_0 - 1 500	Sig gen B (for 14 dB SINAD):					
f_0 - 3 000	Sig gen B (for 14 dB SINAD):					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
f_0	Sig gen A - Sig gen B:					
f_0 + 1 500	Sig gen A - Sig gen B:					
f_0 + 3 000	Sig gen A - Sig gen B:					
f_0 - 1 500	Sig gen A - Sig gen B:					
f_0 - 3 000	Sig gen A - Sig gen B:					

CO-CHANNEL REJECTION (bit stream)		**Date:**				**PAGE 2 of 2**
Result of measurement on accredited Free-Field Test Site: Type of test site:... 'b)' value of maximum usable sensitivity (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m).................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m).................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
f_0	Sig gen A (for 10^{-2} BER):					
	Increased level of sig gen A:					
	Sig gen B (for 10^{-2} BER):					
f_0 + 1 500	Sig gen B (for 10^{-2} BER):					
f_0 + 3 000	Sig gen B (for 10^{-2} BER):					
f_0 - 1 500	Sig gen B (for 10^{-2} BER):					
f_0 - 3 000	Sig gen B (for 10^{-2} BER):					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
f_0	Sig gen A - Sig gen B:					
f_0 + 1 500	Sig gen A - Sig gen B:					
f_0 + 3 000	Sig gen A - Sig gen B:					
f_0 - 1 500	Sig gen A - Sig gen B:					
f_0 - 3 000	Sig gen A - Sig gen B:					

CO-CHANNEL REJECTION (messages) **Date:** **PAGE 2 of 2**

Result of measurement on accredited Free-Field Test Site:
Type of test site:...
'b)' value of maximum usable sensitivity (dBμV/m):............................

Limit of maximum usable sensitivity (as given in relevant standard)(dBμV/m)................................

Calculated difference between: Limit and measured 'b)' values (dBμV/m)................................

Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
f_0	Signal generator A level 1:					
	Signal generator A level 2:					
	Signal generator A level 3:					
	Signal generator A level 4:					
	Signal generator A level 5:					
	Signal generator A level 6:					
	Signal generator A level 7:					
	Signal generator A level 8:					
	Signal generator A level 9:					
	Signal generator A level 10:					
	Average sig gen A output:					
	Increased level of sig gen A					
	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
f_0 + 1 500	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
f_0 + 3 000	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					

	Average sig gen A output:					
f_0 - 1 500	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
f_0 - 3 000	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
f_0	Sig gen A - Sig gen B:					
f_0 + 1 500	Sig gen A - Sig gen B:					
f_0 + 3 000	Sig gen A - Sig gen B:					
f_0 - 1 500	Sig gen A - Sig gen B:					
f_0 - 3 000	Sig gen A - Sig gen B:					

8.2.2.1.5 Overall results sheet

The results should be presented in tabular form as shown in table 47:

Table 47: Overall results sheet

CO-CHANNEL REJECTION	**Date:**	**PAGE 1 of 1**
Co-channel rejection ratio		dB
Measurement uncertainty (95 %)		dB

8.2.3 Adjacent channel selectivity

NOTE: This test is only usually carried out using a Test Fixture.

Definition

The ***adjacent channel selectivity*** is a measure of the capability of the receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

For analogue speech:

it is specified as the lower value (of the upper and lower adjacent channels) of the ratios, in decibels, of the levels of the unwanted signal expressed as field strength to a specified wanted signal level expressed as field strength which produces, through a telephone psophometric weighting network, a SINAD ratio of 14 dB.

For bit stream:

it is specified as the lower value (of the upper and lower adjacent channels) of the ratios, in decibels, of the levels of the unwanted signal level expressed as field strength to a specified wanted signal level expressed as field strength producing a data signal with a bit error ratio of 10^{-2}.

For messages:

it is specified as the lower value (of the upper and lower adjacent channels) of the ratios, in decibels, of the levels of the unwanted signal level expressed as field strength to a specified wanted signal level expressed as field strength which produces after demodulation a message acceptance ratio of 80 %.

8.2.3.1 Test Fixture

8.2.3.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;
- 2 RF signal generators;
- 50 Ω load;
- AF source.

Additional requirements for analogue speech:

- 2nd AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 48).

8.2.3.1.2 Method of measurement

1 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of maximum usable sensitivity (for the particular type of data modulation i.e. analogue speech, bit stream or messages) should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

a) the EUT by itself on the accredited Free-Field Test Site;

b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

c) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

d) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

The value recorded for configuration b) during the verification procedure should be entered on page 2 of the log book results sheet (table 48). This value should be converted to dBμV/m (from μV/m) before entering it in the log book results sheet.

For all modulation types, the maximum usable sensitivity limit (as stated in the relevant standard) as well as the calculated difference between this value and the b) value recorded during the verification procedure should both be entered on page 2 of the log book results sheet (table 48).

2 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This configuration should be noted on page 1 of the log book results sheet (table 48).

3 The assembly should be connected to the test equipment as shown in figure 98 where acoustic coupling to the EUT is illustrated.

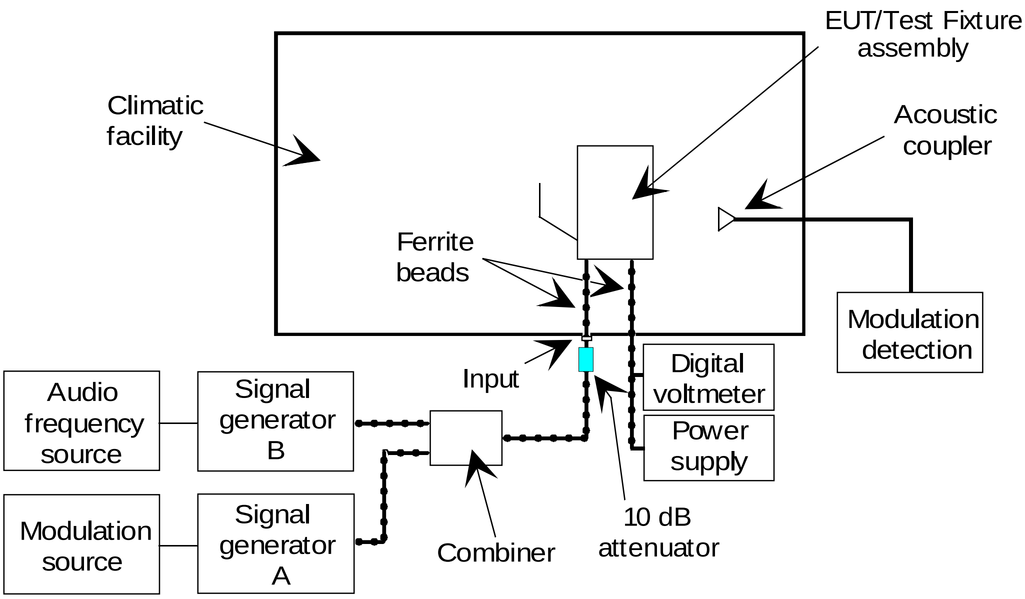

Figure 98: Adjacent channel selectivity using a Test Fixture (shown with acoustic coupler)

4 Normal conditions (as stated in the relevant standard) should exist within the climatic facility.

5 The output from signal generator B should be tuned to the frequency of the adjacent channel immediately above the nominal frequency of the EUT. It should be modulated with test modulation A-M3 produced by the AF generator. This is the unwanted signal as far as the test is concerned.

For analogue speech:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation A-M1 produced by the modulation source (an AF generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The output signal level of signal generator A should be adjusted until the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) indicates a 20 dB SINAD ratio has been obtained. The signal generator level should be increased by the difference between the limit of the maximum usable sensitivity - the Free-Field Test Site measured maximum usable sensitivity. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 48).

6d The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6e The output of signal generator B should then be switched on and its level adjusted until the SINAD ratio (again as measured through a telephone psophometric weighting network) is reduced to 14 dB. The corresponding output power level of signal generator B should be recorded on page 2 of the log book results sheet (table 48).

6f The output from signal generator B should then be tuned to the frequency of the adjacent channel immediately below the nominal frequency. It should retain the modulation A-M3. Step 6e should be repeated keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6c.

6g The procedure should now resume with step 7.

For bit stream:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation D-M2 produced by the modulation source (a bit stream generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The EUT should be directly connected to the modulation detector (a bit error measuring test set which should also receive a direct input from the bit stream generator) and the output signal level of signal generator A should be adjusted until a bit error ratio of 10^{-2} is obtained. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 48).

6d The output signal level of signal generator A should then be increased above the level noted in step 6c by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 48).

NOTE 1: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6e The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6f The output of signal generator B should then be switched on and its level adjusted until a bit error ratio of about 10^{-1} is obtained.

6g The wanted signal should be transmitted at the level set in step 6d whilst the level of signal generator B (the unwanted signal) is reduced in 1 dB steps until a bit error ratio of 10^{-2} is obtained. The corresponding output power level of signal generator B should be recorded on page 2 of the log book results sheet (table 48).

6h The output from signal generator B should then be tuned to the frequency of the adjacent channel immediately below the nominal frequency. It should retain the modulation A-M3. Steps 6f and 6g should be repeated keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6d.

6i The procedure should now resume with step 7.

For messages:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation D-M3 produced by the modulation source (a message generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The output signal level of signal generator A should be adjusted until the modulation detector (a response measuring test set) indicates that a successful message response ratio of less than 10 % has been obtained.

6d The output signal level of signal generator A should then be successively increased in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level should be recorded on page 2 of the log book results sheet (table 48).

6e The output signal level of signal generator A should then be decreased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 48). The message should then be continuously repeated. In each case, if a successful response **is not** obtained, the input level should be increased by 1 dB and the new value recorded. If a successful response **is** obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the input level should be reduced by 1 dB and the new value recorded in the log book results sheet. No input signal levels should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded in the log book results sheet (table 48).

6f The 10 values of signal generator output level recorded should then be averaged and the resulting value should be entered on page 2 of the log book results sheet (table 48).

6g The output signal level of signal generator A should then be increased above the calculated average level recorded in step 6f by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 48).

NOTE 2: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6h The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6i Whilst repeatedly transmitting the message from signal generator A, the output of signal generator B should then be switched on and its output level adjusted until a successful message acceptance ratio of less than 10 % is obtained.

6j The output signal level of signal generator B should then be successively reduced in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level from signal generator B should be recorded on page 2 of the log book results sheet (table 48).

6k The output signal level of signal generator B should then be increased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 48). The wanted signal (signal generator A) should then be repeatedly transmitted. In each case, if a successful response **is not** obtained, the level of the unwanted signal (signal generator B) should be continuously reduced by 1 dB and the new value recorded. If a successful response **is** obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been observed. In this case, the unwanted signal level should be reduced by 1 dB and the new value recorded in the log book results sheet. No levels of the unwanted signal should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded in the log book results sheet (table 48).

6l The 10 values of signal level recorded should then be averaged and the resulting value should be entered on page 2 of the log book results sheet (table 48).

6m The output from signal generator B should then be tuned to the frequency of the adjacent channel immediately below the nominal frequency. It should retain the modulation A-M3. Steps 6i to 6l should be repeated keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6g.

6n The procedure should now continue with step 7.

7 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

8 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required.

NOTE 3: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 4: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

9 The supply voltage to the EUT should be set to the upper extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should then be repeated.

10 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should again be repeated.

11 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

12 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 5: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 6: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

13 The supply voltage to the EUT should be set to the lower extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should then be repeated.

14 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should again be repeated.

15 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

8.2.3.1.3 Procedure for completion of the results sheets

Some final calculations need to be made before the overall results sheet (table 49) can be completed. The first of these calculations derives the difference in levels between the wanted signal and the unwanted signal for the stipulated reception (i.e. 14 dB SINAD for analogue speech, 10^{-2} bit error ratio for bit stream or 80 % message acceptance ratio for messages). In all cases, the relevant values can be found on page 2 of the log book results sheet (table 48) and the resulting level differences are the adjacent channel selectivity values for the EUT.

For analogue speech: For both channels, the difference (in dB) between the signal generator A level and the level of signal generator B (for 14 dB SINAD) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 48). The actual calculation is:

signal generator B level (for 14 dB *SINAD) - signal generator A increased (step 6c) level* dB

For bit stream: For both channels, the difference (in dB) between the increased level (step 6d) of signal generator A and the level of signal generator B (for 10^{-2} BER) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 48). The actual calculation is:

signal generator B level (for 10^{-2} BER) - signal generator A increased level (step 6d) dB

For messages: For both channels, the difference (in dB) between the increased level (step 6g) of signal generator A and the average level of signal generator B for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 48). The actual calculation is:

average signal generator B level - signal generator A increased (step 6g) level dB

For all types of data modulation, the adjacent channel selectivity for the EUT is the lowest of the 10 level differences (2 channels, 5 temperature/voltage combinations) between generators A and B. This lowest value should be entered in the overall results sheet (table 49).

The final value needed to complete the overall results sheet (table 49) is the overall measurement uncertainty. This should be calculated in accordance with TR 100 028-2 [7], subclause 8.2.3.1.

8.2.3.1.4 Log book entries

Table 48: Log book results sheet

ADJACENT CHANNEL SELECTIVITY		**Date:**		**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:..................**		**Humidity:...............%** **Type No:..............**	**Frequency:.............MHz** **Serial No:..................**	
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
Signal generator A				N/A
Signal generator B				N/A
RF cable within climatic facility				
RF cable, climatic facility input to combiner				
RF cable, combiner to sig gen A				
RF cable, combiner to sig gen B				
RF Combiner				
50 Ω load				N/A
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
AF source			N/A	N/A
2nd AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)			N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A
Audio load (if applicable)			N/A	N/A
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)			N/A	N/A
Mounting configuration of EUT				

ADJACENT CHANNEL SELECTIVITY (analogue speech) Date: PAGE 2 of 2						
Result of measurement on accredited Free-Field Test Site: Type of test site:.. 'b)' value of maximum usable sensitivity (dBµV/m):...........................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m)................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Adjacent channel	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
HIGH	Sig gen A (for 20 dB SINAD):					
	Increased level of sig gen A:					
	Sig gen B (for 14 dB SINAD):					
LOW	Sig gen B (for 14 dB SINAD):					
Adjacent channel	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
HIGH	Sig gen A - Sig gen B:					
LOW	Sig gen A - Sig gen B:					
	Adjacent channel selectivity (dB):					

ADJACENT CHANNEL SELECTIVITY (bit stream) Date: PAGE 2 of 2						
Result of measurement on accredited Free-Field Test Site: Type of test site:.. 'b)' value of maximum usable sensitivity (dBµV/m):...........................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m)................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Adjacent channel	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
HIGH	Sig gen A (for 10^{-2} BER):					
	Increased level of sig gen A:					
	Sig gen B (for 10^{-2} BER):					
LOW	Sig gen B (for 10^{-2} BER):					
Adjacent channel	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
HIGH	Sig gen A - Sig gen B:					
LOW	Sig gen A - Sig gen B:					
	Adjacent channel selectivity (dB):					

ADJACENT CHANNEL SELECTIVITY (messages)	Date:				PAGE 2 of 2	
Result of measurement on accredited Free-Field Test Site: Type of test site:... 'b)' value of maximum usable sensitivity (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m).................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Adjacent channel	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
HIGH	Signal generator A level 1:					
	Signal generator A level 2:					
	Signal generator A level 3:					
	Signal generator A level 4:					
	Signal generator A level 5:					
	Signal generator A level 6:					
	Signal generator A level 7:					
	Signal generator A level 8:					
	Signal generator A level 9:					
	Signal generator A level 10:					
	Average sig gen A output:					
	Increased level of sig gen A					
	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
LOW	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
Adjacent channel	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
HIGH	Sig gen A - Sig gen B:					
LOW	Sig gen A - Sig gen B:					
	Adjacent channel selectivity (dB):					

8.2.3.1.5 Overall results sheet

The results should be presented in tabular form as shown in table 49.

