TCN 68-231:2005

LAND MOBILE RADIO EQUIPMENT USING AN INTEGRAL ANTENNA INTENDED FOR THE TRANSMISSION OF DATA (AND SPEECH)

Technical Requirements

CONTENTS

FOREWORD

The technical standard TCN 68-231: 2005 ”Land Mobile Radio Equipment using an integral antenna intended for the transmission of data (and speech) - Technical Requirements” is based on Recommendation EN 300-390-1 V1.2.1 (2000-09) and EN 300-390-2 V1.1.1 (2000-09), with references to ETSI Standards ETS 300-390 (1996-02), ETR 027 and ETR 028 of the European Telecommunication Standards Institute (ETSI).

The technical standard TCN 68-231: 2005 is drafted by Research Institute of Posts and Telecommunications (RIPT) at the proposal of Department of Science & Technology and issued following the Decision No. 28/2005/QD-BBCVT of the Minister of Posts and Telematics dated 17/08/2005.

The technical standard TCN 68-231: 2005 is issued in a bilingual document (Vietnamese version and English version). In cases of interpretation disputes, Vietnamese version is applied.

Department of Science & Technology

Land Mobile Radio Equipment using an integral antenna intended for the transmission of data (and speech) Technical requirements

(Issued together with the Decision No 28/2005/QD-BBCVT dated 17/08/2005 of the Minister of Posts and Telematics)

1. Scope

This technical standard applies to constant envelope angle modulation systems for use in the land mobile service, using the available bandwidth, operating on radio frequencies between 30 MHz and 1 000 MHz, with channel separations of 12.5 kHz and 25 kHz.

This technical standard applies to digital and combined analogue and digital radio equipment, which is hand portable, using an integral antenna and intended for the transmission of data and/or speech.

2. References

[1] ETSI EN 300 390-1 V1.2.1 (2000-09): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and using an integral antenna "; Part 1: Technical characteristics and test conditions.

[2] ETSI EN 300 390-2 V1.1.1 (2000-09): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and using an integral antenna"; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R & TTE Directive.

[3] ETS 300 390 (1996-02): “Radio Equipment and System (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”

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

[5] ETSI ETR 027 (September 1991): "Radio Equipment and Systems; Methods of Measurement for Mobile Radio Equipment ".

[6] ETSI ETR 028: "Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics".

[7] ITU-T Recommendation O.153 (1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[8] ETSI ETS 300 341: "Radio Equipment and Systems (RES); Land Mobile Service; Technical characteristics and test conditions for radio equipment using integral antenna transmitting signals to initiate a specific response in the receiver ".

[9] IEC 60489-3 (1988): "Methods of measurement for radio equipment used in the mobiles services. Part 3: Receivers for A3E or F3E emissions".

3. Definitions and abbreviations

3.1. Definitions

3.1.1. Constant envelope angle modulation

Either phase modulation (G3) or frequency modulation (F3).

3.1.2. Integral antenna

Antenna designed to be connected to the equipment without the use of a 50 Ω external connector and considered to be part of the equipment. An integral antenna may be fitted internally or externally to the equipment.

3.1.3. Conducted measurements

Measurements which are made using a direct RF connection to the equipment under test.

3.1.4. Radiated measurements

Measurements which involve the absolute measurement of a radiated field.

3.1.5. Base station

Equipment fitted with an antenna connector, for use with an external antenna and intended for use in a fixed location.

3.1.6. Mobile station

Mobile equipment fitted with an antenna connector, for use with an external antenna, normally used in a vehicle or as a transportable station.

3.1.7. Handportable station

Equipment either fitted with an antenna connector or an integral antenna, or both, normally used on a stand-alone basis, to be carried on a person or held in the hand.

3.2. Abbreviations

AC	*Alternative Current*
dBc	*dB relative to the carrier power*
DC	*Direct Current*
emf	*Electro-motive force*
erp	*Effective radiated power*
FM	*Frequency Modulation*
FFSK	*Fast Frequency Shift Keying*
FSK	*Frequency Shift Keying*
IF	*Intermediate Frequency*
LSB	*Least Significant Bit*
PLL	*Phase Lock Loop*
MSB	*Most Significant Bit*
rms	*Root-mean-square*
RF	*Radio Frequency*
R_X	*Receiver*
SINAD	*(signal + noise + distortion) / (noise + distortion)*
T_X	*Transmitter*
VSWR	*Voltage Standing Wave Ratio*

General requirements

3.2. Presentation of equipment for testing purposes

Each equipment submitted for type testing shall fulfill the requirements of the present document on all channels over which it is intended to operate.

To simplify and harmonize the type testing procedures between the different test laboratories, measurements shall be performed, according to the present document, on samples of equipment defined in subclauses 4.1.1 to 4.1.11. These subclauses are intended to give confidence that the requirements set out in the present document have been met without the necessity of performing measurements on all channels.

3.2.1. Choice of model for type approval

The manufacturer shall provide one or more production model(s) of the equipment, as appropriate, for type approval testing.

If type approval is given on the basis of tests on a preliminary model, then the corresponding production models shall be identical in all respects with the preliminary model tested.

3.2.2. Definitions of alignment range and switching range

The manufacturer shall, when submitting equipment for type testing, state the alignment ranges for the receiver and the transmitter.

The alignment range (AR) is defined as the frequency range over which the receiver and the transmitter can be programmed and/or realigned to operate, without any physical change of components other than programmable read only memories (ROM) or crystals (for the receiver and the transmitter).

The manufacturer shall also state the switching range of the receiver and the transmitter (which may differ).The switching range is the maximum frequency range over which the receiver or the transmitter can be operated without reprogramming or realignment. For the purpose of all measurements, the receiver and transmitter shall be considered separately.

3.2.3. Definition of the categories of the alignment range (AR1 and AR2)

The alignment range falls into one of two categories.

The first category corresponds to a limit of the alignment range, of the receiver and the transmitter, which is less than 10% of the highest frequency of the alignment range for equipment operating on frequencies up to 500 MHz, or less than 5% for equipment operating above 500 MHz. This category is defined as AR1.

The second category corresponds to an alignment range of the receiver and transmitter which is greater than 10% of the highest frequency of the alignment range for equipment on frequencies up to 500 MHz, or greater than 5% for equipment operating above 500 MHz. This category is defined as AR2.

3.2.4. Choice of frequencies

The frequencies for testing shall be chosen by the manufacturer in consultation with the appropriate laboratory, in accordance with subclauses 4.1.5 to 4.1.11. The manufacturer when selecting the frequencies for testing shall ensure that the chosen frequencies are within one or more of the national bands for which type approval is required.

3.2.5. Testing of single channel equipment of category AR1

In the case of single channel equipment of the category AR1, one sample of the equipment shall be tested. Full tests shall be carried out on a channel within 100 kHz of the centre frequency of the alignment range.

3.2.6. Testing of single channel equipment of category AR2

In the case of single channel equipment of the category AR2, three samples of the equipment shall be tested. Tests shall be carried out on a total of three channels.

The frequency of the channel of the first sample shall be within 100 kHz of the highest frequency of the alignment range.

The frequency of the channel of the second sample shall be within 100 kHz of the lowest frequency of the alignment range.

The frequency of the channel of the third sample shall be within 100 kHz of the centre frequency of the alignment range.

Full tests shall be carried out on all three channels.

3.2.7. Testing of two channel equipment of category AR1

In the case of two channel equipment of category AR1, one sample of the equipment shall be tested. Tests shall be carried out on the two channels.

The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range.

The frequency of the lower channel shall be within 100 kHz of the lowest frequency of the switching range. In addition the average of the frequencies of the two channels shall be within 100 kHz of the centre frequency of the alignment range.

Full tests shall be carried out on the upper channel and limited tests on the lower channel.

3.2.8. Testing of two channel equipment of category AR2

In the case of two channel equipment of the category AR2, three samples of the equipment shall be tested. Tests shall be carried out on a total of four channels.

The highest frequency of the switching range of one sample shall be within 100 kHz of the centre frequency of the alignment range. The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range and the frequency of the lower channel shall be within 100 kHz of the lowest frequency of the switching range.

Full tests shall be carried out on the upper channel and limited tests on the lower channel.

The frequency of one of the channels of the second sample shall be within 100 kHz of the highest frequency of the alignment range.

Full tests shall be carried out on this channel.

The frequency of one of the channels of the third sample shall be within 100 kHz of the lowest frequency of the alignment range.

Full tests shall be carried out on this channel.

3.2.9. Testing of multi channel equipment (more than two channels) of category AR1

In the case of multi channel equipment of the category AR1, one sample of the equipment shall be tested.

The centre frequency of the switching range of the sample shall correspond to the centre frequency of the alignment range.

Full tests shall be carried out on a frequency within 100 kHz of the centre frequency of the switching range. Limited tests shall be carried out within 100 kHz of the lowest and also within 100 kHz of the highest frequency of the switching range.

3.2.10. Testing of multi channel equipment (more than two channels) of category AR2 (switching range less than alignment range)

In the case of multi channel equipment of the category AR2 with switching range less than alignment range, three samples of the equipment shall be tested.

Tests shall be carried out on a total of five channels.

The centre frequency of the switching range of one sample shall be within 100 kHz of the centre frequency of the alignment range. The frequency of the upper channel shall be within 100 kHz of the highest frequency of the switching range and the frequency of the lower channel shall be within 100 kHz of the lowest frequency of the switching range.

Full tests shall be carried out on the centre channel and limited tests on the upper and lower channel.

The frequency of one of the channels of the second sample shall be within 100 kHz of the highest frequency of the alignment range.