Table 49: Overall results sheet

ADJACENT CHANNEL SELECTIVITY	Date: PAGE 1 of 1
Adjacent channel selectivity	dB
Measurement uncertainty (95 %)	dB

8.2.4 Intermodulation immunity

NOTE: This test is only usually carried out using a Test Fixture.

Definition

The ***intermodulation immunity*** is a measure of the capability of a receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

For analogue speech: it is specified as the ratio in decibels of the common level of two equal unwanted signals to a specified level of the wanted signal at the receiver input, which produces through a psophometric weighting network a SINAD ratio of 14 dB.

For bit stream: it is specified as the ratio in decibels of the common level of two equal unwanted signals to a specified level of the wanted signal at the receiver input for which the bit error ratio is 10^{-2}.

For messages: it is specified as the ratio in decibels of the common level of two equal unwanted signals to a specified level of the wanted signal at the receiver input for which the message acceptance ratio is 80 %.

8.2.4.1 Test Fixture

8.2.4.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;
- 2 RF Combiners;
- 3 RF signal generators;
- 50 Ω load;
- AF source.

Additional requirements for analogue speech:

- 2nd AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;

- Message generator;
- Response measuring test set.

The type and serial numbers of all items of test equipment should be recorded in the log book results sheet (table 50).

8.2.4.1.2 Method of measurement

1 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of maximum usable sensitivity (for the particular type of data modulation i.e. analogue speech, bit stream or messages) should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

a) the EUT by itself on the accredited Free-Field Test Site;

b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

c) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

d) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

The value recorded for configuration b) during the verification procedure should be entered on page 2 of the log book results sheet (table 50). This value should be converted to dBμV/m (from μV/m) before entering it in the log book results sheet.

For all modulation types, the maximum usable sensitivity limit (as stated in the relevant standard) as well as the calculated difference between this value and the b) value recorded during the verification procedure should both be entered on page 2 of the log book results sheet (table 50).

2 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This configuration should be noted on page 1 of the log book results sheet (table 50).

3 The assembly should be connected to the test equipment as shown in figure 99 where direct coupling to the audio out socket on the EUT is illustrated.

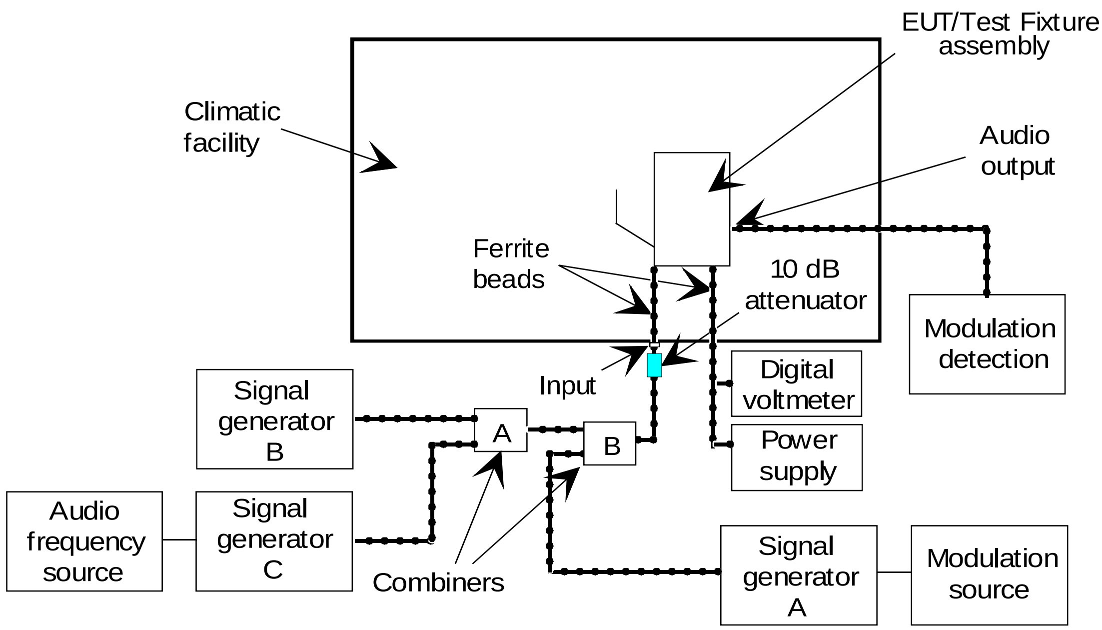

Figure 99: Intermodulation immunity using a Test Fixture (shown with a direct connection to the EUT audio out socket)

4 Normal conditions (as stated in the relevant standard) should exist within the climatic facility.

5 The output from signal generator B should be unmodulated and tuned to a frequency 50 kHz above the nominal frequency of the receiver. This is one of the two unwanted signals as far as the test is concerned.

6 The output from signal generator C should be tuned to a frequency 100 kHz above the nominal frequency of the receiver. It should be modulated with test modulation A-M3. This is the second unwanted signal as far as the test is concerned.

For analogue speech:

7a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated with test modulation A-M1 produced by the modulation source (an AF generator). This is the wanted signal as far as the test is concerned.

7b The output signal levels of signal generators B and C should be switched off and the cable connecting the output of combiner A to one of the inputs of combiner B should be disconnected from the combiner B input port. The vacated combiner B port should then be terminated with a 50 Ω load.

7c The output signal level of signal generator A should be adjusted until the modulation detector (a SINAD meter incorporating a telephone psophometric weighting network) indicates a 20 dB SINAD ratio has been obtained. The signal generator level should be increased by the difference between the limit of the maximum usable sensitivity - the Free-Field Test Site measured maximum usable sensitivity. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 50).

NOTE 1: The output level increase is the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

7d The cable from the output of combiner A should then be reconnected to the input of combined B (replacing the 50 Ω load).

7e The two unwanted signals produced by signal generators B and C should then both be switched on. Their amplitudes, whilst being maintained equal, should be adjusted until a reduced SINAD ratio of 14 dB (again as measured through a telephone psophometric weighting network) is obtained.

7f The frequency of signal generator B should then be adjusted to produce the maximum degradation to the SINAD ratio, after which the amplitudes of both unwanted signals should be re-adjusted to return to the required SINAD ratio of 14 dB. The equal levels of signal generators B and C should be recorded on page 2 of log book results sheet (table 50).

7g The outputs from signal generators B and C should then be tuned to frequencies 50 kHz and 100 kHz respectively below the nominal frequency of the receiver. The output from signal generator B should remain unmodulated, that from signal generator C should remain modulated with test modulation A-M3.

7h Steps 7e and 7f should then be repeated.

7i The procedure should now resume with step 8.

For bit stream:

7a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation D-M2 produced by the modulation source (a bit stream generator). This is the wanted signal as far as the test is concerned.

7b The output signal levels of signal generators B and C should be switched off and the cable connecting the output of combiner A to one of the inputs of combiner B should be disconnected from the combiner B input port. The vacated combiner B port should then be terminated with a 50 Ω load.

7c The EUT should be directly connected to the modulation detector (a bit error measuring test set which should also receive a direct input from the bit stream generator) and the output signal level of signal generator A should be adjusted until a bit error ratio of 10^{-2} is obtained. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 50).

7d The output signal level of signal generator A should then be increased above the level noted in step 7c by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 50)

NOTE 2: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

7e The cable from the output of combiner A should then be reconnected to the input of combined B (replacing the 50 Ω load).

7f The two unwanted signals produced by signal generators B and C should then both be switched on. Their amplitudes, whilst being maintained equal, should be adjusted such that a bit error ratio of about 10^{-1} is obtained.

7g The wanted signal should be transmitted whilst observing the bit error ratio and the level of signal generators B and C (the unwanted signals) reduced in 1 dB steps until a bit error ratio of 10^{-2} is obtained. The corresponding output power levels of signal generators B and C should be recorded on page 2 of the log book results sheet (table 50).

7h The outputs from signal generators B and C should then be tuned to frequencies 50 kHz and 100 kHz respectively below the nominal frequency of the receiver. The output from signal generator B should remain unmodulated, that from signal generator C should remain modulated with test modulation A-M3.

7i The tuning and modulation of signal generator A should be retained as set in step 7a and its output level retained as set in step 7d. Steps 7f and 7g should then be repeated.

For messages:

7a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation D-M3 produced by the modulation source (a message generator). This is the wanted signal as far as the test is concerned.

7b The output signal levels of signal generators B and C should be switched off and the cable connecting the output of combiner A to one of the inputs of combiner B should be disconnected from the combiner B input port. The vacated combiner B port should then be terminated with a 50 Ω load.

7c The output signal level of signal generator A should be adjusted until a successful message response ratio of less than 10 % is obtained.

7d The output signal level of signal generator A should then be successively increased in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level should be recorded on page 2 of the log book results sheet (table 50).

7e The output signal level of signal generator A should then be decreased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 50). The message should then be continuously repeated. In each case, if a successful response **is not** obtained, the input level should be increased by 1 dB and the new value recorded. If a successful response **is** obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the input level should be reduced by 1 dB and the new value recorded in the log book results sheet. No input signal levels should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded on page 2 of the log book results sheet (table 50).

7f The 10 values of signal level recorded should then be averaged and entered on page 2 of the log book results sheet (table 50).

7g The output signal level of signal generator A should then be increased above the calculated average level recorded in step 7f by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 50).

NOTE 3: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant Standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

7h The cable from the output of combiner A should then be reconnected to the input port of combiner B (replacing the 50 Ω load).

7i The two unwanted signals produced by signal generators B and C should then both be switched on. Their amplitudes, whilst being maintained equal, should be adjusted such that a message acceptance ratio of less than 10 % is obtained.

7j The equal output signal levels of signal generators B and C should then be successively reduced in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal levels from signal generators B and C should be recorded on page 2 of the log book results sheet (table 50).

7k The equal output signal levels of signal generators B and C should then be increased by 1 dB and the new values recorded on page 2 of the log book results sheet (table 50). The wanted signal (signal generator A) should then be continuously repeated. In each case, if a successful response **is not** obtained, the level of the unwanted signals (signal generators B and C) should be reduced by 1 dB and the new values recorded. If a successful response **is** obtained, the levels of the unwanted signals should not be changed until three consecutive successful responses have been observed. In this case, the unwanted signal levels should be reduced by 1 dB and the new values recorded in the log book results sheet. No levels of the unwanted signals should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal levels have been recorded on page 2 of the log book results sheet (table 50).

7l The 10 values of signal level from signal generators B and C recorded in steps 7j and 7k should then be averaged and entered in the log book results sheet (table 50).

7m The outputs from signal generators B and C should then be tuned to frequencies 50 kHz and 100 kHz respectively below the nominal frequency of the receiver. The output from signal generator B should remain unmodulated, that from signal generator C should remain modulated with test modulation A-M3.

7n The tuning and modulation of signal generator A should be retained as set in step 7a and its output level retained as set in step 7g. Steps 7i to 7l should then be repeated.

7o The procedure should now continue with step 8.

8 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

9 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required.

NOTE 3: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 4: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

10 The supply voltage to the EUT should be set to the upper extreme as given in the relevant standard. Steps 5, 6 and the multi-stage step 7 should then be repeated.

11 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant standard. Steps 5, 6 and the multi-stage step 7 should again be repeated.

12 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

13 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 5: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 6: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

14 The supply voltage to the EUT should be set to the lower extreme as given in the relevant Standard. Steps 5, 6 and the multi-stage step 7 should then be repeated.

15 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant Standard. Steps 5, 6 and the multi-stage step 7 should again be repeated.

16 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

8.2.4.1.3 Procedure for completion of the results sheets

Some final calculations need to be made before the overall results sheet (table 51) can be completed. The first of these calculations derives the difference in levels between the wanted signal and the equal amplitude unwanted signals for the stipulated reception (i.e. 14 dB SINAD for analogue speech, 10^{-2} bit error ratio for bit stream or 80 % message acceptance ratio for messages). In all cases, the relevant values can be found on page 2 of the log book results sheet (table 50) and the resulting level differences are the intermodulation immunity values for the EUT.

For analogue speech: For both frequency combinations of signal generators B and C, the difference (in dB) between the signal generator A level (for 20 dB SINAD) and the equal level of signal generators B and C (for 14 dB SINAD) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 50). The actual calculation is:

equal level of generators B and C (for 14 dB *SINAD) - generator A increased (step 7c) level* dB

For bit stream: For both frequency combinations of signal generators B and C, the difference (in dB) between the increased level (step 7d) of signal generator A and the equal level of signal generators B and C (for 10^{-2} BER) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 50). The actual calculation is:

equal level of generators B an C (for 10^{-2} *BER) - generator A increased level (step 7d)* dB

For messages: For both frequency combinations of signal generators B and C, the difference (in dB) between the increased level (step 7g) of signal generator A and the equal average level of signal generators B and C for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 50). The actual calculation is:

equal average level of generators B and C - generator A increased level (step 7g) dB

For all types of data modulation, the intermodulation immunity for the EUT is the lowest of the 10 level differences (2 different frequency combinations, 5 temperature/voltage combinations) between generator A and jointly generators B and C. The lowest value should be entered in the overall results sheet (table 50).

The final value needed to complete the overall results sheet (table 51) is the overall measurement uncertainty. This should be calculated in accordance with ETR subclause 8.2.4.1.

8.2.4.1.4 Log book entries

Table 50: Log book results sheet

INTERMODULATION IMMUNITY		**Date:**		**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:.................**		**Humidity:...............%** **Frequency:.............MHz** **Type No:..............**		**Serial No:..................**
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
Signal generator A				N/A
Signal generator B				N/A
Signal generator C				
RF cable within climatic facility				
RF cable, climatic facility input to combiner B				
RF cable, combiner B to sig gen A				
RF cable, combiner A to B				
RF cable, combiner A to sig gen B				
RF cable, combiner A to sig gen C				
RF Combiner A				
RF Combiner B				
50 Ω load				N/A
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
AF source			N/A	N/A
2nd AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)			N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A
Audio load (if applicable)			N/A	N/A
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)			N/A	N/A
		Mounting configuration of EUT		

INTERMODULATION IMMUNITY (analogue speech)	**Date:**					**PAGE 2 of 2**
Result of measurement on accredited Free-Field Test Site: Type of test site:.. 'b)' value of maximum usable sensitivity (i.e. IN TEST FIXTURE) (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m).................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
of B and C	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+50, +100 kHz	Sig gen A (for 20 dB SINAD):					
	Increased level of sig gen A:					
	Sig gen B (for 14 dB SINAD):					
-50, -100 kHz	Sig gen B (for 14 dB SINAD):					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
of B and C	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+50, +100 kHz	Sig gens B and C level - - Sig gen A level:					
-50, -100 kHz	Sig gens B and C level - - Sig gen A level:					

INTERMODULATION IMMUNITY (bit stream)	**Date:**					**PAGE 2 of 2**
Result of measurement on accredited Free-Field Test Site: Type of test site:.. 'b)' value of maximum usable sensitivity (i.e. IN TEST FIXTURE) (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m).................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
of B and C	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+50, +100 kHz	Sig gen A (for 10^{-2} BER):					
	Increased level of sig gen A:					
	Sig gens B/C (for $\geq 10^{-2}$ BER)					
-50, -100 kHz	Sig gens B/C (for $\geq 10^{-2}$ BER)					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
of B and C	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+50, +100 kHz	Sig gens B and C level - - Sig gen A level:					
-50, -100 kHz	Sig gens B and C level - - Sig gen A level:					

INTERMODULATION IMMUNITY (messages)		Date:				PAGE 2 of 2
Result of measurement on accredited Free-Field Test Site: Type of test site:.. 'b)' value of maximum usable sensitivity (dBμV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBμV/m)................................						
Calculated difference between: Limit and measured 'b)' values (dBμV/m)................................						
Frequency of B and C	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
+50, +100 kHz	Signal generator A level 1:					
	Signal generator A level 2:					
	Signal generator A level 3:					
	Signal generator A level 4:					
	Signal generator A level 5:					
	Signal generator A level 6:					
	Signal generator A level 7:					
	Signal generator A level 8:					
	Signal generator A level 9:					
	Signal generator A level 10:					
	Average sig gen A output:					
	Increased level of sig gen A					
	Sig gens B and C level 1:					
	Sig gens B and C level 2:					
	Sig gens B and C level 3:					
	Sig gens B and C level 4:					
	Sig gens B and C level 5:					
	Sig gens B and C level 6:					
	Sig gens B and C level 7:					
	Sig gens B and C level 8:					
	Sig gens B and C level 9:					
	Sig gens B and C level 10:					
	Average sig gen A output:					
-50, -100 kHz	Sig gens B and C level 1:					
	Sig gens B and C level 2:					
	Sig gens B and C level 3:					
	Sig gens B and C level 4:					
	Sig gens B and C level 5:					
	Sig gens B and C level 6:					
	Sig gens B and C level 7:					
	Sig gens B and C level 8:					
	Sig gens B and C level 9:					
	Sig gens B and C level 10:					
	Average sig gen A output:					
Frequency of B and C	**Temperature:**	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
+50, +100 kHz	Sig gens B and C level - - Sig gen A level:					
-50, -100 kHz	Sig gens B and C level - - Sig gen A level:					

8.2.4.1.5 Overall results sheet

The results should be presented in tabular form as shown in table 51.

Table 51: Overall results sheet

INTERMODULATION IMMUNITY	Date: PAGE 1 of 1
Intermodulation immunity	dB
Expanded uncertainty (95 %)	dB

8.2.5 Blocking immunity or degradation

NOTE: This test is only usually carried out using a Test Fixture.

Definition

The ***blocking immunity (or desensitization)*** is a measure of the capability of the receiver to receive a wanted modulated signal at the nominal frequency without exceeding a given degradation due to the presence of an unwanted unmodulated high input signal.

For analogue speech: it is specified as the ratio, in decibels, of the level of the unwanted signal expressed as a field strength to the specified level of the wanted signal expressed as a field strength which produces, through a telephone psophometric weighting network, a SINAD ratio of 14 dB.

For bit stream: it is specified as the ratio, in decibels, of the level of the unwanted signal expressed as a field strength to the specified level of the wanted signal expressed as a field strength which produces a data signal with a bit error ratio of 10^{-2}.

For messages: it is specified as the ratio, in decibels, of the level of the unwanted signal expressed as a field strength to the specified level of the wanted signal expressed as a field strength which produces after demodulation a message acceptance ratio of 80 %.

8.2.5.1 Test Fixture

8.2.5.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuator;
- Power supply;
- Connecting cables;
- Test Fixture;
- Climatic facility;
- Accredited Free-Field Test Site;
- 2 RF signal generators;
- 50 Ω load.

Additional requirements for analogue speech:

- AF source;
- SINAD meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;

- Response measuring test set.

The type and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 52).

8.2.5.1.2 Method of measurement

1 The Test Fixture should have been verified for use, with the particular type of EUT, on an accredited Free-Field Test Site in accordance with clause 6. Four different measurements of the value of maximum usable sensitivity (for the particular type of data modulation i.e. analogue speech, bit stream or messages) should have been taken during the verification, each corresponding to a different configuration of the EUT, namely:

a) the EUT by itself on the accredited Free-Field Test Site;

b) the EUT secured in the Test Fixture, again on the accredited Free-Field Test Site;

c) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly on the accredited Free-Field Test Site;

d) the power input to the Test Fixture's RF connector with the Test Fixture/EUT assembly in the climatic facility.

The value recorded for configuration b) during the verification procedure should be entered on page 2 of the log book results sheet (table 52). This value should be converted to dBμV/m (from μV/m) before entering it in the log book results sheet.

For all modulation types, the maximum usable sensitivity limit (as stated in the relevant standard) as well as the calculated difference between it and the b) value recorded during the verification procedure should both be entered on page 2 of the log book results sheet (table 52).

2 The EUT should still be secured in the Test Fixture and the Test Fixture/EUT assembly should be placed in the climatic facility in a repeatable position. This configuration should be noted on page 1 of the log book results sheet (table 52).

3 The assembly should be connected to the test equipment as shown in figure 100 where acoustic coupling to the EUT is illustrated.

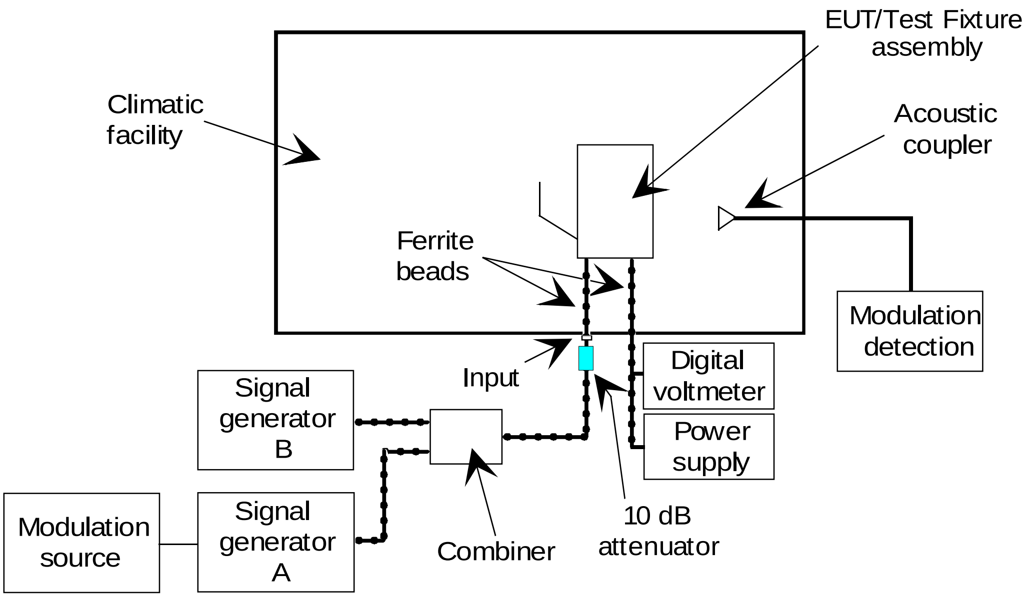

Figure 100: Blocking immunity or desensitization using a Test Fixture (shown with acoustic coupler)

4 Normal conditions (as stated in the relevant standard) should exist within the climatic facility.

5 The output from signal generator B should be tuned to a frequency 1 MHz above the nominal frequency of the EUT. It should not be modulated. This is the unwanted signal as far as the test is concerned.

For analogue speech:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation A-M1 produced by the modulation source (an AF generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The output signal level of signal generator A should be adjusted until the modulation detector (a SINAD ratio incorporating a telephone psophometric weighting network) indicates a 20 dB SINAD ratio has been obtained. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 52) and the audio output power should be noted.

NOTE 1: The output level increase is the difference between the limit for maximum usable sensitivity (as given in the relevant standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6d The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6e The output of signal generator B should then be switched on and its level adjusted until the SINAD ratio (again as measured through a telephone psophometric weighting network) is reduced to 14 dB. The corresponding output power level of signal generator B should be recorded on page 2 of the log book results sheet (table 52).

6f The audio output power should be measured to ensure that it has not reduced by 3 dB or more from that noted in step 6c.

6g The output from signal generator B should then be tuned, in turn, to frequencies of 2 MHz, 5 MHz and 10 MHz above the nominal frequency of the receiver, followed by 1 MHz, 2 MHz, 5 MHz and 10 MHz below the same nominal frequency. Step 6e should be repeated for each frequency, keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6c.

6h The procedure should now resume with step 7.

For bit stream:

6a The output from signal generator A should be tuned to the nominal frequency of the receiver. It should be modulated by test modulation D-M2 produced by the modulation source (a bit stream generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The EUT should be directly connected to the modulation detector (a bit error measuring test set which should also receive a direct input from the bit stream generator) and the output signal level of signal generator A should be adjusted until a bit error ratio of 10^{-2} is obtained. The corresponding output power level of signal generator A should be recorded on page 2 of the log book results sheet (table 52).

6d The output signal level of signal generator A should then be increased above the level noted in step 6c by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 52).

NOTE 2: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6e The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6f The output of signal generator B should then be switched on and its level adjusted until a bit error ratio of about 10^{-1} is obtained.

6g The wanted signal should be transmitted at the level set in step 6d whilst the level of signal generator B (the unwanted signal) is reduced in 1 dB steps until a bit error ratio of 10^{-2} or better is obtained. The corresponding output power level of signal generator B should be recorded on page 2 of the log book results sheet (table 52).

6h The output from signal generator B should then be tuned, in turn, to frequencies of 2 MHz, 5 MHz and 10 MHz above the nominal frequency of the receiver, followed by 1 MHz, 2 MHz, 5 MHz and 10 MHz below the same nominal frequency. Steps 6f and 6g should be repeated for each frequency, keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6d.

6i The procedure should now resume with step 7.

For messages:

6a The output from signal generator A should be tuned to the nominal frequency of the EUT. It should be modulated by test modulation D-M3 produced by the modulation source (a message generator). This is the wanted signal as far as the test is concerned.

6b The output signal level of signal generator B should be switched off and the cable from its output should be disconnected at the combiner input. The vacated combiner port should then be terminated with a 50 Ω load.

6c The output signal level of signal generator A should be adjusted until the modulation detector (a response measuring test set) indicates that a successful message response ratio of less than 10 % has been obtained.

6d The output signal level of signal generator A should then be successively increased in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level should be recorded on page 2 of the log book results sheet (table 52).

6e The output signal level of signal generator A should then be decreased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 52). The message should then be continuously repeated. In each case, if a successful response is not obtained, the input level should be increased by 1 dB and the new value recorded. If a successful response is obtained, the input level should not be changed until three consecutive successful responses have been observed. In this case, the input level should be reduced by 1 dB and the new value recorded in the log book results sheet. No input signal levels should be recorded unless preceded by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded in the log book results sheet (table 52).

6f The 10 values of signal generator output level recorded should then be averaged and the resulting value should be entered on page 2 of the log book results sheet (table 52).

6g The output signal level of signal generator A should then be increased above the calculated average level recorded in step 6f by the difference in the two values recorded in step 1 plus 3 dB. This new value of signal generator output level should be recorded on page 2 of the log book results sheet (table 52).

NOTE 3: The output level increase is 3 dB plus the difference between the limit for maximum usable sensitivity (as given in the relevant standard) and the measured value of maximum usable sensitivity for the complete EUT/Test Fixture assembly recorded on the accredited test-site.

6h The cable from the output of signal generator B should then be reconnected to the combiner port (replacing the 50 Ω load).

6i Whilst repeatedly transmitting the message from signal generator A, the output of signal generator B should then be switched on and its output level adjusted until a successful message acceptance ratio of less than 10 % is obtained.

6j The output signal level of signal generator B should then be successively reduced in 2 dB steps for each occasion that a successful response **is not** obtained until 3 consecutive successful responses are observed. The corresponding output signal level from signal generator B should be recorded on page 2 of the log book results sheet (table 52).

6k The output signal level of signal generator B should then be increased by 1 dB and the new value recorded on page 2 of the log book results sheet (table 52). The wanted signal (signal generator A) should then be repeatedly transmitted. In each case, if a successful response **is not** obtained, the level of the unwanted signal (signal generator B) should be continuously reduced by 1 dB and the new value recorded. If a successful response **is** obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been observed. In this case, the unwanted signal level should be reduced by 1 dB and the new value recorded in the log book results sheet. No levels of the unwanted signal should be recorded unless **preceded** by a change in signal level. The repetition should be stopped after 10 values of signal level have been recorded in the log book results sheet (table 52).

6l The 10 values of signal level recorded should then be averaged and the resulting value should be entered on page 2 of the log book results sheet (table 52).

6m The output from signal generator B should then be tuned, in turn, to frequencies of 2 MHz, 5 MHz and 10 MHz above the nominal frequency of the receiver, followed by 1 MHz, 2 MHz, 5 MHz and 10 MHz below the same nominal frequency. Steps 6i and 6l should be repeated for each frequency, keeping the tuning and modulation of signal generator A as set in step 6a and its output level as set in step 6g.

6n The procedure should now continue with step 7.

7 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the upper extreme of temperature.

8 The climatic facility should be allowed adequate time at the extreme condition for all components to settle to the temperature required.

NOTE 4: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 5: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

9 The supply voltage to the EUT should be set to the upper extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should then be repeated.

10 The supply voltage to the EUT should then be set to the lower extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should again be repeated.

11 The EUT and its power supplies should then be switched off and the climatic facility programmed to provide the lower extreme of temperature.

12 The climatic facility should be allowed adequate time at the extreme temperature condition for all components to settle to the temperature required.

NOTE 6: For tests at extreme conditions, the relevant standard will specify the extreme temperatures and voltages to apply, along with stabilization and operating periods which should both be completed before any measurements are carried out.

NOTE 7: To avoid thermally shocking the EUT, it is recommended that the rates of change of temperature should not exceed 1°C per minute. The preferred rate of change of temperature is 0,33°C per minute.

13 The supply voltage to the EUT should be set to the lower extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should then be repeated.

14 The supply voltage to the EUT should then be set to the upper extreme as given in the relevant Standard. Step 5 and the multi-stage step 6 should again be repeated.