Full tests shall be carried out on this channel.

The frequency of one of the channels of the third sample shall be within 100 kHz of the lowest frequency of the alignment range.

Full tests shall be carried out on this channel.

3.2.11. Testing of multi channel equipment (more than two channels) of category AR2 (switching range equals the alignment range)

In the case of multi channel equipment of the category AR2 with switching range equal to alignment range, one sample of the equipment shall be tested.

The centre frequency of the switching range of the sample shall correspond to the centre frequency of the alignment range.

Full tests shall be carried out on a frequency within 100 kHz of the centre frequency of the switching range and within 100 kHz of the lowest and also within 100 kHz of the highest frequency of the switching range.

3.3. Testing for compliance with technical requirements

3.3.1. Normal and extreme test conditions

Measurements shall be made under normal test conditions, and also, where stated, under extreme test conditions.

3.3.2. Test power source

- During measurements, the power source of the equipment shall be replaced by a test power source, capable of producing normal and extreme test voltages as specified in clauses 4.2.3.2 and 4.2.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.
- If the equipment is provided with a permanently connected power cable, the test voltage shall be that measured at the point of connection of the power cable to the equipment.
- For battery operated equipment the battery shall be removed and the test power source shall be applied as close to the battery terminals as practicable.
- During tests the power source voltages shall be maintained within a tolerance ± 1 % relative to the voltage at the beginning of each test. The value of this tolerance is critical for power measurements.

3.3.3. Normal test conditions

3.3.3.1. Normal temperature and humidity

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

- Temperature: +10ºC to +30ºC;
- Relative humidity: 20 % to 75 %.

3.3.3.2. Normal test power source

3.3.3.2.1. ***Mains voltage***

- The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of this standard, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed.
- The frequency of the test power source corresponding to the AC mains shall be between 49 Hz and 51 Hz.

3.3.3.2.2. ***Regulated lead-acid battery power sources used on vehicles***

- When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source used on vehicles, the normal test voltage shall be 1.1 times the nominal voltage of the battery.

3.3.3.2.3. ***Other power sources***

- For operation from other power sources or types of battery, the normal test voltage shall be that declared by the equipment manufacturer.

3.3.4. Extreme test conditions

3.3.4.1. Extreme temperatures

- For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.1.1.3, at the upper and lower temperatures of the following range: -20°C to +50ºC.
- For the purpose of the note to table 5.1, clause 5.1.1.2, an additional reduced extreme temperature range of 0ºC to +30ºC shall be used when the equipment is not able to fulfill the requirement of table 5.1 over the extreme temperature range of -20°C to +50ºC.
- Type test reports shall state the temperature range used.

3.3.4.2. Extreme test source voltages.

3.3.4.2.1. Mains voltage.

The extreme test voltage for equipment to be connected to an ac mains source shall be the nominal mains voltage ±10 %.

3.3.4.2.2. Regulated lead-acid battery power sources on vehicles.

When the equipment is intended for operation from the usual type of regulated lead-acid battery power sources used on vehicles, the extreme test voltages shall be 1.3 and 0.9 times the nominal voltage of the battery (6 V, 12 V etc).

3.3.4.2.3. Power sources using other types of batteries.

The lower extreme test voltage for equipment with power sources using the following batteries shall be:

- for the Leclanche or the lithium type of battery: 0.85 times the nominal voltage of the battery;
- for the mercury type or nickel-cadmium type of battery: 0.9 times the nominal voltage of the battery.

No upper extreme test voltages apply.

3.3.4.2.4. Other power sources.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing laboratory and shall be recorded in test reports.

3.3.5. Procedure for tests at extreme temperatures

- Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilizing period.
- In the case of equipment containing temperature stabilization circuits designed to operate continuously, the temperature stabilization circuits may be switched on for 15 minutes after thermal balance has been attained, and the equipment shall then meet the specified requirements.
- If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or a longer period of time as may be decided by the testing laboratory, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

3.3.5.1. Procedure for equipment designed for continuous operation

If the manufacturer states that the equipment is designed for continuous operation, the test procedure shall be as follows.

- Before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit condition for a period of half an hour after which the equipment shall meet the specified requirements.
- Before tests at the lower extreme temperature the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for a period of one minute after which the equipment shall meet the specified requirements.

3.3.5.2. Procedure for equipment designed for intermittent operation

If the manufacturer states that the equipment is designed for intermittent operation, the test procedure shall be as follows.

- Before tests at the upper extreme temperature the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements.

Before tests at the lower extreme temperature the equipment shall be left in the test chamber until thermal balance is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements.

3.4. General conditions

3.4.1. Normal test signals (wanted and unwanted signals)

The wanted signals for methods of measurement with bit streams and messages are defined in subclauses A.1.1 and A.1.2 respectively.

The signal A-M3 is used as an unwanted signal for methods of measurement with either bit streams or messages for measurements such as co-channel rejection and adjacent channel selectivity. It shall be as follows:

- signal A-M3, consisting of an RF signal, modulated by an audio frequency signal of 1 kHz with a deviation of 12 % of the channel separation.

3.4.1.1. Signals for bit stream measurements

When the equipment is designed to transmit continuous bit streams (e.g. data, facsimile, image transmission, digital speech) the normal test signal shall be as follows:

- signal D-M0, consisting of an infinite series of 0-bits;
- signal D-M1, consisting of an infinite series of 1-bits;
- signal D-M2, consisting of a pseudorandom bit sequence of at least 511 bits according to ITU-T Recommendation O.153;
- signal D-M2', this is the same type as D-M2, but the pseudorandom bit sequence is independent of D-M2 (perhaps identical with D-M2 but started at a different point of time).

Applying an infinite series of 0 bits or 1 bits does not normally produce the typical bandwidth. Signal D-M2 is designed to produce a good approximation of the typical bandwidth.

3.4.1.2. Signals for messages

- When the equipment is intended to be tested using messages, the normal test signal shall be trains of correctly coded bits or messages.
- The normal test signals and modulations shall be obtained as follows:
    - + signal D-M3, corresponding to single bursts, used for measurements using the up-down method, triggered either manually or by an automatic testing system.
    - + signal D-M4, consisting of correctly coded signals, messages transmitted sequentially, one by one, without gaps between them.
- D-M3 is used for receiver methods of measurement with messages where there is a need to transmit single messages a number of times . The corresponding normal test modulation shall be agreed between the manufacturer and the test laboratory.
- The test signal D-M4 is used for transmitter methods of measurement such as adjacent channel power and radiated spurious emissions

- Details of D-M3 and D-M4 shall be included in the test report.

3.4.2. Artificial antenna

Tests on the transmitter requiring the use of the test fixture shall be carried out with a substantially non-reactive non-radiating load of 50 Ω connected to the test fixture terminals.

3.4.3. Arrangements for test signals at the input of the receiver via a test fixture or a test antenna

Sources of test signals for application to the receiver via a test fixture or a test antenna shall be connected in such a way that the impedance presented to the test fixture, the stripline or the test antenna is 50 Ω. This requirement shall be met irrespective of whether one or more signals using a combining network are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the emf at the output of the source prior to connection to the appropriate input connector.

The effects of any intermodulation products and noise produced in the test signal sources shall be negligible.

3.5. Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

a) the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of the present document;

b) the actual measurement uncertainty of the test laboratory carrying out the measurements, for each particular measurement shall be included in the test report;

c) the value of the actual measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 4.1 (absolute measurement uncertainties).

Table 4.1: Absolute measurement uncertainties: maximum values

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-7}$
Radiated RF Power	± 6 dB
Conducted RF Power variations using a test fixture	± 0.75 dB
Adjacent channel power	± 5 dB
Sensitivity	± 3 dB
Two-signal measurement, valid up to 4 GHz (using a test fixture)	± 4 dB
Two-signal measurements using radiated fields (note)	± 6 dB
Three-signal measurement (using a test fixture)	± 3 dB
Radiated emission of the transmitter, valid up to 12,75 GHz	± 6 dB
Radiated emission of receiver, valid up to 12,75 GHz	± 6 dB
Transmitter transient attack time	± 20 %

Transmitter transient release time	± 20 %
Transmitter transient frequency	± 250 Hz

4. Technical specifications

4.1. Transmitter requirement

4.1.1. Frequency error

*4.1.1.1. **Definition***

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation and the nominal frequency of the transmitter.

*4.1.1.2. **Limit***

The frequency error shall not exceed the values given in table 5.1., under normal, extreme or any intermediate set of conditions.

Table 5.1: Frequency error

Channel Separation (kHz)	Frequency error limit (kHz)				
	Below 47 MHz	**47 to 137 MHz**	**Above 137 to 300 MHz**	**Above 300 to 500 MHz**	**Above 500 to 1000 MHz**
25	± 0.60	± 1.35	± 2.00	± 2.00	± 2.50 (note)
12.5	± 0.60	± 1.00	± 1.50	± 1.50 (note)	No value specified
NOTE: For handportable stations having integral power supplies, these limits only apply to the reduced extreme temperature range 0 °C to + 30 °C. However for the full extreme temperature conditions (subclause 4.2.4.1), exceeding the reduced extreme temperature range above, the following frequency error limits apply: ± 2.50 kHz between 300 MHz and 500 MHz; ± 3.00 kHz between 500 MHz and 1 000 MHz.					