15 On completion of the extreme conditions, the climatic facility should be returned to the normal condition.

8.2.5.1.3 Procedure for completion of the results sheets

Some final calculations need to be made before the overall results sheet (table 53) can be completed. The first of these calculations derives the difference in levels between the wanted signal and the unwanted signal for the stipulated reception (i.e. 14 dB SINAD for analogue speech, 10^{-2} bit error ratio for bit stream or 80 % message acceptance ratio for messages). In all cases, the relevant values can be found on page 2 of the log book results sheet (table 52) and the resulting level differences are the blocking immunity (or desensitization) values for the EUT.

For analogue speech: For all frequencies, the difference (in dB) between the signal generator A level (for 20 dB SINAD) and the level of signal generator B (for 14 dB SINAD) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 52). The actual calculation is:

signal generator B level (for 14 dB SINAD) - signal generator A increased (step 6c) level dB

For bit stream: For all frequencies, the difference (in dB) between the increased level (step 6d) of signal generator A and the level of signal generator B (for 10^{-2} BER) for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 52). The actual calculation is:

signal generator B level (for 10^{-2} BER) - signal generator A increased level (step 6d) dB

For messages: For all frequencies, the difference (in dB) between the increased level (step 6g) of signal generator A and the average level of signal generator B for each temperature/voltage combination should be calculated and entered on page 2 of the log book results sheet (table 52). The actual calculation is:

average signal generator B level - signal generator A increased (step 6g) level dB

For all types of data modulation, the blocking immunity (or desensitization) for the EUT is the lowest of the 40 level differences (8 frequencies, 5 temperature/voltage combinations) between generators A and B. This lowest value should be entered in the overall results sheet (table 53).

The final value needed to complete the overall results sheet (table 53) is the overall measurement uncertainty. This should be calculated in accordance with TR 100 028-2 [7], subclause 8.2.5.1.

8.2.5.1.4 Log book entries

Table 52: Log book results sheet

BLOCKING IMMUNITY (OR DESENSITIZATION) Date:				**PAGE 1 of 2**
Temperature:.........°C **Manufacturer of EUT:..................**	**Humidity:...............%** **Type No:.............**		**Frequency:............MHz** **Serial No:.................**	
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**
Digital voltmeter			N/A	N/A
Power supply			N/A	N/A
Ferrite beads (for RF cables)			N/A	N/A
Ferrite beads (for power cables)			N/A	N/A
10 dB attenuator				
Signal generator A				N/A
Signal generator B				N/A
RF cable within climatic facility				
RF cable, climatic facility input to combiner				
RF cable, combiner to sig gen A				
RF cable, combiner to sig gen B				
RF Combiner				
50 Ω load				N/A
Climatic facility			N/A	N/A
Accredited Free-Field Test Site			N/A	N/A
AF source (if applicable)			N/A	N/A
SINAD meter (if applicable)			N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A
Audio load (if applicable)			N/A	N/A
Bit stream generator (if applicable)			N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A
Message generator (if applicable)			N/A	N/A
Response measuring test set (if applicable)			N/A	N/A
Mounting configuration of EUT				

BLOCKING IMMUNITY (OR DESENSITIZATION) (analogue speech) Date: PAGE 2 of 2						
Result of measurement on accredited Free-Field Test Site: Type of test site:... 'b)' value of maximum usable sensitivity (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m)................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
Sig gen B	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+1 MHz	Sig gen A (for 20 dB SINAD):					
	Increased level of sig gen A:					
	Sig gen B (for 14 dB SINAD):					
+2 MHz	Sig gen B (for 14 dB SINAD):					
+5 MHz	Sig gen B (for 14 dB SINAD):					
+10 MHz	Sig gen B (for 14 dB SINAD):					
-1 MHz	Sig gen B (for 14 dB SINAD):					
-2 MHz	Sig gen B (for 14 dB SINAD):					
-5 MHz	Sig gen B (for 14 dB SINAD):					
-10 MHz	Sig gen B (for 14 dB SINAD):					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
Sig gen B	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+1 MHz	Sig gen A - Sig gen B:					
+2 MHz	Sig gen A - Sig gen B:					
+5 MHz	Sig gen A - Sig gen B:					
+10 MHz	Sig gen A - Sig gen B:					
-1 MHz	Sig gen A - Sig gen B:					
-2 MHz	Sig gen A - Sig gen B:					
-5 MHz	Sig gen A - Sig gen B:					
-10 MHz	Sig gen A - Sig gen B:					

BLOCKING IMMUNITY (OR DESENSITIZATION) (bit stream) Date: PAGE 2 of 2						
Result of measurement on accredited Free-Field Test Site: Type of test site:... 'b)' value of maximum usable sensitivity (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m)................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
Sig gen B	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+1 MHz	Sig gen A (for 10^{-2} BER):					
	Increased level of sig gen A:					
	Sig gen B (for 10^{-2} BER):					
+2 MHz	Sig gen B (for 10^{-2} BER):					
+5 MHz	Sig gen B (for 10^{-2} BER):					
+10 MHz	Sig gen B (for 10^{-2} BER):					
-1 MHz	Sig gen B (for 10^{-2} BER):					
-2 MHz	Sig gen B (for 10^{-2} BER):					
-5 MHz	Sig gen B (for 10^{-2} BER):					
-10 MHz	Sig gen B (for 10^{-2} BER):					
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
Sig gen B	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+1 MHz	Sig gen A - Sig gen B:					
+2 MHz	Sig gen A - Sig gen B:					
+5 MHz	Sig gen A - Sig gen B:					
+10 MHz	Sig gen A - Sig gen B:					
-1 MHz	Sig gen A - Sig gen B:					
-2 MHz	Sig gen A - Sig gen B:					
-5 MHz	Sig gen A - Sig gen B:					
-10 MHz	Sig gen A - Sig gen B:					

BLOCKING IMMUNITY (OR DESENSITIZATION) (messages) Date: PAGE 2 of 2						
Result of measurement on accredited Free-Field Test Site: Type of test site:... 'b)' value of maximum usable sensitivity (dBµV/m):............................						
Limit of maximum usable sensitivity (as given in relevant standard)(dBµV/m)................................						
Calculated difference between: Limit and measured 'b)' values (dBµV/m)................................						
Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
Sig gen B	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+1 MHz	Signal generator A level 1:					
	Signal generator A level 2:					
	Signal generator A level 3:					
	Signal generator A level 4:					
	Signal generator A level 5:					
	Signal generator A level 6:					
	Signal generator A level 7:					
	Signal generator A level 8:					
	Signal generator A level 9:					
	Signal generator A level 10:					
	Average sig gen A output:					
	Increased level of sig gen A					
	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					

Frequency Sig gen B	Temperature:	T(normal)	T(high)		T(low)	
	Voltage:	V(normal)	V (high)	V (low)	V (high)	V (low)
	Average sig gen A output:					
+2 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
+5 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
+10 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
-1 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
-2 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					

	Average sig gen A output:					
-5 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					
-10 MHz	Signal generator B level 1:					
	Signal generator B level 2:					
	Signal generator B level 3:					
	Signal generator B level 4:					
	Signal generator B level 5:					
	Signal generator B level 6:					
	Signal generator B level 7:					
	Signal generator B level 8:					
	Signal generator B level 9:					
	Signal generator B level 10:					
	Average sig gen A output:					

Frequency	**Temperature:**	T(normal)	T(high)		T(low)	
Sig gen B	**Voltage:**	V(normal)	V (high)	V (low)	V (high)	V (low)
+1 MHz	Sig gen A - Sig gen B:					
+2 MHz	Sig gen A - Sig gen B:					
+5 MHz	Sig gen A - Sig gen B:					
+10 MHz	Sig gen A - Sig gen B:					
-1 MHz	Sig gen A - Sig gen B:					
-2 MHz	Sig gen A - Sig gen B:					
-5 MHz	Sig gen A - Sig gen B:					
-10 MHz	Sig gen A - Sig gen B:					

8.2.5.1.5 Overall results sheet

The results should be presented in tabular form as shown in table 53.

Table 53: Overall results sheet

BLOCKING IMMUNITY (OR DESENSITIZATION)	**Date:** **PAGE 1 of 1**
Blocking immunity (or desensitization)	dB
Expanded uncertainty (95 %)	dB

8.2.6 Spurious response immunity to radiated fields (30 MHz to 4 GHz)

In this test method, two signals are transmitted simultaneously towards the EUT. One simulates the wanted signal, whilst the other simulates an unwanted, interfering signal. Both signals are transmitted from the same test antenna, into which they are fed through a combining network. The wanted signal (in the range 30 MHz - 1 000 MHz) is at the nominal frequency of the receiver and is transmitted at the level specified in the ETS for the specific data type. The unwanted signal has a different modulation and is at a very much higher power level.

Definition

The spurious response immunity to radiated fields is a measure of the capability of the receiver to discriminate between the wanted modulated radiated field at the nominal frequency and an unwanted radiated field at any other frequency at which a response is obtained.

For analogue speech:

it is specified as the ratio, in decibels, of an unwanted signal level expressed as field strength to a specified wanted signal level expressed as field strength producing, through a telephone psophometric weighting network, a SINAD ratio of 14 dB.

For bit stream:

it is specified as the ratio, in decibels, of an unwanted signal level expressed as field strength to a specified wanted signal level expressed as field strength producing a data signal with a bit error ratio of 10^{-2}.

For messages:

it is specified as the ratio, in decibels, of an unwanted signal level expressed as field strength to a specified wanted signal level expressed as field strength producing after demodulation a message acceptance ratio of 80 %.

8.2.6.1 Anechoic Chamber

8.2.6.1.1 Apparatus required

- Digital voltmeter;
- Ferrite beads;
- 10 dB attenuators;
- Power supply;
- Connecting cables;
- Combining network;
- RF load;
- Power amplifier;
- 3 axis field probe;
- Anechoic Chamber;
- Test antenna (broadband antenna recommended e.g. biconic, typically 30 MHz to 200 MHz, LPDAs,

typically 200 MHz to 1 GHz and 1 GHz to 4 GHz);

- Measuring antenna (half wavelength dipole as detailed in ANSI C63.5 1988 recommended);
- Swept frequency RF Signal generator;
- Receiving device (measuring receiver or spectrum analyser).
- FM source.

Additional requirements for analogue speech:

- AF source;
- SINAD Meter (incorporating telephone psophometric weighting network);
- Acoustic coupler (alternatively: audio load).

Additional requirements for bit stream:

- Bit stream generator;
- Bit error measuring test set.

Additional requirements for messages:

- Acoustic coupler;
- Message generator;
- Response measuring test set.

The types and serial numbers of all items of test equipment should be recorded on page 1 of the log book results sheet (table 55).

NOTE: The half wavelength dipole antennas, incorporating matching/transforming baluns, for the procedure are available in the following bands: 20 MHz - 65 MHz, 65 MHz - 180 MHz, 180 MHz - 400 MHz, 400 MHz - 1 000 MHz. Constructional details are contained in ANSI C63.5 (1988) [11]. In the recommended antenna scheme for this band, a shortened dipole is used at all frequencies from 30 MHz up to 80 MHz.

8.2.6.1.2 Method of measurement

Determination of the Transform Factor for the Anechoic Chamber

1 For this part of the test, it is necessary to position either the 3-axis probe (if it possesses adequate dynamic range to allow the wanted field strength to be measured) or the measuring antenna (in the recommended scheme: a tuned ANSI C63.5 (1988) [11] half wavelength dipole for frequencies of 80 MHz and above, a shortened dipole for frequencies from 30 MHz up to 80 MHz) within the chamber such that its phase centre is at the same point that the phase centre of the EUT will occupy in the second part of the test (the EUT being mounted in an orientation which matches that of its normal usage as declared by the manufacturer). The precise point should always be on the axis of rotation of the turntable, and either on the central axis of the chamber or at a convenient height within the quiet zone. The vertical offset of the phase centre of the EUT from the central axis (if any) should be either measured remotely or determined by sitting the EUT on the turntable. The offset should be recorded on page 2 of the log book results sheet (table 55).

NOTE 1: If the position of the phase centre within the EUT is unknown but the antenna is visible, then the vertical offset from the central axis of the point at which the antenna meets the case of the EUT should be used. If the phase centre is unknown and there is no visible antenna the volume centre of the EUT should be used instead.

NOTE 2: If a 3-axis probe is being used to measure the field strength of the wanted signal, steps 2 and 3 should be omitted.

2 The measuring antenna should be adjusted to correspond to the nominal frequency of the EUT and positioned with its phase centre on the axis of rotation of the turntable and at the same vertical offset from the central axis of the chamber (if any) as determined for the EUT in step 1. The measuring antenna should be oriented for vertical polarization.

NOTE 3: For all frequencies below 80 MHz, a shortened dipole (as defined in subclause 6.2.3) should be used. The dipole arm length is defined from the centre of the balun block to the tip of the arm. From a fully extended state, each telescopic element, in turn, should be "pushed in" from the tip until the required length is obtained. The outermost section should fully compress before any of the others, and so on. Table 2 gives the dipole arm lengths and choice of balun for set frequencies. Where the test frequency does not correspond to a set frequency in the table, the arm length to be used should be determined by linear interpolation between the closest set values.

NOTE 4: The turntable should be constructed from non-conducting, low relative dielectric constant (preferably less than 1,5) material(s).

3 The measuring antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber, to the receiving device.

4 The test antenna (a broadband antenna which is functional at both the nominal frequency of the EUT as well as covering either the calculated frequency at which a spurious response may occur or part of the limited frequency range) should be tuned to the nominal frequency of the EUT and mounted with the height of its phase centre at the same vertical offset from the central axis of the chamber (if any) as recorded in step 1, so

that the measurement axis is parallel to the central axis of the chamber. The test antenna should be oriented to the same polarization as the measuring antenna.

NOTE 5: The measurement axis is the straight line joining the phase centres of the transmitting and receiving devices.

5 The test antenna should be connected via a 10 dB attenuator and the calibrated, ferrited coaxial cable associated with that end of the chamber, to signal generator A via the combiner whose other port should be terminated in the RF load. The output from signal generator A should be unmodulated and tuned to the nominal frequency of the EUT. See figure 101.

NOTE 6: Steps 6 and 7 should be omitted if a 3-axis probe is being used to measure the wanted field strength.

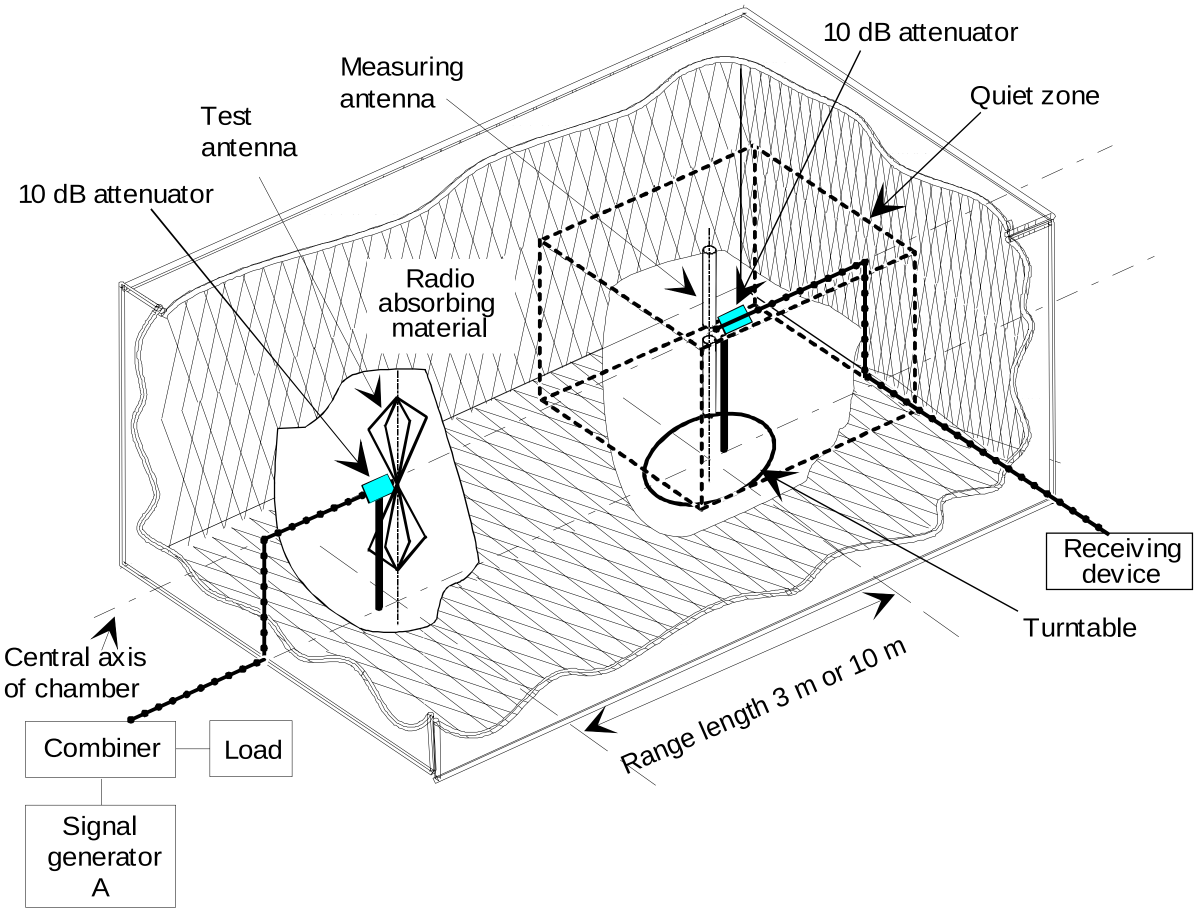

Figure 101: Equipment layout for determining the Transfer Factor in an Anechoic Chamber

6 The output level of the signal generator should be adjusted until a received signal level at least 20 dB above the noise floor is observed on the receiving device.

7 The received signal level (dBμV) appearing on the receiving device along with the output level from the signal generator (dBm) should be recorded on page 2 of the log book results sheet (table 55). The Transform Factor for the chamber (i.e. the factor relating the output power level from the signal generator (dBm) to the resulting field strength (dBμV/m) at the point of measurement) should then be calculated according to the following formula:

Transform Factor (dB) *= received signal level (dBμV)*

+ measuring antenna cable loss (i.e. loss between measuring antenna and receiving device input)

+ measuring antenna attenuator loss

+ measuring antenna balun loss

+ mutual coupling and mismatch loss correction factor (if applicable)

+ antenna factor of the measuring antenna

- signal generator output level (dBm)

NOTE 7: Guidance for deriving/calculating/finding the unknown values in the above formula for Transform Factor are given in table 54. The resulting values should be entered on page 2 of the log book results sheet (table 55).

The resulting value for the Transform Factor should be entered on page 2 of the log book results sheet (table 55).

Table 54: Guidance for deriving Transform Factor

Values in the formula for Transform Factor
Measuring antenna cable loss: Obtained directly from the calibration data.
Measuring antenna attenuator loss: Obtained from calibration data.
Measuring antenna balun loss: If not known from calibration data, the value should be taken as 0,30 dB.
Mutual coupling and mismatch loss correction factors between the test antenna and the measuring antenna: For ANSI dipoles (30 MHz to 180 MHz) values can be obtained from annex A: table A1. For frequencies > 180 MHz, this value is 0,00 dB. For non-ANSI dipoles this value is 0,00 dB.
Antenna factor of the measuring antenna: For ANSI dipoles: Antenna factor = 20 $\log_{10}$ (f) - 31,4 dB dB/m (where f is the frequency in MHz) For other types the value can be obtained from calibration data.

8 If a measuring antenna is being used, the output power level of the signal generator (dBm) should be adjusted, using the calculated value for the Transform Factor, to provide the wanted signal level (dBμV/m, as specified in the relevant ETS or EN) in the vicinity of the EUT. Alternatively, if a 3-axis probe is being used to measure the field strength, the output power level of the signal generator (dBm) should be adjusted to provide the wanted signal level (as specified in the relevant ETS or EN).

EUT set-up

9 The 3-axis probe or measuring antenna should be replaced on the turntable by the EUT. The EUT should be positioned on the turntable such that its phase centre is in the same place as formerly occupied by the centre of the 3-axis probe or the phase centre of the measuring antenna.

NOTE 8: If the position of the phase centre within the EUT is unknown but the antenna is a single rod which is visible and vertical in normal usage, the axis of the antenna should be aligned with the axis of rotation of the turntable. If the phase centre is not known and there is no visible antenna the volume centre of the EUT should be aligned with the axis of rotation of the turntable.

10 The EUT should be mounted in an orientation which matches that of its normal usage as declared by the manufacturer. The normal to its reference face should point directly towards the test antenna. This is the 0° reference angle for the test. This orientation and mounting configuration should be recorded on page 1 of the log book results sheet (table 55).

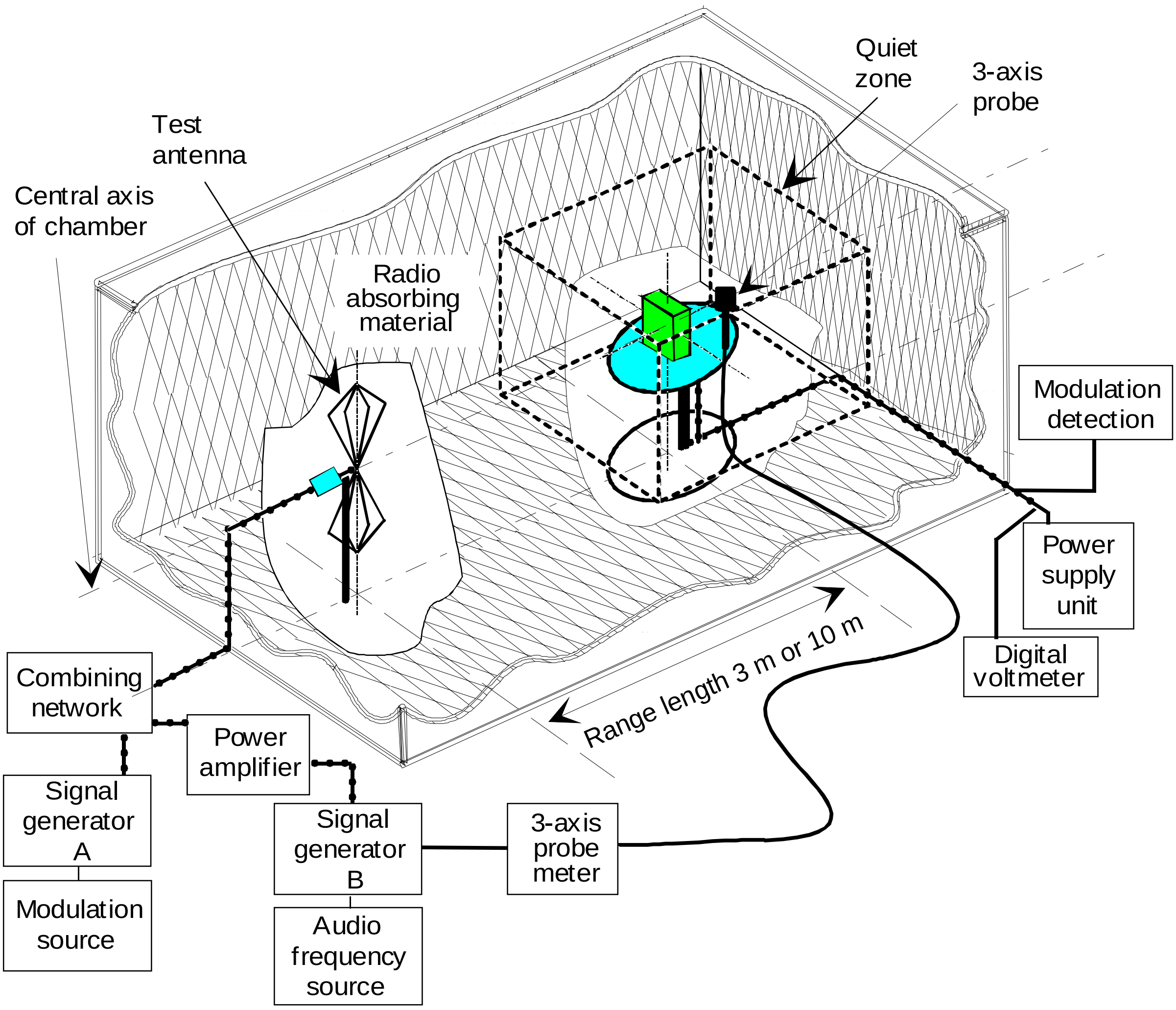

Figure 102: Anechoic Chamber set-up for Spurious response immunity tests

Measurement of the EUT

11 The two signal generators should be connected to the test antenna as shown in figure 102. Signal generator A provides the wanted signal. It should remain at the level set in step 8 and at the nominal frequency of the EUT. Signal generator B and the power amplifier provide the interfering, unwanted signal. Test modulation A-M3, produced by a second modulation frequency source, should be applied to the output of signal generator B which should be tuned to the lowest frequency of the *limited frequency range*.

For analogue speech:

12a Signal generator A should be modulated with test modulation A-M1 produced by the AF source. Signal generator B should then have its level adjusted to give a field strength, as measured by the 3-axis probe, which is 80 dB in excess of the *wanted signal level*. The output power of signal generator B should then be levelled at this field strength, using the 3-axis probe, to ensure that at any frequency, the generated field strength is the same. The frequency of the unwanted signal should then be continuously varied over the entire *limited frequency range* noting any frequencies which degrade the SINAD ratio below 20 dB. These frequencies should be recorded on page 2 of the log book results sheet (table 55).

NOTE 9: The response time of the SINAD meter should be taken into account when deciding the sweep speed for signal generator B.

12b In turn, signal generator B should be tuned to each of the frequencies recorded in step 12a as well as to those frequencies outside the *limited frequency range* at which it has been calculated that a response may occur. At each frequency, the output power level of signal generator B should be adjusted to provide a 14 dB SINAD ratio from the EUT. The corresponding value of field strength (µV/m), as measured on the 3-axis probe, should be recorded on page 2 of the log book results sheet (table 55).

NOTE 10: The field strength measurement on the unwanted signal can be made despite the presence of the wanted signal since its magnitude is greatly in excess of that for the wanted signal.

12c The spurious response immunity ratio to radiated fields for analogue speech should be calculated, for each of the frequencies concerned, as the ratio in dB of the field strength of the unwanted signal to the *wanted signal level* at the receiver input and should be recorded on page 2 of the log book results sheet (table 55).

For bit stream:

12a Signal generator A should be modulated with test modulation D-M2 produced by the bit stream generator. The reference bit stream output from the bit stream generator should be connected to the reference bit stream input on the bit error detector. Signal generator B should then be adjusted to give a field strength, as measured by the 3-axis probe, which is 80 dB in excess of the *wanted signal level*. The output power of signal generator B should then be levelled at this field strength, using the 3-axis probe, to ensure that at any frequency, the generated field strength is the same. The frequency of the unwanted signal should then be continuously varied over the entire *limited frequency range* noting any frequencies which produce a response i.e. a change in bit error ratio. These frequencies should be recorded on page 2 of the log book results sheet (table 55).

NOTE 11: The response time of the bit error measuring test set should be taken into account when deciding the sweep speed for signal generator B.

12b In turn, signal generator B should be tuned to each of the frequencies recorded in step 12a as well as to those frequencies outside the *limited frequency range* at which it has been calculated that a response may occur. At each frequency, the output power level of signal generator B should be adjusted to provide a bit error ratio of 10^{-2} from the EUT. The corresponding value of field strength (µV/m), as measured on the 3-axis probe, should be recorded on page 2 of the log book results sheet (table 55).

12c The spurious response immunity ratio to radiated fields for bit stream should be calculated, for each of the frequencies concerned, as the ratio in dB of the field strength of the unwanted signal to the *wanted signal level* at the receiver input and should be recorded on page 2 of the log book results sheet (table 55).

For messages:

NOTE 12: The test sequence which ensures the 80 % message acceptance criterion is very time consuming. It is considered impractical to combine this test sequence with a continuous frequency sweep (as occurs in the corresponding procedures for analogue speech and bit stream data) since the sweep speed for signal generator B would have to be extremely slow to allow capture of narrow band spurious responses.

12a The EUT should be monitored via an acoustic coupler (pipe) which is made from low dielectric constant (i.e. less than 1,5) material(s) for message acceptance.

12b Signal generator A should be modulated with test modulation D-M3 produced by the message generator and signal generator B should be tuned to the first frequency for which it has been calculated that a response might occur.

12c The wanted signal should then be transmitted repeatedly and the unwanted signal switched on. The input level of the unwanted signal should be adjusted until a successful message ratio of less than 10 % is obtained.

12d The level of the unwanted signal should be reduced by 2 dB for each occasion that a successful response is not observed. This procedure should be continued until three consecutive successful responses have been observed. The value of field strength as indicated by the 3-axis probe should then be recorded on page 2 of the log book results sheet (table 55).

12e The unwanted signal level should be increased by 1 dB and the new value of field strength recorded on page 2 of the log book results sheet (table 55). The wanted signal should then be continuously repeated. In each case if a response is NOT obtained the level of the unwanted signal should be reduced by 1 dB and the new field strength value recorded in the results sheet. If a successful response IS obtained, the level of the unwanted signal should not be changed until three consecutive successful responses have been obtained. In this case the unwanted signal should be increased by 1 dB and the new field strength value recorded on page 2 of the log book results sheet (table 55). No levels of the field strength should be recorded unless preceded by a change in level. The measurement should be stopped after a total of 10 values have been recorded.

12f The 10 recorded values of field strength recorded during steps 12d and 12e should then be averaged according to the following formulation:

$$\text{Average field strength } (\mu V/m) = \sqrt{\left(\frac{10}{\sum_{i=1}^{i=10} \frac{1}{\text{field strength } \left(mV/m\right)_i^{\;2}}} \right)}$$

12g Steps 12c to 12f should be repeated at each frequency within the specified frequency range at which it is calculated that a spurious response could occur.