*4.1.1.3. **Method of measurement***

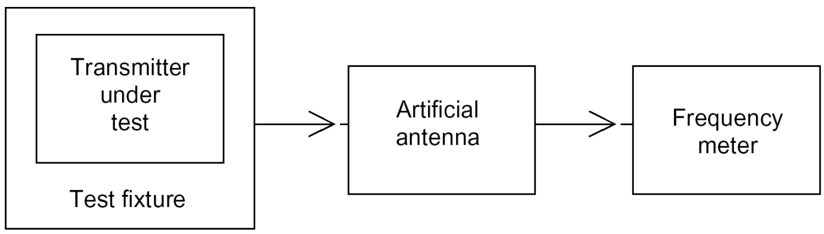


Figure 1: Measurement arrangement

The equipment shall be placed in a test fixture (clause A.6) connected to the artificial antenna (subclause 4.3.2). The carrier frequency shall be measured in the absence of modulation.

The measurement shall be made under normal test conditions (subclause 4.2.3) and repeated under extreme test conditions (subclause 4.2.4.1 and 4.2.4.2) applied simultaneously.

4.1.2. Effective radiated power

Administrations may state the maximum value for the maximum effective radiated power of transmitters; this can be a condition for issuing the license.

If the equipment is designed to operate with different carrier powers, the rated maximum effective radiated power for each level or range of levels shall be declared by the manufacturer. The power adjustment control shall not be accessible to the user.

The requirements of the present document shall be met for all power levels at which the transmitter is intended to operate. For practical reasons measurements shall be performed only at the lowest and the highest power level at which the transmitter is intended to operate.

4.1.2.1. ***Definition***

The maximum effective radiated power is defined as the effective radiated power in the direction of maximum field strength under specific conditions of measurement.

The rated maximum effective radiated power is the maximum effective radiated power declared by the manufacturer.

The average effective radiated power is defined as the average of the effective radiated power measured in 8 directions.

The rated average effective radiated power shall also be declared by the manufacturer.

4.1.2.2. ***Limit***

The maximum effective radiated power under normal test conditions shall be within $\mathbf{d_f}$ of the rated maximum effective radiated power.

The average effective radiated power under normal test conditions shall be within $\mathbf{d_f}$ of the rated average effective radiated power.

The allowance for the characteristics of the equipment (±1.5 dB) shall be combined with the actual measurement uncertainty in order to provide d_f, as follows:

$$\mathbf{d_f^2 = d_m^2 + d_e^2}$$

where:

- d_m is the actual measurement uncertainty;
- d_e is the allowance for the equipment (±1.5 dB);
- d_f is the final difference.

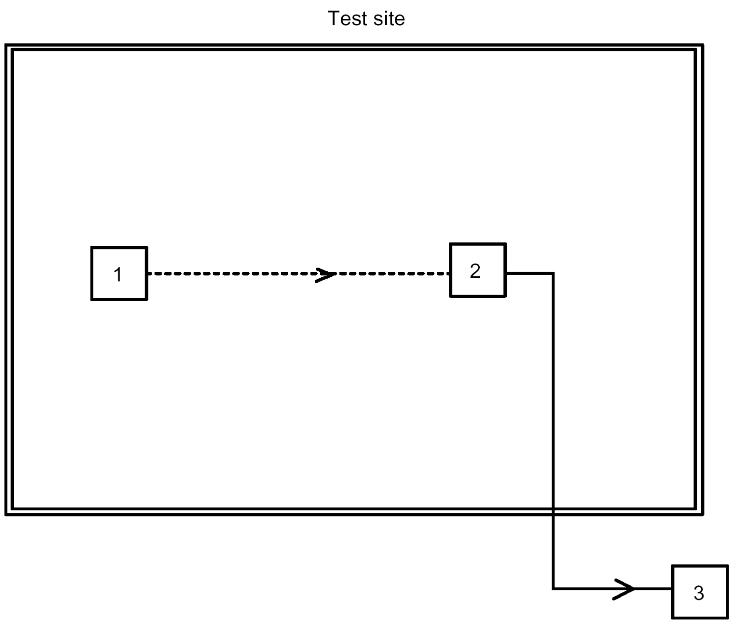
All values shall be expressed in linear terms.

In all cases the actual measurement uncertainty shall comply with annex 4.4, table 4.1.

Furthermore, the maximum effective radiated power shall not exceed the maximum value allowed by the administrations.

4.1.2.3. ***Method of measurement***

4.1.2.3.1. Maximum effective radiated power under normal test conditions



1) Transmitter under test; 2) Test antenna; 3) Spectrum analyzer or selective voltmeter

Figure 2: Measurement arrangement

a) A test site which fulfils the requirements for the specified frequency range of this measurement shall be used. The test antenna shall be orientated initially for vertical polarization unless otherwise stated. The transmitter under test shall be placed on the support in its standard position (subclause A.2) and switched on preferably in the absence of modulation.

b) The spectrum analyzer or selective voltmeter shall be tuned to the transmitter carrier frequency. The test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyzer or selective voltmeter.

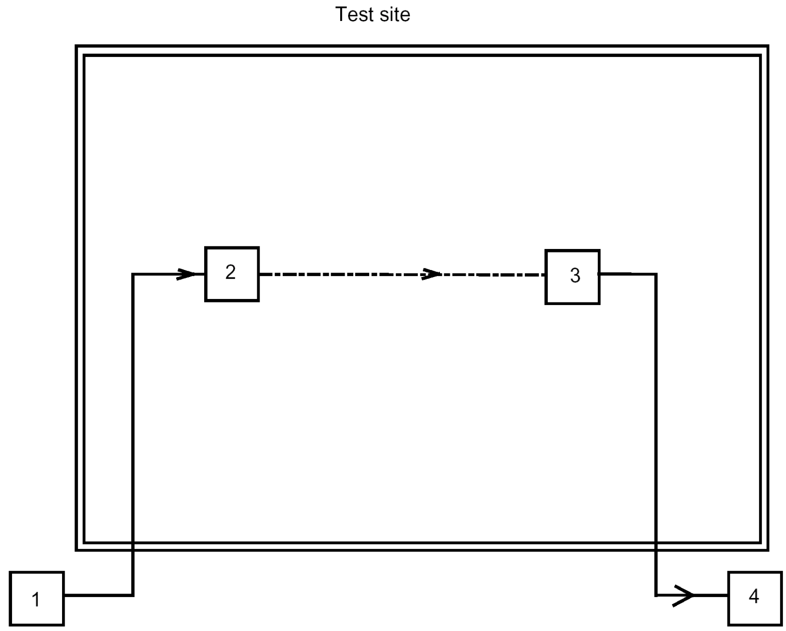
c) The transmitter shall be rotated through 360° around a vertical axis until a higher or the "highest" maximum signal is received.

d) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This level shall be recorded. (This maximum may be a lower value than the value obtainable at heights outside the specified limits). The test antenna may not need to be raised or lowered if the measurement is carried out on a test site according to subclause A.1.2.

e) Using measurement arrangement of figure 3, the substitution antenna shall replace the transmitter antenna in the same position and in vertical polarization. The frequency of the signal generator shall be adjusted to the transmitter carrier frequency. The test antenna shall be raised or lowered as necessary to ensure that the maximum signal is still received.

The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver.

The value of the maximum effective radiated power of the equipment under test is equal to the power supplied by the signal generator increased by the known relationship if necessary and after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna.



1) Signal generator. 2) Substitution antenna. 3) Test antenna. 4) Spectrum analyzer or selective voltmeter.

Figure 3: Measurement arrangement

f) Steps b) to e) above shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

g) The maximum effective radiated power of the equipment under test shall be expressed as the higher of the two values found in step e).

4.1.2.3.2. Average effective radiated power under normal test conditions

a) The procedures in steps b) to e) described in subclause 5.1.2.3.1 shall be repeated, except that in step c) the transmitter shall be rotated through 8 positions, 45° apart, starting at the position corresponding to maximum effective radiated power. (subclause 5.1.2.3.1. step g).

b) The average effective radiated power corresponding to the eight measured values is given by:

$$Average\ radiated\ power = \frac{\sum_{1}^{8} P_i}{8}$$

where P_i is the power corresponding to each position.

4.1.2.3.3. Method of measurements of maximum and average effective radiated power under extreme test conditions.

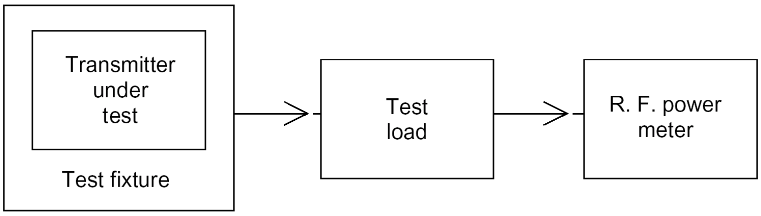


Figure 4: Measurement arrangement

a) The measurement shall also be performed under extreme test conditions. Due to the impossibility of repeating the above measurement on a test site under extreme temperature conditions, only a relative measurement is performed, using the test fixture.

b) The power delivered to the test load is measured under normal and extreme test conditions, and the difference in dB is recorded. This difference is algebraically added to the average effective radiated power under normal test conditions, in order to obtain the average effective radiated power under extreme test conditions.

c) A similar calculation will provide the maximum effective radiated power.

d) Additional uncertainties can occur under extreme test conditions due to the calibration of the test fixture.

4.1.3. Adjacent channel power

4.1.3.1. ***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 centered 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.

4.1.3.2. ***Limit***

For channel separation of 25 kHz, the adjacent channel power shall not exceed a value of 70.0 dB below the carrier power of the transmitter without the need to be below 0.20 µW.

For channel separation of 12.5 kHz, the adjacent channel power shall not exceed a value of 60.0 dB below the transmitter carrier power without the need to be below 0.20 mW.