12h The spurious response immunity to radiated fields for messages should be calculated, for the frequency concerned, as the ratio in dB of the average field strength of the unwanted signal (step 12f) to the wanted signal level at the receiver input and should be recorded on page 2 of the log book results sheet (table 55).

8.2.6.1.3 Procedure for completion of the results sheets

No special processing of the results is necessary to provide the spurious response immunity, since all calculations are performed during the procedure. However, to complete the overall results sheet (table 56) it is necessary, firstly to transfer some or all of the response frequencies and their corresponding values for spurious response immunity and secondly to calculate the expanded measurement uncertainty associated with the procedure. This should be carried out as detailed in TR 100 028-2 [7], subclause 8.2.6.1.

8.2.6.1.4 Log book entries

Table 55: Log book results sheet

SPURIOUS RESPONSE IMMUNITY			**Date:**		**Page 1 of 2**
Temperature:.........°C **Manufacturer of EUT:....................**		**Humidity:..............%** **Type No:.............**		**Frequency:............MHz** **Serial No:.................**	
Range length:......................					
Test equipment item	**Type No.**	**Serial No.**	**VSWR**	**Insertion loss**	**Antenna factor**
Test antenna				N/A	
Test antenna attenuator					N/A
Test antenna cable					N/A
Measuring antenna				N/A	
Measuring antenna attenuator					N/A
Measuring antenna cable					N/A
Ferrite beads			N/A	N/A	N/A
Combining network				N/A	N/A
RF load				N/A	N/A
Signal generator				N/A	N/A
Digital voltmeter			N/A	N/A	N/A
Power supply			N/A	N/A	N/A
Frequency modulation source			N/A	N/A	N/A
AF source (if applicable)			N/A	N/A	N/A
SINAD meter (if applicable)			N/A	N/A	N/A
AF load (if applicable)			N/A	N/A	N/A
Bit stream generator (if applicable)			N/A	N/A	N/A
Bit error measuring test set (if applicable)			N/A	N/A	N/A
Acoustic coupler (if applicable)			N/A	N/A	N/A
Message generator (if applicable)			N/A	N/A	N/A
Response measuring test set (if applicable)			N/A	N/A	N/A
Mounting configuration of EUT					

SPURIOUS RESPONSE IMMUNITY (analogue speech)	**Date:**	**Page 2 of 2**
Received signal level		dBµV
Signal generator output level		dBm
Transform Factor		dB
Wanted signal level: µV/m		**Limited frequency range:** MHz
Response and calculated frequencies (MHz)	**Field strength of unwanted signal for 14 dB SINAD (µV/m)**	**Spurious response immunity:** Field strength of unwanted signal - Wanted signal level (dB)

Values in the formula for Transform Factor			
Measuring antenna cable loss		Measuring antenna cable loss	
Measuring antenna attenuator loss		Measuring antenna attenuator loss	
Measuring antenna balun loss		Measuring antenna balun loss	
Mutual coupling and mismatch loss (30 MHz - 180 MHz)		Mutual coupling and mismatch loss (30 MHz - 180 MHz)	
Antenna factor of the measuring antenna		Antenna factor of the measuring antenna	

SPURIOUS RESPONSE IMMUNITY (bit stream)	**Date:**	**Page 2 of 2**
Received signal level		dBµV
Signal generator output level		dBm
Transform Factor		dB
Wanted signal level: µV/m		**Limited frequency range:** MHz
Response and calculated frequencies (MHz)	**Field strength of unwanted signal for 10^{-2} BER (µV/m)**	**Spurious response immunity:** Field strength of unwanted signal - Wanted signal level (dB)

Values in the formula for Transform Factor			
Measuring antenna cable loss		Measuring antenna cable loss	
Measuring antenna attenuator loss		Measuring antenna attenuator loss	
Measuring antenna balun loss		Measuring antenna balun loss	
Mutual coupling and mismatch loss (30 MHz - 180 MHz)		Mutual coupling and mismatch loss (30 MHz - 180 MHz)	
Antenna factor of the measuring antenna		Antenna factor of the measuring antenna	

SPURIOUS RESPONSE IMMUNITY (messages)	**Date:**	**Page 2 of 2**
Received signal level		dBµV
Signal generator output level		dBm
Transform Factor		dB
Wanted signal level: µV/m		**Limited frequency range:** MHz
Calculated frequencies (MHz)	**Field strength of unwanted signal for**	**Spurious response immunity:** Field strength of unwanted signal - Wanted signal level

	80 % acceptance (µV/m)	(dB)

Values in the formula for Transform Factor			
Measuring antenna cable loss		Measuring antenna cable loss	
Measuring antenna attenuator loss		Measuring antenna attenuator loss	
Measuring antenna balun loss		Measuring antenna balun loss	
Mutual coupling and mismatch loss (30 MHz - 180 MHz)		Mutual coupling and mismatch loss (30 MHz - 180 MHz)	
Antenna factor of the measuring antenna		Antenna factor of the measuring antenna	

8.2.6.1.5 Statement of results

The results should be presented in tabular form as shown in table 56.

Table 56: Overall results sheet

SPURIOUS RESPONSE IMMUNITY	**Date:** **Page 1 of 1**
Frequency (MHz)	**Spurious response immunity (dB)**
Expanded uncertainty (95 %)	dB

9 Duplex operation

All measurements described in this subclause are very critical and require high decoupling between the transmitter and the signal generators in use.

9.1 Spurious response immunity

9.1.1 Spurious response immunity for analogue speech

9.1.1.1 Definition

The spurious response immunity (duplex) for analogue speech is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the *nominal frequency* and an unwanted signal at any other frequency at which a response is obtained, in the presence of a transmitter working simultaneously with the receiver under duplex operation.

It is specified as the ratio in decibels of the level of the unwanted signal to the level of the wanted signal at the receiver input, which produces through a *psophometric weighting network* a SINAD ratio of 14 dB.

9.1.1.2 Method of measurement

Two methods are described covering EUTs with combined one or two antenna sockets. In each measuring arrangement additional attenuators (not shown) may be required to avoid producing spurious signals by intermodulation in the test apparatus.

9.1.1.2.1 Equipment operating with one antenna

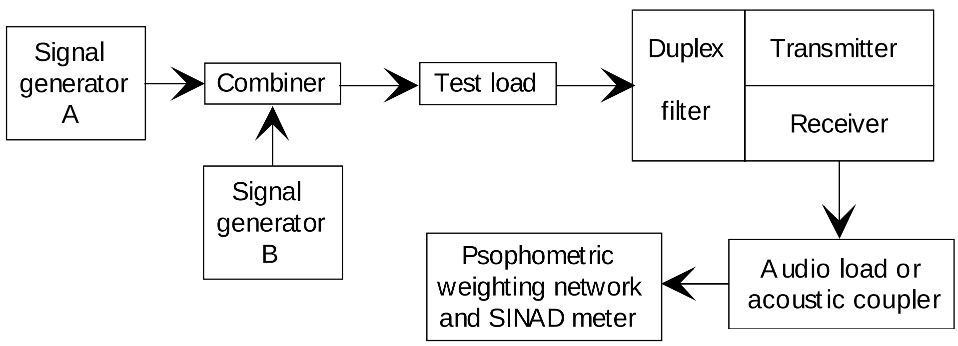

Figure 103: Spurious response rejection configuration with duplex filter

a) The antenna terminal of the equipment comprising the receiver, transmitter and *duplex filter* should be connected to a *test load.*

b) The transmitter should operate at the maximum *rated RF output power* and should be unmodulated.

c) Two signal generators A and B should be connected to the receiver input via a *combining network* and the *test load* so that they do not affect the impedance matching. The wanted signal, represented by signal generator A, should be at the nominal frequency and should have *test modulation A-M1*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3*.

d) Repeat steps b) to d) of the spurious response immunity measurement for analogue speech (subclause 8.1.4.1).

This measurement should be performed around the measuring frequencies f_m derived from the expressions:

$$p \times f_t + q \times f_m = f_r \text{ and } f_m = n \times f_t \pm f_{i1}$$

where:

f_t is the transmitter frequency;

f_r is the receiver frequency;

f_{i1} is the frequency of the first intermediate frequency of the receiver;

P, q and n are integer numbers.

Particular attention is drawn to the following values:

$$p = -1, q = 2 \text{ and } p = 2, q = -1.$$

9.1.1.2.2 Equipment operating with two antennas

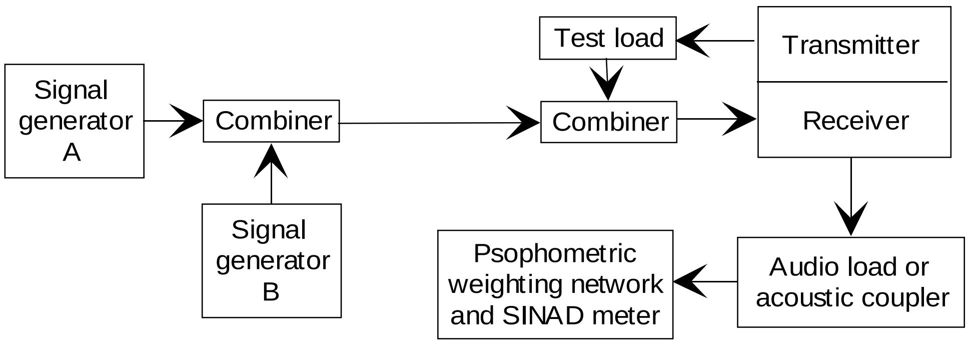

Figure 104: Spurious response rejection configuration without a duplex filter

a) The transmitter should be connected to a *test load* to dissipate the *rated RF output power* of the transmitter the rating of which is declared by the manufacturer. The *test load* output should be connected to the receiver input by means of a *combining network*. The total attenuation between transmitter and receiver has to be adjusted to be 30 dB.

b) The transmitter should operate at the maximum *rated RF output po*wer and should be unmodulated.

c) Two signal generators A and B should be connected to the receiver input via the two *combining networks* so that they do not affect the impedance matching. The wanted signal, represented by signal generator A, should be at the nominal frequency and should have *test modulation AM-1*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3.*

d) Repeat steps b) to d) of the spurious response immunity measurement for analogue speech (subclause 8.1.4.1).

This measurement should be performed around frequencies f_m derived from the expressions:

$$p \times f_t + q \times f_m = f_r \text{ and } f_m = n \times f_t \pm f_i f_1$$

where:

f_t is the transmitter frequency;

f_r is the receiver frequency;

$f_i f_1$ is the frequency of the first intermediate frequency of the receiver;

P, q and n are integer numbers.

Particular attention is drawn to the following values:

$$p = -1, q = 2 \text{ and } p = 2, q = -1.$$

9.1.2 Spurious response immunity for bit stream

9.1.2.1 Definition

The spurious response immunity for bit stream (duplex) is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the *nominal frequency* and an unwanted signal at any other frequency at which a response is obtained, in the presence of a transmitter working simultaneously with the receiver under duplex operation.

It is specified as the ratio in decibels of the level of the unwanted signal to the level of the wanted signal at the receiver input for which the bit error ratio is 10^{-2}.

9.1.2.2 Method of measurement

Two methods are described covering EUTs with combined one or two antenna sockets. In each measuring arrangement additional attenuators (not shown) may be required to avoid producing spurious signals by intermodulation in the test apparatus.

9.1.2.2.1 Equipment operating with one antenna

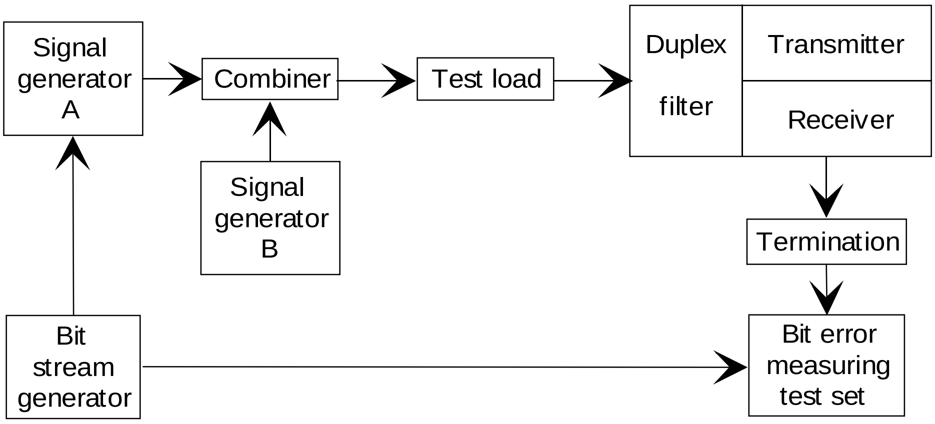

Figure 105: Spurious response rejection configuration with duplex filter

a) The antenna terminal of the equipment comprising the receiver, transmitter and *duplex filter* should be connected to a *test load*.

b) The transmitter should operate at the maximum *rated RF output power* and should be unmodulated.

c) Two signal generators A and B should be connected to the receiver input via a *combining network* and the *test load* so that they do not affect the impedance matching. The wanted signal, represented by signal generator A, should be at the nominal frequency of the receiver and should have *test modulation D-M2*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to a frequency within the specified frequency range at which it is calculated that a spurious response could occur.

d) Repeat steps b) to f) of the spurious response immunity measurement for bit stream (subclause 8.1.4.2).

This measurement should be performed around frequencies f_m derived from the expressions:

$$p \times f_t + q \times f_m = f_r \text{ and } f_m = n \times f_t \pm f_i f_1$$

where:

f_t is the transmitter frequency;

f_r is the receiver frequency;

$f_i f_1$ is the frequency of the first intermediate frequency of the receiver;

P, q and n are integer numbers.

Particular attention is drawn to the following values:

p = -1, q = 2 and p = 2, q = -1.

9.1.2.2.2 Equipment operating with two antennas

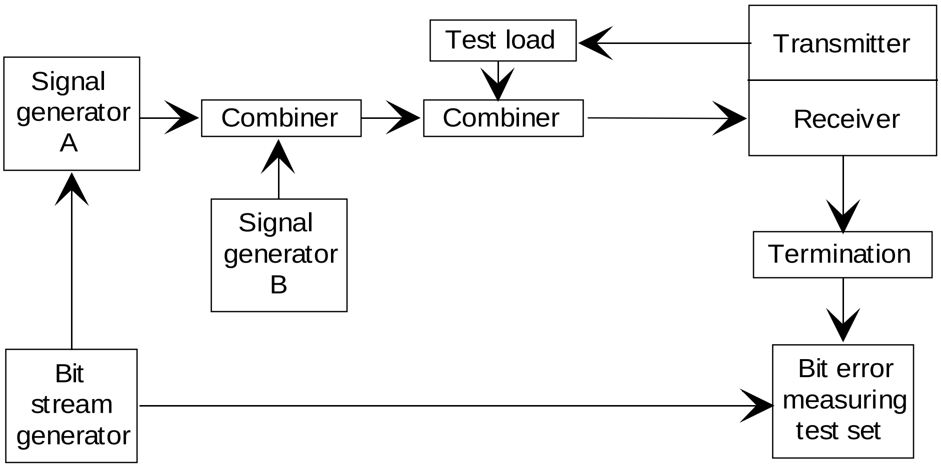

Figure 106: Spurious response rejection configuration without duplex filter

a) The transmitter should be connected to an *test load* to dissipate the *rated radio frequency output power* of the transmitter the rating of which is declared by the manufacturer. The *test load* output should be connected to the receiver input by means of a *combining network*. The total attenuation between transmitter and receiver has to be adjusted to be 30 dB.

b) The transmitter should operate at the maximum *rated RF output power* and should be unmodulated.

c) Two signal generators A and B should be connected to the receiver input via the two *combining networks* so that they do not affect the impedance matching. The wanted signal, represented by signal generator A, should be at the *nominal frequency* of the receiver and should have *test modulation D-M2*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to a frequency within the specified frequency range at which it is calculated that a spurious response could occur.

d) Repeat steps b) to f) of the spurious response immunity measurement for bit stream (subclause 8.1.4.2).

This measurement should be performed around frequencies f_m derived from the expressions:

$$p \times f_t + q \times f_m = f_r \text{ and } f_m = n \times f_t \pm f_i f_1$$

where:

f_t is the transmitter frequency;

f_r is the receiver frequency;

$f_i f_1$ is the frequency of the first intermediate frequency of the receiver;

P, q and n are integer numbers.

Particular attention is drawn to the following values:

p = -1, q = 2 and p = 2, q = -1.

9.1.3 Spurious response immunity for messages

9.1.3.1 Definition

The spurious response immunity for messages (duplex) is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the *nominal frequency* and an unwanted signal at any other frequency at which a response is obtained, in the presence of a transmitter working simultaneously with the receiver under duplex operation.

It is specified as the ratio in decibels of the level of the unwanted signal to the level of the wanted signal at the receiver input for which the message acceptance ratio is 80 %.

9.1.3.2 Method of measurement

Two methods are described covering EUTs with combined one or two antenna sockets. In each measuring arrangement additional attenuators (not shown) may be required to avoid producing spurious signals by intermodulation in the test apparatus.

9.1.3.2.1 Equipment operating with one antenna

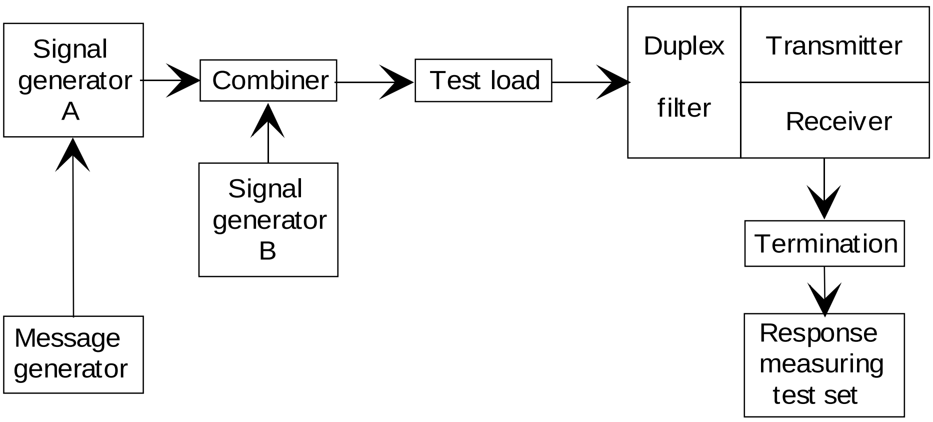

Figure 107: Spurious response rejection configuration with duplex filter

a) The antenna terminal of the equipment comprising the receiver, transmitter and *duplex filter* should be connected to a *test load.*

b) The transmitter should operate at the maximum *rated RF output power* and should be unmodulated.

c) Two signal generators, A and B should be connected to the receiver via a *combining network* and the *test load* so they do not affect the impedance matching. The wanted signal, represented by signal generator A, should be at the *nominal frequency* and should have *test modulation D-M3.* The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to a frequency within the specified frequency range at which it is anticipated that a spurious response could occur.

d) Repeat steps b) to g) of the spurious response immunity measurement for messages (subclause 8.1.4.3).

This measurement should be performed around frequencies f_m derived from the expressions:

$$p \times f_t + q \times f_m = f_r \text{ and } f_m = n \times f_t \pm f_i f_1$$

where f_t is the transmitter frequency;

f_r is the receiver frequency;

$f_i f_1$ is the frequency of the first intermediate frequency of the receiver;

P, q and n are integer numbers.

Particular attention is drawn to the following values:

p = -1, q = 2 and p = 2, q = -1.

9.1.3.2.2 Equipment operating with two antennas

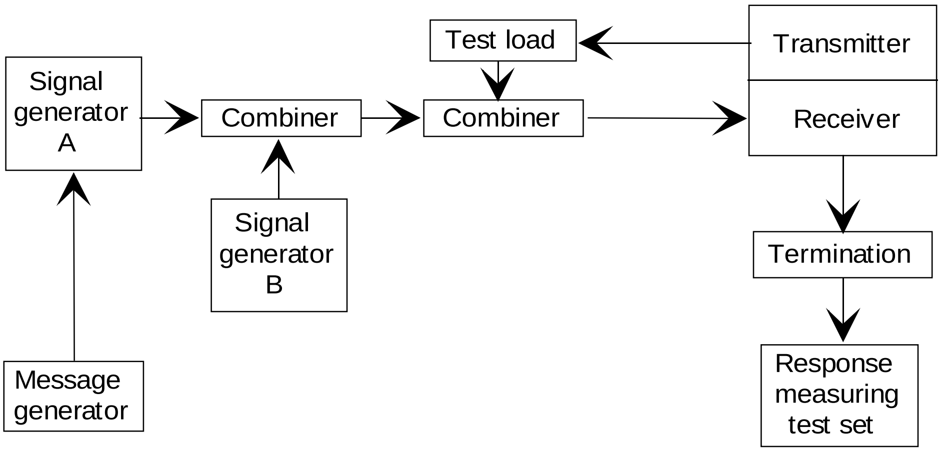

Figure 108: Spurious response rejection configuration without duplex filter

a) The transmitter should be connected to an *test load* to dissipate the *rated RF output power* of the transmitter the rating of which is declared by the manufacturer. The *test load* output should be connected to the receiver input by means of a *combining network*. The total attenuation between transmitter and receiver has to be adjusted to be 30 dB.

b) The transmitter should operate at the maximum *rated RF output powe*r and should be unmodulated.

c) Two signal generators, A and B should be connected to the receiver via a the two *combining networks* so they do not affect the impedance matching. The wanted signal, represented by signal generator A, should be at the *nominal frequency* and should have *test modulation D-M3*. The unwanted signal, represented by signal generator B, should have *test modulation A-M3* and should be adjusted to a frequency within the specified frequency range at which it is calculated that a spurious response could occur.

d) Repeat steps b) to g) of the spurious response immunity measurement for messages (subclause 8.1.4.3).

This measurement should be performed around frequencies f_m derived from the expressions:

$$p \times f_t + q \times f_m = f_r \text{ and } f_m = n \times f_t \pm f_i f_1$$

where:

f_t is the transmitter frequency;

f_r is the receiver frequency;

$f_i f_1$ is the frequency of the first intermediate frequency of the receiver;

P, q and n are integer numbers.

Particular attention is drawn to the following values:

p = -1, q = 2 and p = 2, q = -1.

9.2 Desensitization

9.2.1 Desensitization for analogue speech

9.2.1.1 Definition

The desensitization for analogue speech (duplex) is the degradation of the sensitivity of the receiver resulting from the transfer of power from the transmitter to the receiver due to unwanted coupling effects.

It is specified as the difference, in decibels, of the levels of measured usable sensitivity for analogue speech with simultaneous transmission and without.

9.2.1.2 Method of measurement

9.2.1.2.1 Equipment operating with one antenna

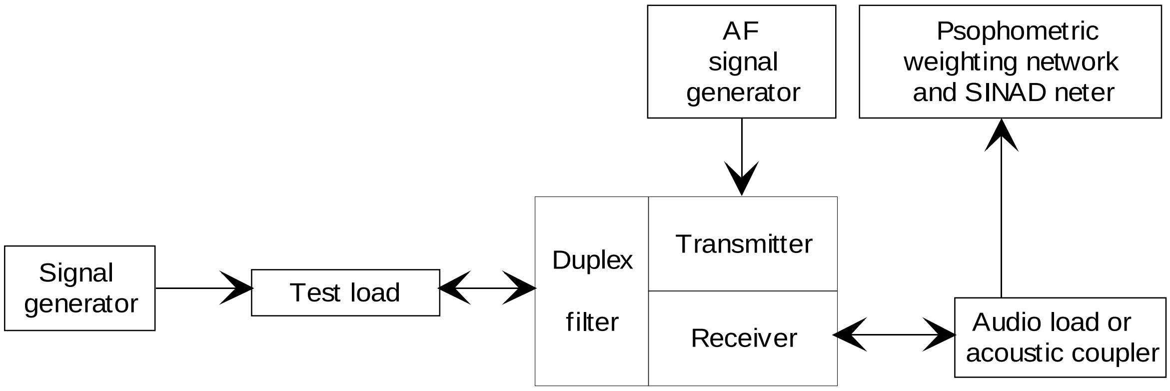

Figure 109: Receiver desensitization configuration for equipment with duplex filter

a) The antenna terminal of the equipment comprising the receiver, transmitter and *duplex filter* should be connected to a *test load.*

b) A signal generator at the *nominal frequency* and with *test modulation A-M1* should be connected to the *test load* so that it does not affect the impedance matching.

c) The transmitter should operate at the maximum *rated RF output power* and should have *test modulation A-M3.*

d) The receiver measured usable sensitivity for analogue speech should then be measured through a *psophometric weighting network* and the output level of the signal generator should be recorded in dBµV.

e) The transmitter should then be switched off, the receiver measured usable sensitivity for analogue speech should again be measured and the output level of the signal generator should be recorded in dBµV.

f) The desensitization for analogue speech (duplex) is recorded as the difference between the values recorded in steps d) and e).

9.2.1.2.2 Equipment operating with two antennas

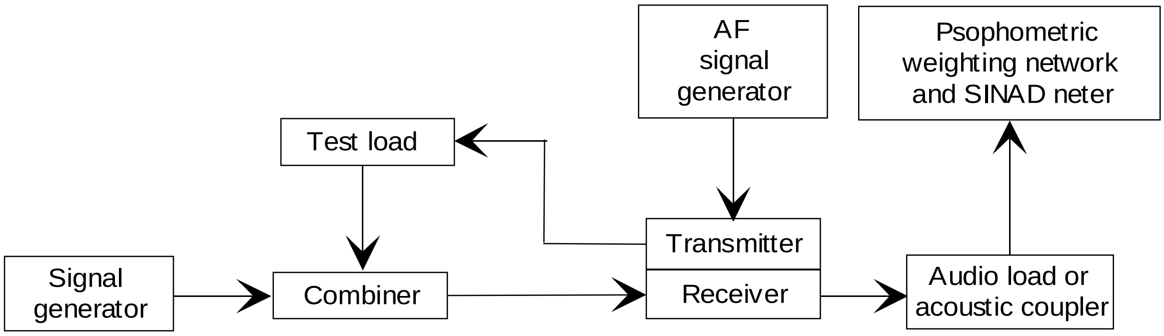

Figure 110: Receiver desensitization configuration for equipment without duplex filter

a) The transmitter should be connected to a *test load* to dissipate the *rated radio frequency output power* of the transmitter the rating of which is declared by the manufacturer. The *test load* output should be connected to the receiver input by means of a *combining network*. The total attenuation between transmitter and receiver is adjusted to be 30 dB.

b) A signal generator at the *nominal frequency* and with *test modulation A-M1* should be connected to the *combining network* in such a way as not to affect the impedance matching.

c) Repeat steps c) to f) of the measurement detailed in subclause 9.2.1.2.1.

9.2.2 Desensitization for bit stream

9.2.2.1 Definition

The desensitization for bit stream (duplex) is the degradation of the sensitivity of the receiver resulting from the transfer of power from the transmitter to the receiver due to unwanted coupling effects.

It is specified as the difference, in decibels, of the levels of measured usable sensitivity for bit stream with simultaneous transmission and without.

9.2.2.2 Method of measurement

9.2.2.2.1 Equipment operating with one antenna

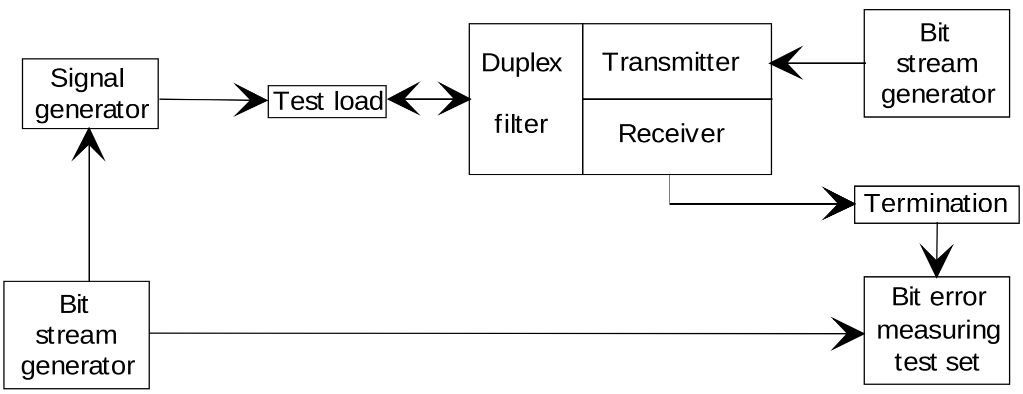

Figure 111: Receiver desensitization configuration for equipment with duplex filter

a) The antenna terminal of the equipment comprising the receiver, transmitter and *duplex filter* should be connected to a *test load*.

b) A signal generator at the *nominal frequency* with *test modulation D-M2* should be connected to the *test load* so that it does not affect the impedance matching.

c) The transmitter should operate at the maximum *rated RF output power* with *test modulation D-M2* (which should start at a different time then the one used in step b)).

d) The receiver measured usable sensitivity for bit stream should be measured and the output level of the signal generator should be recorded in dBμV.

e) The transmitter should then be switched off, the receiver measured usable sensitivity for bit stream should again be measured and the output level of the signal generator should be recorded in dBμV.

f) The desensitization for bit stream (duplex) is recorded as the difference between the values recorded in steps d) and e).