In the case where the equipment is not capable of producing an unmodulated carrier, these measurements shall also be performed under extreme test conditions. Under extreme test conditions, the measured adjacent channel power shall not exceed:

- 65 dB below the carrier for equipment with channel separations of 25 kHz; and
- 55 dB for channel separations of 12.5 kHz;

4.1.3.3. ***Method of measurement***

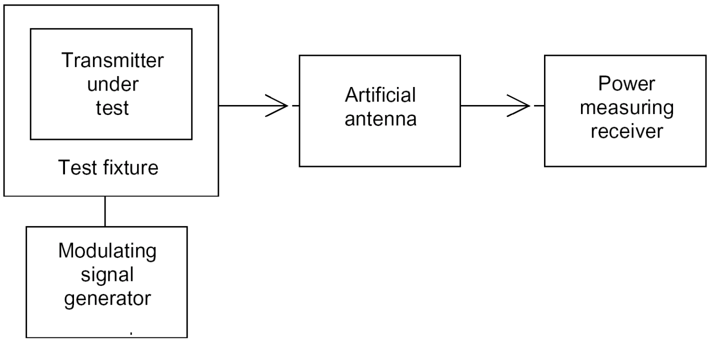


Figure 5: Measurement arrangement

a) The transmitter under test shall be placed in the test fixture (clause A.6) connected via the artificial antenna (subclause 4.3.2) to a power measuring receiver calibrated to measure *rms* power level. The level at the receiver input shall be within its allowed limit. The transmitter shall be operated at the maximum carrier power level available.

b) With the transmitter unmodulated, the tuning of the power measuring receiver shall 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 shall be recorded.

c) The tuning of the power measuring receiver shall 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 5.2.

Table 5.2: Frequency displacement

Channel separation (kHz)	Displacement (kHz)
12.5	8.25
25	17

d) The transmitter shall be modulated by the test signal D-M2 or D-M4 (subclause 4.3.1).

e) The power measuring receiver variable attenuator shall be adjusted to obtain the same meter reading as in step b). This value shall be recorded.

f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in step b) and e). 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) shall be repeated with the power measuring receiver tuned to the other side of the carrier.

h) For the purpose of equipment which is not capable of producing an unmodulated carrier, the measurement shall be repeated under extreme test conditions. (subclauses 4.2.4.1 and 4.2.4.2 applied simultaneously).

4.1.4. Radiated spurious emissions

4.1.4.1. ***Definition***

Spurious emissions are emissions at frequencies, other than those of the carrier and sidebands associated with normal modulation, radiated by the antenna and by the cabinet of the transmitter.

They are specified as the radiated power of any discrete signal.

4.1.4.2. ***Limit***

The power of any radiated spurious emission shall not exceed the values given in table 5.3.

Table 5.3: Radiated spurious emissions

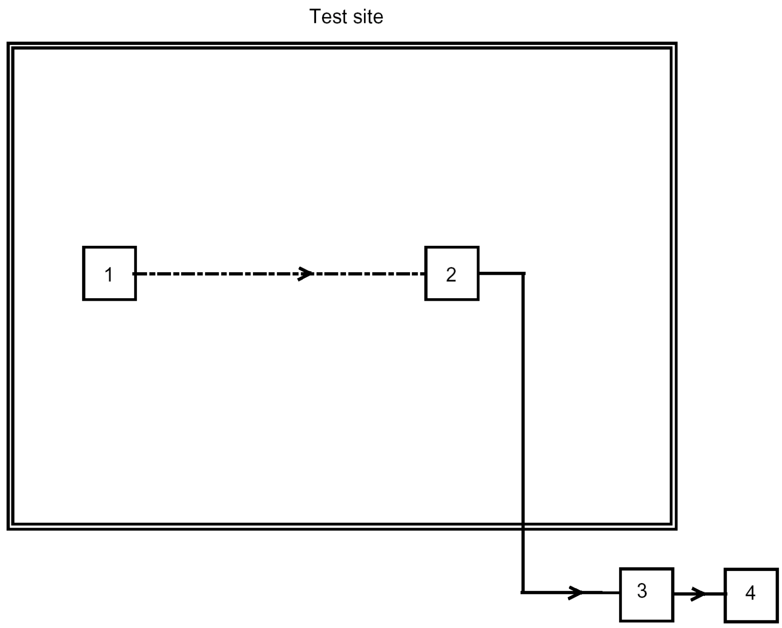
Frequency range	Tx operating	Tx standby
30 MHz to 1 GHz	0.25 µW (-36.0 dBm)	2.0 nW (-57.0 dBm)
Above 1 to 12.75 GHz	1.00 µW (-30.0 dBm)	20.0 nW (-47.0 dBm)

4.1.4.3. ***Method of measurement***

a) A test site which fulfils the requirements of the specified frequency range of this measurement shall be used. The test antenna shall be orientated initially for vertical polarization and connected to a spectrum analyzer or a selective voltmeter, through a suitable filter to avoid overloading of the spectrum analyzer or selective voltmeter. The bandwidth of the spectrum analyzer or selective voltmeter shall be between 10 kHz and 100 kHz, set to a suitable value to correctly perform the measurement.

   For the measurement of spurious emissions below the second harmonic of the carrier frequency the filter used shall be a high "Q" (notch) filter centered 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 shall be a high pass filter with a stop band rejection exceeding 40 dB. The cut-off frequency of the high pass filter shall be approximately 1.5 times the transmitter carrier frequency.



1) Transmitter under test. 2) Test antenna. 3) High 'Q' (notch) or high pass filter. 4) Spectrum analyzer or selective voltmeter.

Figure 6: Measurement arrangement

The transmitter under test shall be placed on the support in its standard position and shall be switched on without modulation.

If an unmodulated carrier cannot be obtained then the measurements shall be made with the transmitter modulated by the test signal D-M2 or D-M4.

b) The radiation of any spurious emission shall be detected by the test antenna and spectrum analyzer or selective voltmeter over the frequency range 30 MHz to 4 GHz, except for the channel on which the transmitter is intended to operate and its adjacent channels. In addition, for equipment operating on frequencies above 470 MHz, measurements shall be repeated over the frequency range 4 GHz to 12.75 GHz. The frequency of each spurious emission detected shall be recorded. If the test site is disturbed by interference coming from outside, this qualitative search may be performed in a screened room, with a reduced distance between the transmitter and the test antenna.

c) At each frequency at which an emission has been detected, the spectrum analyzer shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyzer.

d) The transmitter shall be rotated through 360° around a vertical axis, until a higher maximum signal is received.

e) The test antenna shall be raised or lowered again through the specified height range until a maximum is obtained. This signal level shall be recorded.

f) Using the measurement arrangement of figure 7, the substitution antenna shall replace the transmitter antenna in the same position and in vertical polarization. It shall be connected to the signal generator.

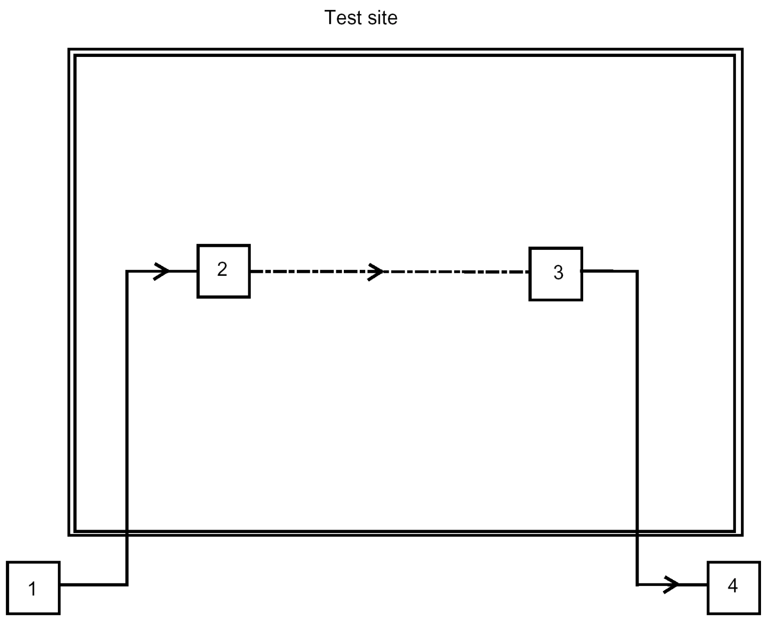
g) At each frequency at which an emission has been detected, the signal generator, substitution antenna and spectrum analyzer or selective voltmeter shall be tuned to the emission frequency. The test antenna shall be raised or lowered through the height range until the maximum signal level is detected on the spectrum analyzer or selective voltmeter.

   The level of the signal generator giving the same signal level on the spectrum analyzer or selective voltmeter as in item e) above shall be recorded. This value, after corrections due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna, is the radiated spurious emission at this frequency.

   The resolution bandwidth of the measuring instrument shall be the smallest bandwidth available which is greater than the spectral width of the spurious component being measured.

h) Steps c) to g) above shall be repeated with the test antenna orientated for horizontal polarization.

i) Steps c) to h) above shall be repeated with the transmitter in stand-by condition (if any).



1) Signal generator. 2) Substitution antenna. 3) Test antenna. 4) Spectrum analyzer

Figure 7: Measurement arrangement

4.1.5. Transmitter attack time

*4.1.5.1. **Definition***

The transmitter attack time (t_a) is the time which elapses between the initiation of the "transmitter on" function (T_{xon}) and:

a) the moment when the transmitter output power has reached a level 1 dB below or 1.5 dB above the steady state power (P_c) and maintains a level within +1.5 dB/-1 dB from P_c thereafter as seen on the measuring equipment or in the power plot as a function of time; or

b) the moment after which the frequency of the carrier always remains within ±1 kHz of its steady state frequency (F_c) as seen on the measuring equipment or the frequency plot as a function of time;

The measured value of t_a is t_{am}; its limit is t_{al}.

*4.1.5.2. **Limit***

The time t_{am} (measured transmitter attack time) shall not exceed t_{al} (the attack time limit) of 25 ms.

*4.1.5.3. **Method of measurement***

The measurement arrangement is shown in figure 8

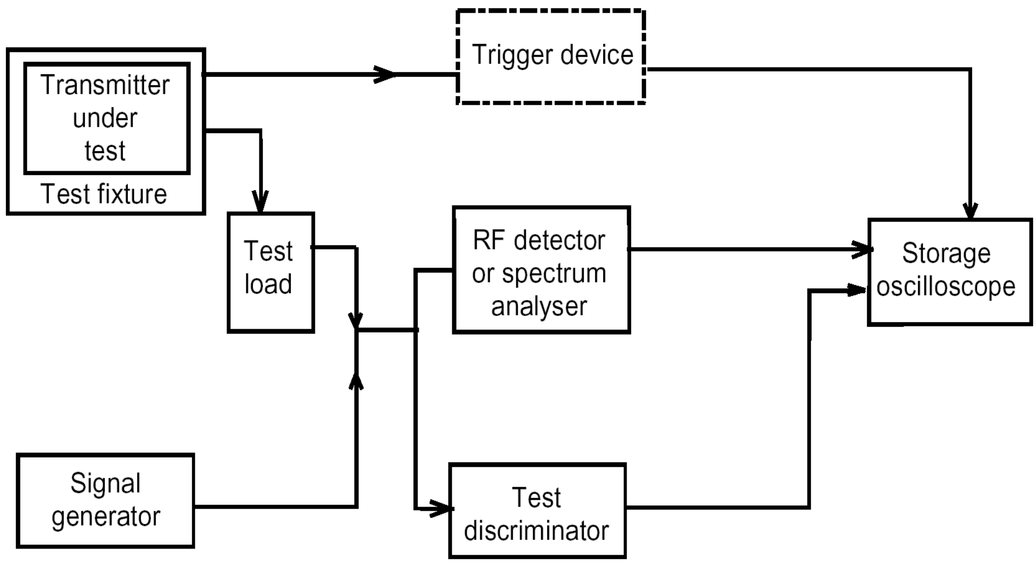


Figure 8: Test arrangement for transient behaviour of transmitter power and frequency, including transmitter attack and release time

a) The transmitter under test shall be placed in the test fixture connected to a RF detector and to a test discriminator via a matched test load. The attenuation of the test load shall 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 "transmitter on" function is initiated.

b) The traces of the oscilloscope shall be calibrated in power and frequency (y-axis) and in time (x-axis), using the signal generator;

c) The transmitter attack time shall be measured by direct reading on the oscilloscope while the transmitter is unmodulated.

4.1.6. Transmitter release time

4.1.6.1. ***Definition***

The transmitter release time (t_r) is the time which elapses between the initiation of the "transmitter off" function (T_{xoff}) and the moment when the transmitter output power has reduced to a level 50 dB below the steady state power (P_c) and remains below this level thereafter as seen on the measuring equipment or in the power plot as a function of time. (figure 11).

The measured value of t_r is t_{rm}; its limit is t_{rl}.

4.1.6.2. ***Limit***

The time t_{rm} (measured transmitter release time) shall not exceed t_{rl} (the release time limit) of 20 ms. ($t_{rm} \leq t_{rl}$)

4.1.6.3. ***Method of measurement.***

The measurement arrangement is shown in figure 8.

a) The transmitter under test shall be placed in the test fixture connected to a RF detector and to a test discriminator via a matched test load. The attenuation of the test load shall 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 long 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 "transmitter off" function is initiated.

b) the traces of the oscilloscope shall be calibrated in power and frequency (y-axis) and in time (x-axis) by replacing the transmitter and test load by the signal generator;

c) the transmitter release time shall be measured by direct reading on the oscilloscope while the transmitter is unmodulated.

4.1.7. Transient behaviour of the transmitter

4.1.7.1. ***Definitions***

The transient behaviour of the transmitter is defined as the time-dependency of transmitter frequency, power and adjacent channel transmitter power when the RF output power is switched on and off.

The following powers, frequencies, frequency tolerances and transient times are specified:

P_o : rated power;

P_c : steady state power;

P_a : adjacent channel transient power. This is the transient power falling into the adjacent channels due to switching the transmitter on and off .

F_o : nominal carrier frequency;

F_c : steady state carrier frequency;

d_f : frequency difference (relative to F_c) or frequency error (absolute) (subclause 5.1.1.1) of the transmitter;

d_{fe} : limit of the frequency error (d_f) in the steady state (subclause 5.1.1);

d_{fo} : limit of the frequency difference (d_f) equal to 1 kHz; if it is impossible to switch off the transmitter modulation one half channel separation is added;

d_{fc} : limit of the frequency difference (d_f) during the transient, equal to one half channel separation; while the frequency difference is less than d_{fc}, the carrier frequency remains within the boundaries of the allocated channel; if it is impossible to switch off the transmitter modulation another half channel separation is added;

T_{xon} : time at which the final irrevocable logic decision to power on the transmitter is taken.

t_{on} : time when the carrier power, exceeds P_c - 30 dB;

t_p : period of time starting at t_{on} and finishing when the power reaches P_c - 6 dB;

t_{am} : transmitter attack time as defined in subclause 5.1.5.1;

t_{al} limit of t_{am} as given in subclause 5.1.5.2;

T_{xoff} : time at which the final irrevocable logic decision to power off the transmitter is taken.

T_{off} : time when the carrier power falls below P_c - 30 dB;

t_d : period of time starting when the power falls below P_c - 6 dB and finishing at t_{off};

t_{rm} : transmitter release time as defined in subclause 5.1.6.1, after which the power remains below P_c - 50 dB;

t_{rl} : limit of t_{rm} as given in subclause 5.1.6.2.

If use is made of a synthesizer and/or a PLL system, for determining the transmitter frequency, then the transmitter shall be inhibited when synchronization is absent or in the case of PLL, when the loop system is not locked.

Timings, frequencies and powers

Figures 9, 10, 11 represent the timings, frequencies and powers as defined in subclauses 5.1.5.1, 5.1.6.1 and 5.1.7.1. The corresponding limits are given in subclauses 5.1.5, 5.1.6 and 5.1.7.

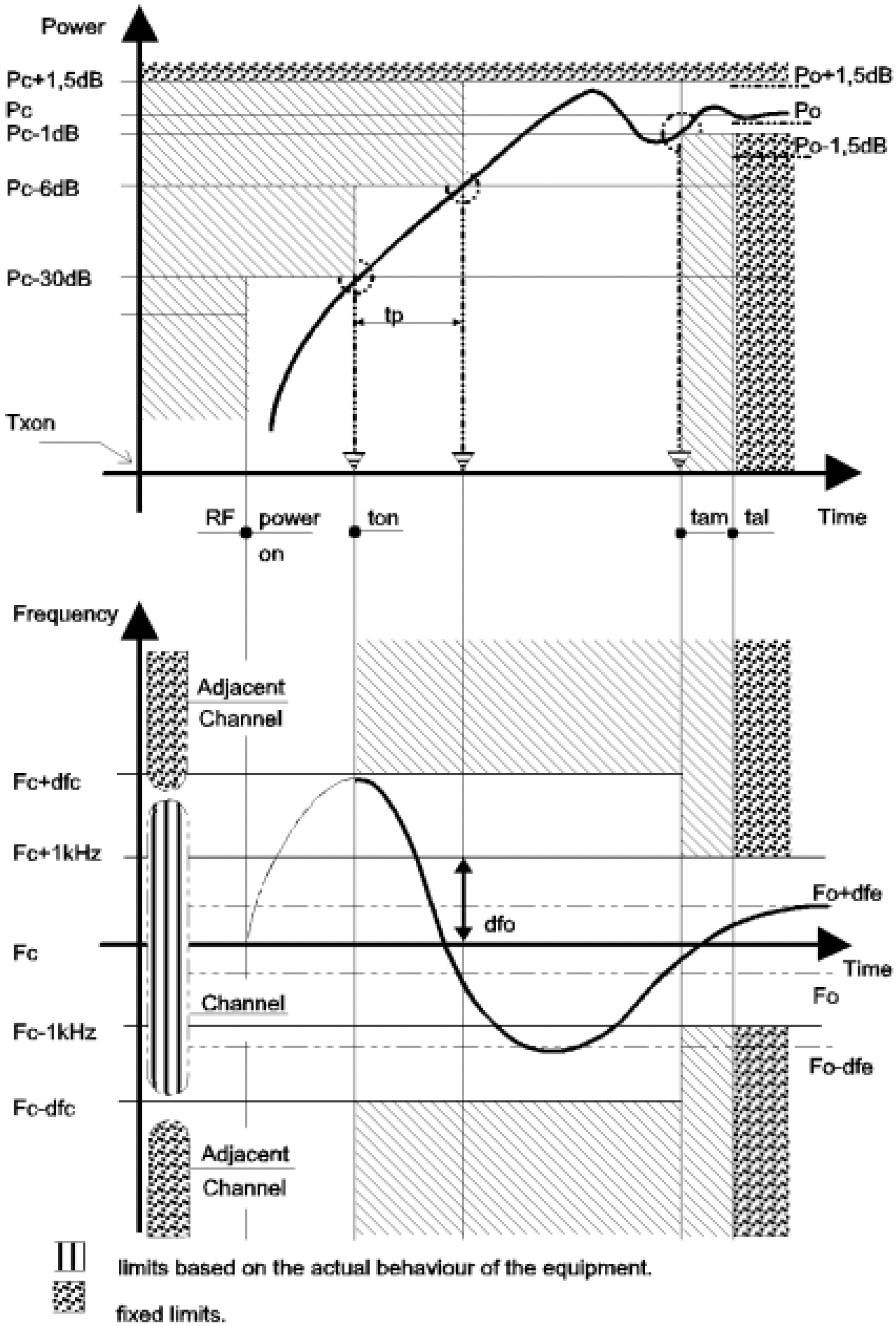


Figure 9: Transmitter attack time and transient behaviour during switch-on (Case where the attack time is given by the behaviour of the power rise)