9.2.2.2.2 Equipment operating with two antennas

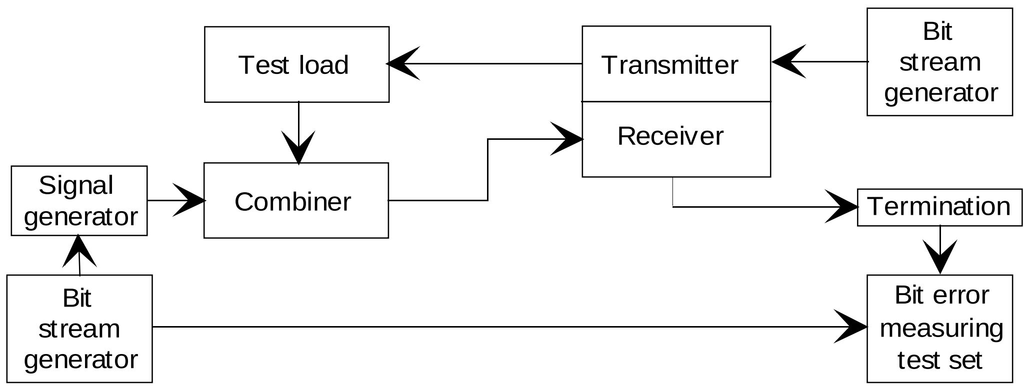

Figure 112: Receiver desensitization configuration for equipment without duplex filter

a) The transmitter should be connected to a *test load* to dissipate the *rated radio frequency output power* of the transmitter the rating of which is declared by the manufacturer. The *test load* output should be connected to the receiver input by means of a *combining network*. The total attenuation between transmitter and receiver is adjusted to be 30 dB.

b) A signal generator at the *nominal frequency* of the receiver with *test modulation D-M2* should be connected to the *combining network* in such a way as not to affect the impedance matching.

c) Repeat steps c) to f) of the measurement detailed in subclause 9.2.2.2.1.

9.2.3 Desensitization for messages

9.2.3.1 Definition

The desensitization for messages (duplex) is the degradation of the sensitivity of the receiver resulting from the transfer of power from the transmitter to the receiver due to unwanted coupling effects.

It is specified as the difference, in decibels, of the levels of measured usable sensitivity for messages with simultaneous transmission and without.

9.2.3.2 Method of measurement

9.2.3.2.1 Equipment operating with one antenna

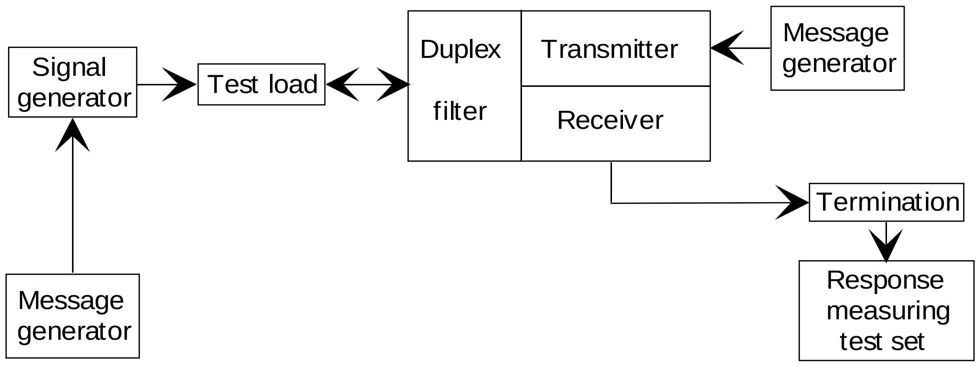

Figure 113: Receiver desensitization configuration for equipment with duplex filter

a) The antenna terminal of the equipment comprising the receiver, transmitter and *duplex filter* should be connected to a *test load.*

b) A signal generator at the *nominal frequency* of the receiver with *test modulation D-M3* should be connected to the *test load* so that it does not affect the impedance matching.

c) The transmitter should operate at the maximum *rated RF output power* with *test modulation D-M3* (which should use a different message and start at a different time then the one used in step b).

d) The receiver measured usable sensitivity for messages should then be measured and the output level of the signal generator should be recorded in dBµV.

e) The transmitter should then be switched off, the receiver measured usable sensitivity for messages should again be measured and the output level of the signal generator should be recorded in dBµV.

f) The desensitization for messages (duplex) is recorded as the difference between the values recorded in steps d) and e).

9.2.3.2.2 Equipment operating with two antennas

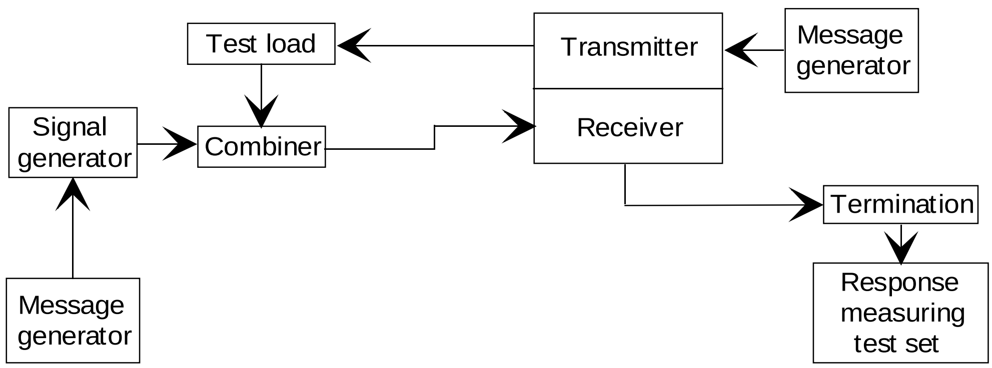

Figure 114: Receiver desensitization configuration for equipment without duplex filter

a) The transmitter should be connected to a *test load* to dissipate the *rated radio frequency output power* of the transmitter the rating of which is declared by the manufacturer. The *test load* output should be connected to the receiver input by means of a *combining network*. The total attenuation between transmitter and receiver has to be 30 dB.

b) A signal generator at the *nominal frequency* of the receiver with *test modulation D-M3* should be connected to the *combining network* in such a way as not to affect the impedance matching.

c) Repeat steps c) to f) of the measurement detailed in subclause 9.2.3.2.1.

Annex A (informative): Correction factors

Table A.1: Mutual coupling and mismatch loss correction factors (Anechoic Chamber)

Frequency (MHz)	Range length 3 m	Range length 10 m		Frequency (MHz)	Range length 3 m	Range length 10 m
30	27,1	25,8		**80**	0,7	0,2
35	24,3	23,3		**90**	0,6	0,1
40	21,7	20,8		**100**	0,6	0,1
45	19,0	18,2		**120**	0,3	0,1
50	16,1	15,4		**140**	0,4	0,1
60	9,7	9,1		**160**	0,3	0,2
70	2,2	1,7		**180**	0,2	0,1

Table A.2: Mutual coupling and mismatch loss correction factors (over a ground plane)

	Horizontal polarization		Vertical polarization	
Freq. (MHz)	**3 m**	**10 m**	**3 m**	**10 m**
30	27,6	26,0	25,2	25,4
35	24,6	23,3	22,4	22,9
40	21,8	20,7	19,8	20, 4
45	19,0	18,1	17,2	17,9
50	16,0	15,1	14,4	15,1
60	9,5	8,9	8,5	9,2
70	2,4	2,8	1,6	2,5
80	0,6	0,8	0,0	0,4
90	0,2	0,4	-0,2	0,1
100	-0,3	0,0	-0,6	0,0
120	-2,3	-1,2	-0,6	0,0
140	-1,0	-0,7	1,1	-0,1
160	-0,3	0,3	0,7	0,0
180	-0,3	0,3	0,3	0,0

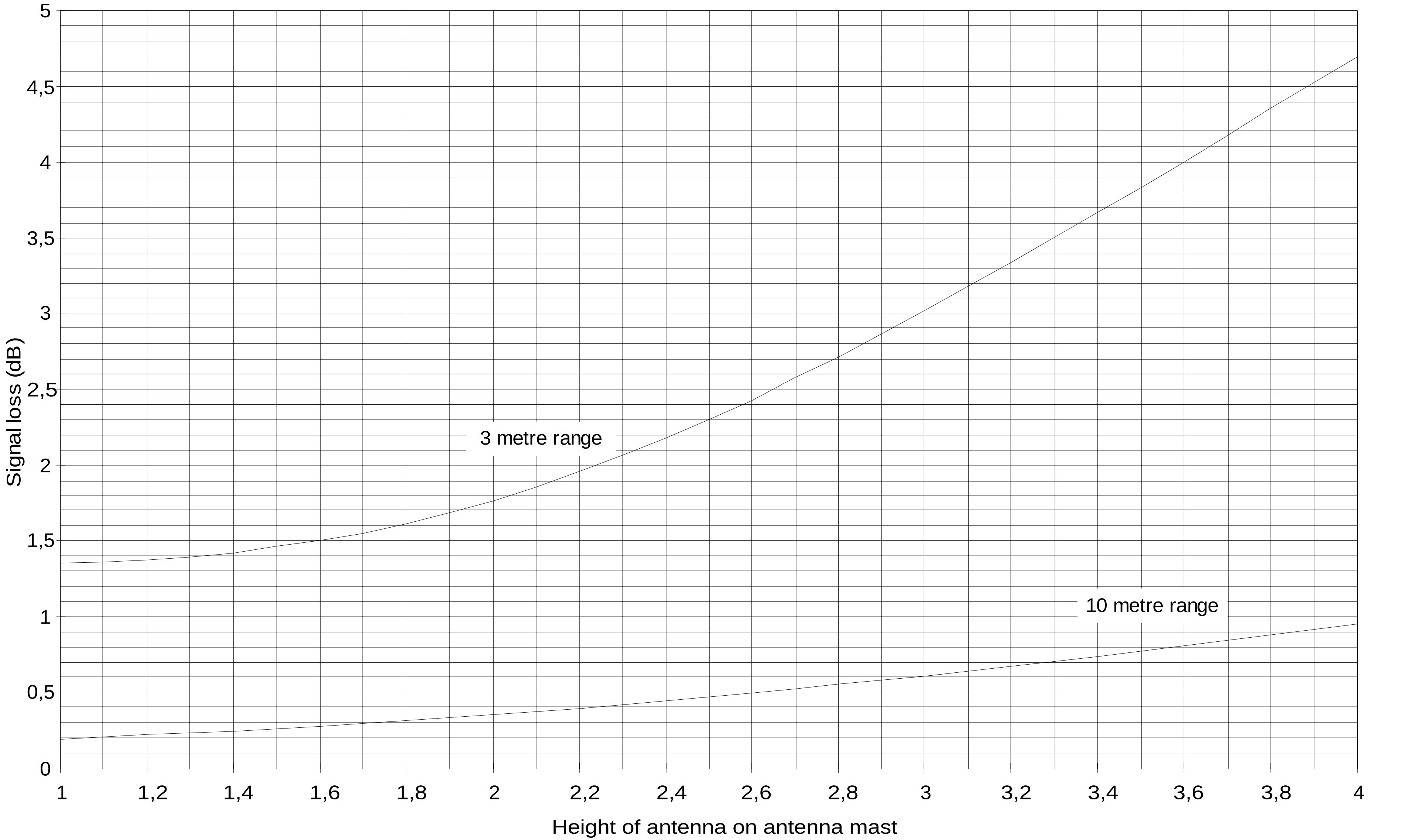

Figure A.1: Signal attenuation for measuring distance

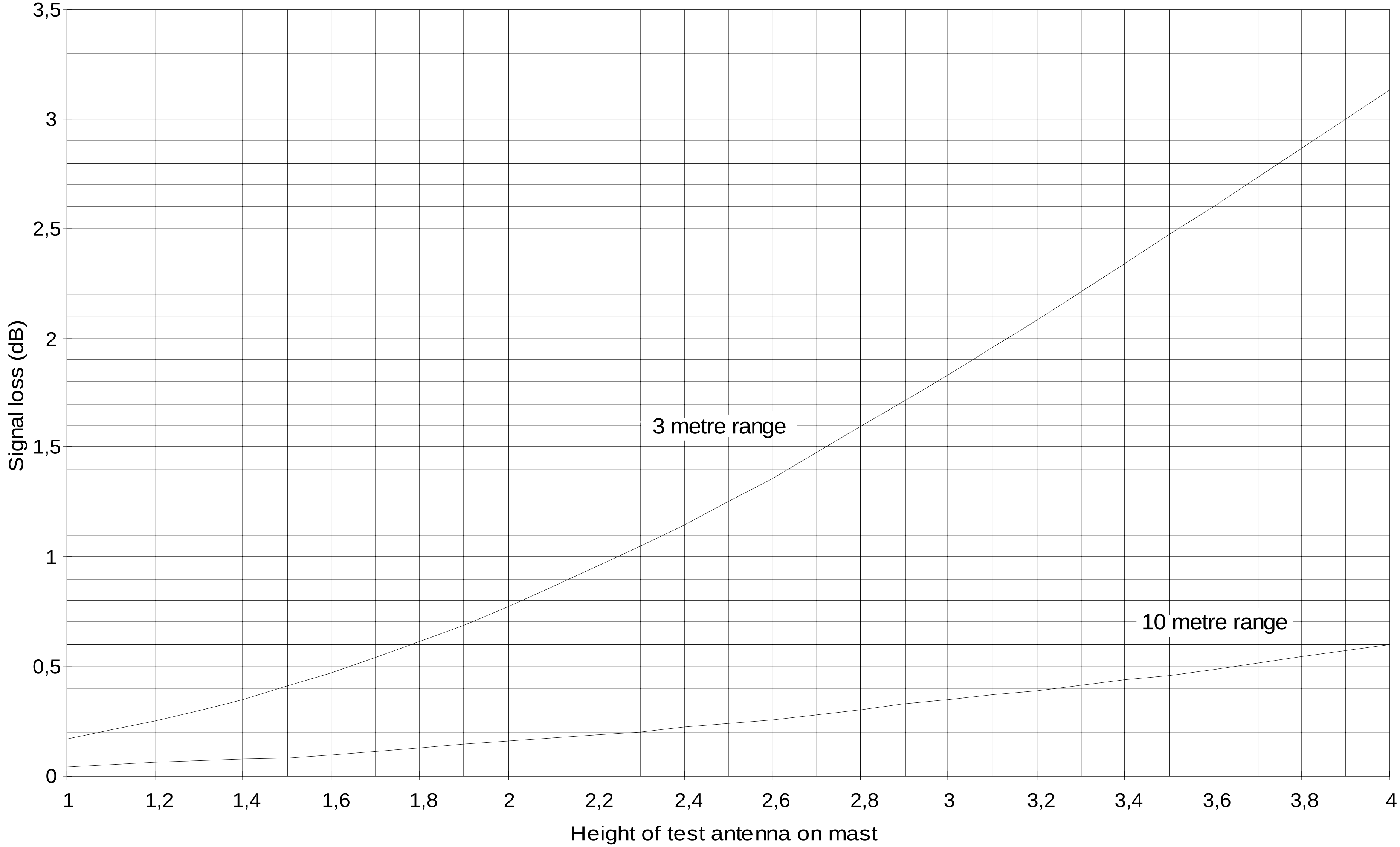

Figure A.2: Signal attenuation for off boresight angle in elevation plane

History

Document history		
Edition 1	September 1991	Publication as ETR 027
V1.2.1	December 1999	Publication