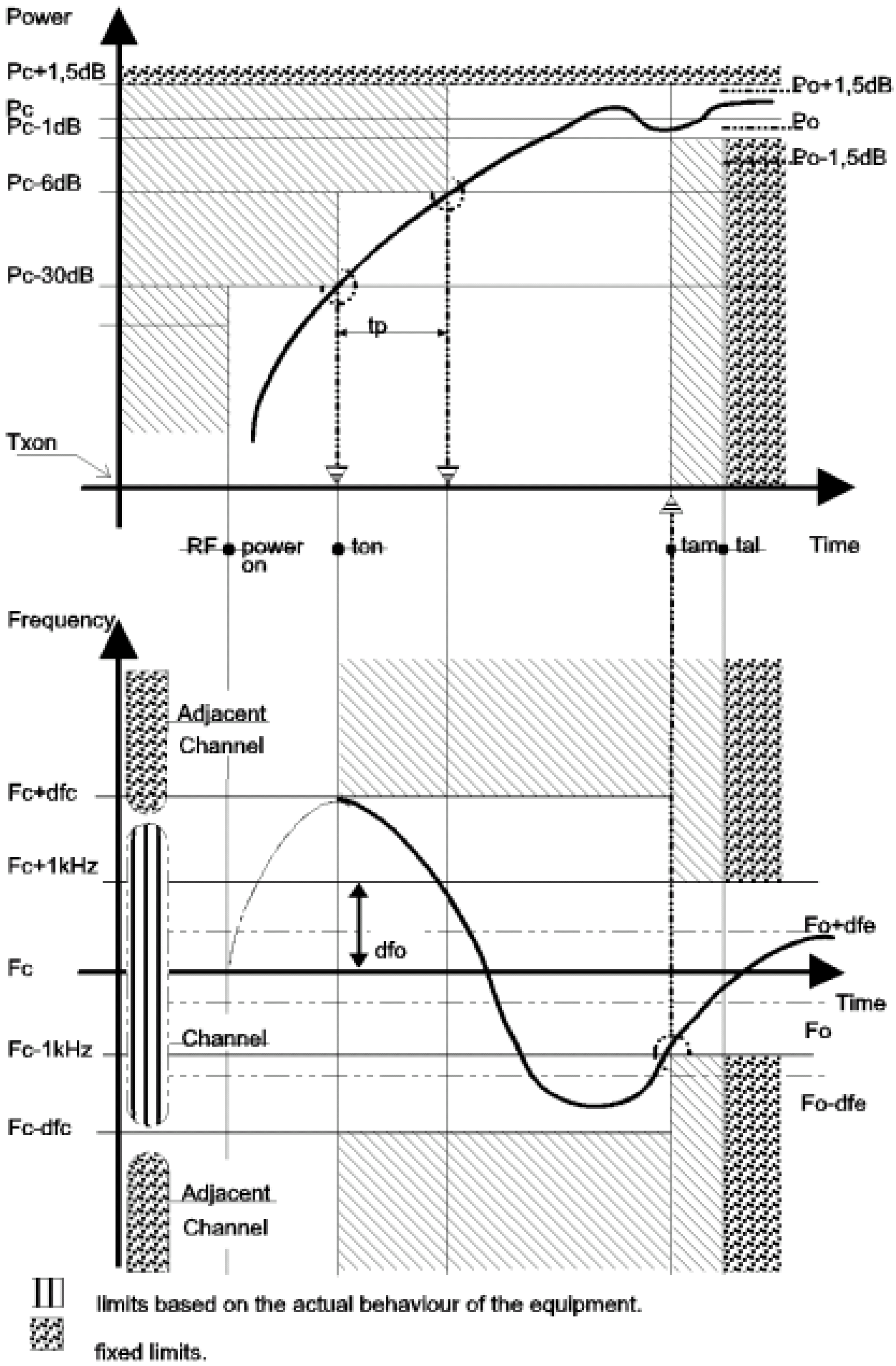


Figure 10: Transmitter attack time and transient behaviour during switch-on (Case where the attack time is given by the behaviour of the frequency)

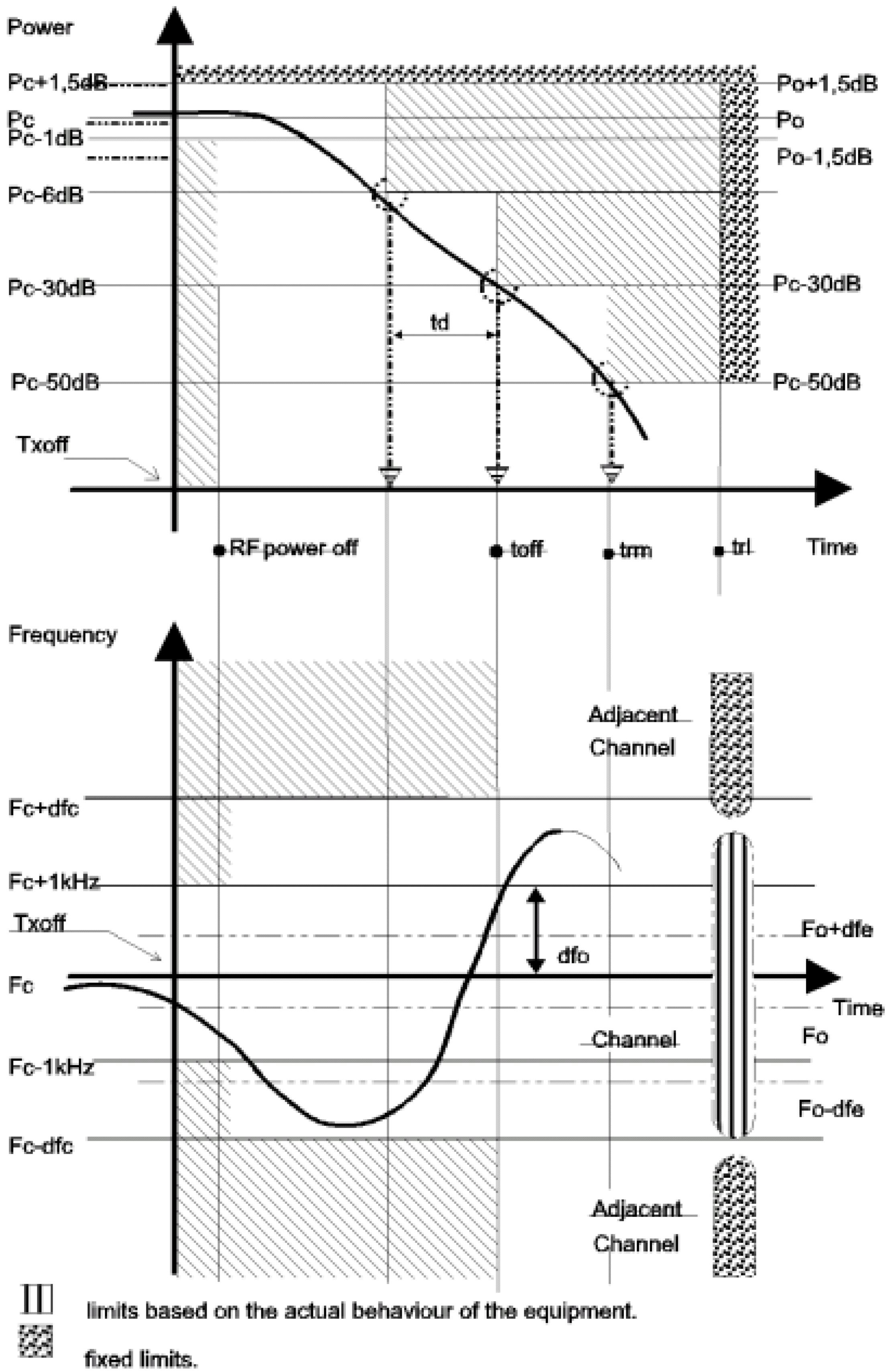


Figure 11: Transmitter release time and transient behaviour, during switch-off

4.1.7.2. ***Limit***

4.1.7.2.1. Time domain analysis of power and frequency

The plots of carrier power and carrier frequency as a function of time, covering in an appropriate way the transients, shall be included in the test report.

At any time when the carrier power is above the steady-state power (P_c) -30 dB, the carrier frequency shall remain within half a channel separation (d_{fc}) from the steady carrier frequency (F_c).

The slopes of the plots corresponding to both attack and release times, shall be such that:

- $t_p \geq 0{,}20$ ms and $t_d \geq 0{,}20$ ms, for attack and release time (subclause 5.1.7.1);
- between the P_c -30 dB point and the P_c -6 dB point, both in the case of attack and release time, the sign of the slope shall not change.

4.1.7.2.2. Adjacent channel transient power

The transient power, in the adjacent channels shall not exceed a value of:

- 60.0 dB below the carrier power of the transmitter (dBc) without the need to be below 2 µW (-27.0 dBm) for channel separations of 20 and 25 kHz;
- 50.0 dBc without the need to be below 2 µW (-27 dBm), for a channel separation of 12.5 kHz.

4.1.7.3. ***Methods of measurement***

The transmitter shall be placed in the test fixture. (clause A6).

The transient timings (switch on/switch off) and the frequency differences occurring during these periods of time can be measured by means of a spectrum analyzer and a test discriminator which meets the requirements indicated in subclause 5.1.7.3.2.

4.1.7.3.1. Time and frequency domain analysis measurements

- The measurement shall be performed with the transmitter unmodulated.
- The transmitter under test shall be placed in the test fixture and connected to the test set-up as shown in figure 12.
- The calibration of the test set-up shall be checked. The output of the test fixture shall be connected to the input of the spectrum analyzer and test discriminator via a power splitter and attenuator(s).
- The attenuation of the power attenuators shall be chosen in such a way that the input of the test equipment is protected against overload and that the limiter amplifier of the test discriminator operates correctly in the limiting range when the power conditions of subclause 5.1.7.1 are reached.

- The spectrum analyzer is set to measure and display power as a function of time ("zero span mode").
- The test discriminator shall be calibrated. This may be carried out by feeding RF voltages from a signal generator with defined frequency differences from the nominal frequency of the transmitter.
- By appropriate means, a triggering pulse is generated for the test equipment when the T_{xon} function or the T_{xoff} function are activated.
- The "RF power on" and the "RF power off" can be monitored.
- The voltage occurring at the test discriminator output shall be recorded as a function of time in correspondence with the power level on a storage device or a transient recorder. This voltage is a measure of the frequency difference. The elapsed periods of time during the frequency transient can be measured using the time base of the storage device. The output of the test discriminator is valid only after t_{on} and before t_{off}.

4.1.7.3.2. Test arrangement and characteristics of the test discriminator

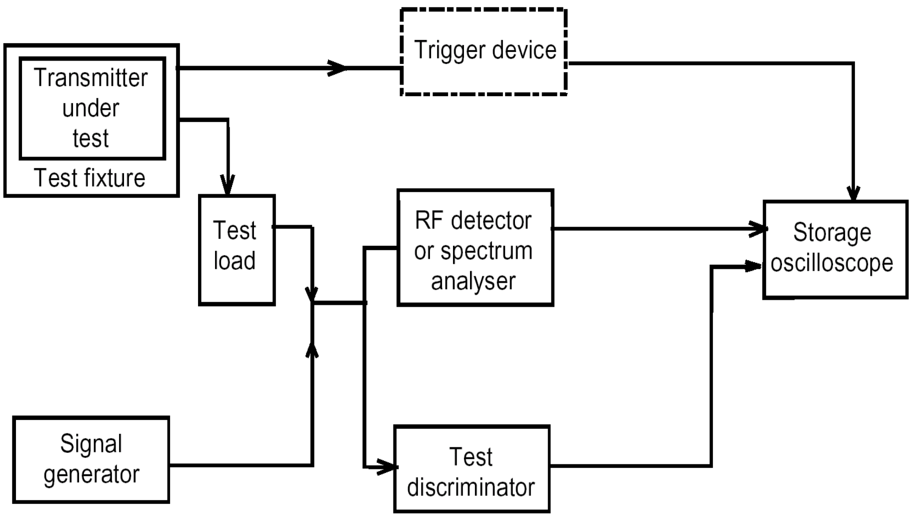


Figure 12: Test arrangement for transient behaviour of transmitter power and frequency, including transmitter attack and release time

The test discriminator may consist of a mixer and a local oscillator (providing the auxiliary frequency) used to convert the transmitter frequency to be measured into the frequency fed to the (broadband) limiter amplifier and the associated broadband discriminator:

- the test discriminator shall be sensitive enough to measure input signals down to Pc - 30 dB;

- the test discriminator shall be fast enough to display the frequency deviations (approximately 100 kHz/100 µs);
- the test discriminator output shall be DC coupled.

4.1.7.3.3. Adjacent channel transient power measurements

The transmitter under test shall be placed in the test fixture (clause A6) and connected via the power attenuator to the "adjacent channel transient power measuring device" as described in subclause 5.1.7.3.4., so that the level at its input shall be between 0 dBm and -10 dBm when the transmitter power is P_c.

a) The transmitter shall preferably be unmodulated and operated at the maximum power level available under normal test conditions.

b) The tuning of the "transient power measuring device" shall be adjusted so that a maximum response is obtained. This is the 0 dBc reference level.

c) The tuning of the "transient power measuring device" shall 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 carrier frequency as given in table 5.4.

Table 5.4: Frequency displacement

Channel separation (kHz)	Displacement (kHz)
12.5	8.25
25	17

d) The transmitter shall be switched on.

e) The spectrum analyzer shall be used to record the first 35 ms of the envelope of the transient power as a function of time. The peak envelope transient power shall be recorded in dBc.

f) The transmitter shall be switched off.

g) The spectrum analyzer shall be used to record the first 35 ms of the envelope of the transient power as a function of time. The peak envelope transient power shall be recorded in dBc.

h) Steps c) to g) shall be repeated with the "transient power measuring device" tuned to the other side of the carrier.

i) The transient power in the adjacent channel during the attack and release times is the dBc value corresponding to the highest of the four powers recorded for the adjacent channels in steps e) and g).

4.1.7.3.4. Characteristics of the adjacent channel transient power measuring device

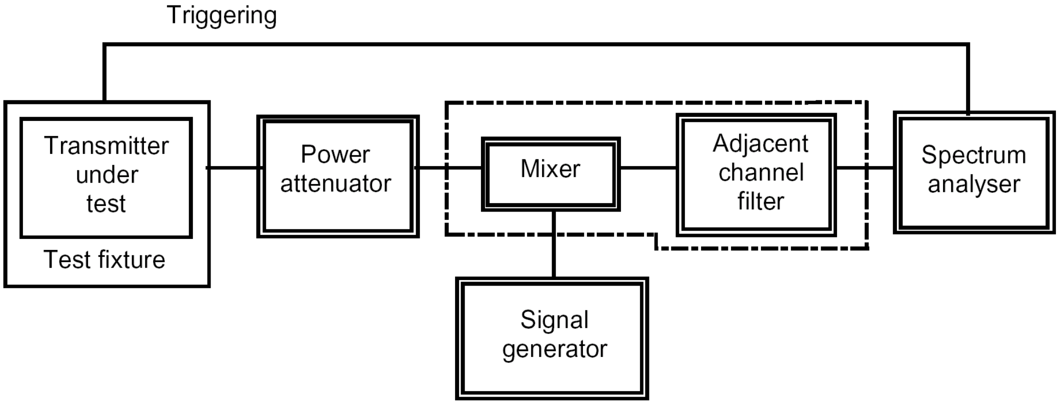


Figure 13: Adjacent channel transient power measuring device measurement arrangement

The adjacent channel transient power measuring device shall be as follows:

- mixer: 50 Ω balanced diode mixer; with an appropriate local oscillator level, for example +7 dBm;
- adjacent channel filter: matched to 50 Ω (annex B);
- spectrum analyzer: 100 kHz bandwidth, peak detection, or power/time measurement provision.

4.2. Receiver requirement

4.2.1. Average usable sensitivity (field strength, data or messages)

*4.2.1.1. **Definition***

The average usable sensitivity (data) expressed as field strength is the average field strength, expressed in dBμV/m, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal (subclause 4.3.1) which will, without interference, produce after demodulation a data signal with a specified bit error ratio or a specified successful message ratio. The specified bit error ratio is 10^{-2}. The specified successful message ratio is 80 %. The average is calculated from 8 measurements of field strength where the receiver is rotated in 45° increments starting at an arbitrary orientation.

NOTE: The average usable sensitivity mostly differs only by a small amount from the maximum usable sensitivity to be found in a particular direction. This is due to the properties of the averaging process as used in the formula in subclauses 5.2.1.3. For instance, an error not exceeding 1.2 dB can be found if the sensitivity is equal in seven directions and is extremely poor in the eighth direction. For the same reason the starting direction (or angle) can be selected randomly.

*4.2.1.2. **Limit***

For the average usable sensitivity limits, four categories of equipment are defined as follows:

category A: equipment having an integral antenna fully within the case;

category B: equipment having an extractable or fixed integral antenna, with an antenna length not exceeding 20 cm external to the case;

category C: equipment having an extractable or fixed integral antenna, with an antenna length exceeding 20 cm external to the case;

category D: equipment not covered by category A, B or C.

Under normal test conditions for categories A, B and D, the average usable sensitivity shall not exceed the field strength values shown in tables 5.5(a) and 5.5(b).

Table 5.5(a): Sensitivity limits for categories A and D

Frequency band (MHz)	Average usable sensitivity in dB relative to 1µV/m
30 to 400	27.0
> 400 to 750	28.5
> 750 to 1000	30.0

Table 5.5(b): Sensitivity limits for category B

Frequency band (MHz)	Average usable sensitivity in dB relative to 1µV/m
30 to 130	18.0
> 130 to 300	19.5
> 300 to 440	21.5
> 440 to 600	23.5
> 600 to 800	25.5
> 800 to 1000	28.0

For category C the following limits shall apply under normal conditions:

- at frequencies greater than 375 MHz the limits shall be as specified in table 5.5(b);
- at frequencies less than or equal to 375 MHz, a correction factor K shall be subtracted from the specified field strengths in table 5.5(b). K shall be calculated as:

$$K = 20 \log_{10} \frac{l + 20}{40}$$

where l is the length of the external part of the antenna in cm.

This correction only applies if the antenna length in cm external to the case is less than ($15000/f_0$ - 20) in cm, where f_0 is the frequency in MHz.

For all categories of equipment, add 6 dB to the limit under normal test conditions to obtain the limit under extreme test conditions.

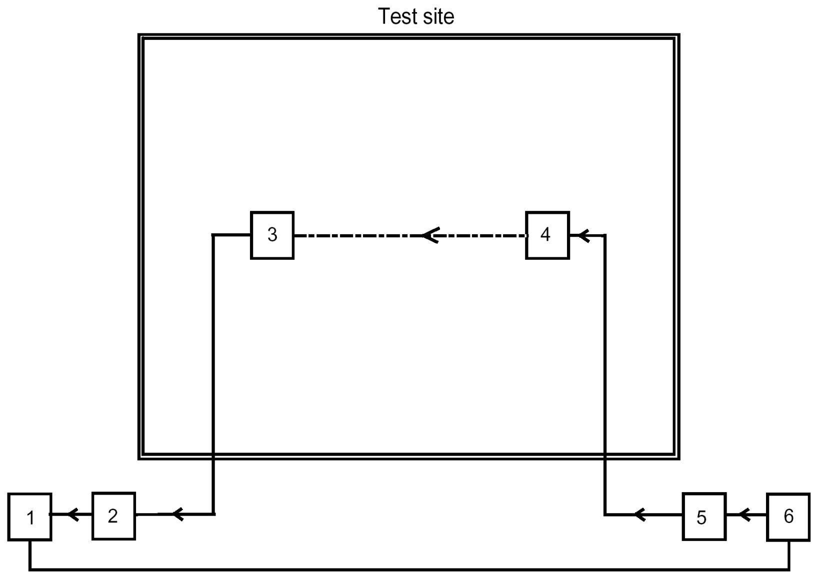
4.2.1.3. ***Method of measurement***

4.2.1.3.1. Method of measurement with continuous bit streams under normal test conditions

a) a signal generator shall be connected to the test antenna; The signal generator shall be at the nominal frequency of the receiver and shall have the normal test signal D-M2 (subclause 4.3.1).

b) the bit pattern of the modulating signal shall be compared to the bit pattern provided by the receiver after demodulation, in order to obtain the bit error ratio;

c) the level of the signal generator shall be adjusted until a bit error ratio of approximately 10^{-1} is obtained;



1) Bit error measuring test set. 2) Photo detector/acoustic coupler. 3) Receiver under test. 4) Test antenna. 5)Signal generator. 6) Bit stream generator.

Figure 14: Measurement arrangement

d) the test antenna shall be raised or lowered through the specified height range to find the lowest bit error ratio;

   The test antenna may not need to be raised or lowered if a test site according to subclause A.1.2 is used, or if the ground floor reflection can effectively be eliminated.

e) the level of the signal generator shall be re-adjusted until a bit error ratio of 10^{-2} is obtained;

f) the minimum signal generator level from step d) shall be recorded;

g) steps c) to f) shall be repeated for the remaining seven positions of the receiver 45° apart;

h) using the relationship described in subclause A.1.2, the eight field strengths X_i (i=1,..., 8) in µV/m corresponding to the levels of the signal generator recorded above shall be calculated and recorded;

i) the average usable sensitivity expressed as field strength E_{mean} (dBμV/m) is given by:

$$E_{mean} = 20 \log \sqrt{\frac{8}{\sum_{i=1}^{i=8} \frac{1}{X_i^2}}}$$

where X_i represents each of the eight field strengths calculated in step h);

j) the reference direction is defined as the direction at which the maximum sensitivity (i.e. corresponding to the minimum field strength recorded during the measurement) occurred during the eight position measurement.

The corresponding direction, height (where applicable) and this reference field strength value shall be recorded.

4.2.1.3.2. Method of measurement with continuous bits streams under extreme test conditions

Using the test fixture in the measurement arrangement of figure 14(b), the measurement of the average usable sensitivity with continuous bit streams shall also be performed under extreme test conditions.

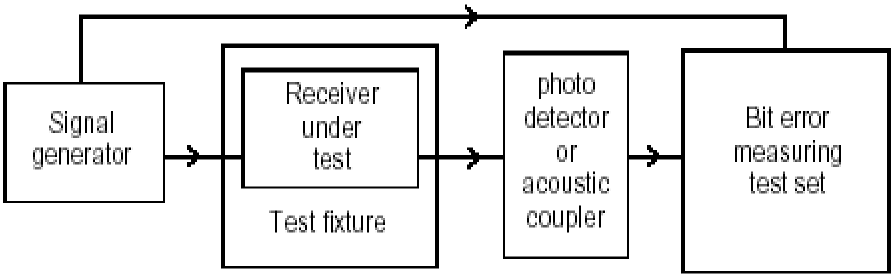
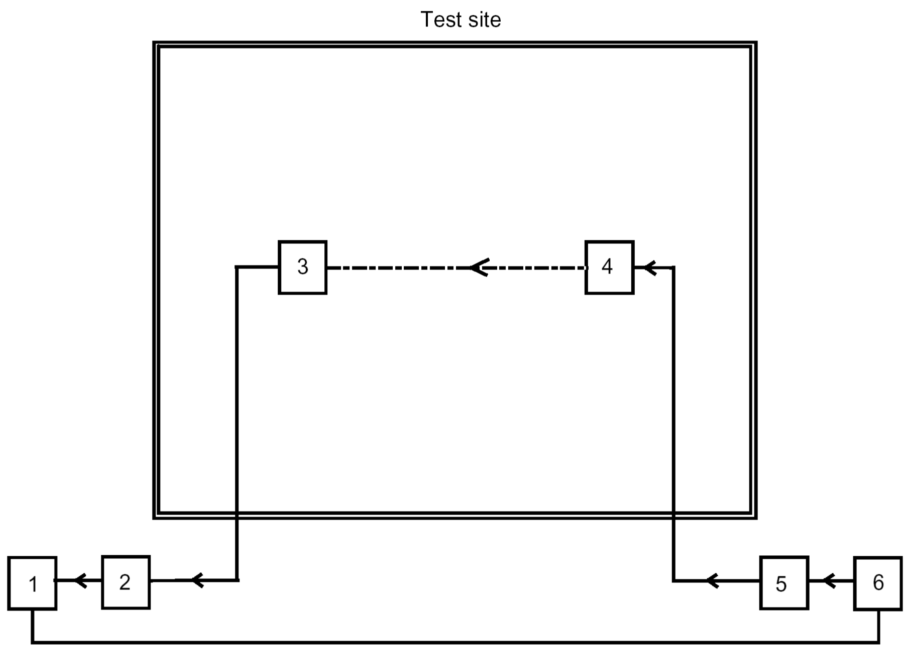


Figure 14(b): Measurement arrangement

The test signal input level providing a bit error ratio of 10^{-2} shall be determined under extreme and under normal test conditions and the difference in dB shall be calculated. This difference shall be added to the average usable sensitivity to radiated fields expressed in dBμV/m, as calculated in subclause 5.2.1.3.1 step i), under normal test conditions, to obtain the sensitivity under extreme test conditions.

4.2.1.3.3. Method of measurement with messages under normal test conditions



1) Message measuring test set. 2) Photo detector/acoustic coupler. 3) Receiver under test. 4) Test antenna. 5) Signal generator. 6) Message generator.

Figure 15(a): Measurement arrangement

a) a signal generator shall be connected to the test antenna; The signal generator shall be at the nominal frequency of the receiver and shall have the normal test modulation (subclause 4.3.1).

b) the level of the signal generator shall be adjusted until a successful message ratio of less than 10 % is obtained;

c) the test antenna shall be raised or lowered through the specified height range to find the maximum successful message ratio; The test antenna may not need to be raised or lowered if a test site is used, or if the ground floor reflection can effectively be eliminated. The level of the test signal shall be re-adjusted to produce the successful message ratio specified in step b).

d) the minimum signal generator level from step c) shall be recorded;

e) the normal test signal shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received;

The level of the test signal shall be increased by 2 dB for each occasion that a message is not successfully received.

The procedure shall be continued until three consecutive messages are successfully received.

This level as the minimum signal generator level in this direction shall be recorded.

f) the level recorded in step e) shall be reduced by 1 dB and the new value shall also be recorded;

The normal test signal shall then be transmitted 20 times. In each case, if a message is not successfully received, the level shall be increased by 1 dB and the new value recorded.

If a message is successfully received, the level shall not be changed until three consecutive messages have been successfully received.

In this case, the level shall be reduced by 1 dB and the new value recorded.

The average of the values recorded corresponds to the successful message ratio of 80%. It shall be used to calculate the field strength associated with each position in step h).

g) Steps b) to f) above shall be repeated for the remaining seven positions (45° apart) of the receiver;

h) Using the relationship described in subclause A.1.2, the eight field strengths X_i ($i = 1,..., 8$) in µV/m corresponding to the above average values shall be calculated and recorded;

i) The average usable sensitivity expressed as field strength E_{mean} (dBµV/m) is given by:

$$E_{mean} = 20\log_{10}\sqrt{\frac{8}{\sum_{i=1}^{i=8}\frac{1}{X_i^2}}}$$

where X_i represents each of the eight field strengths calculated in step h);

j) the reference direction is defined as the direction at which the maximum sensitivity (i.e. corresponding to the minimum field strength recorded during the measurement) occurred during the eight position measurement.

The corresponding direction, height (where applicable) and this reference field strength value shall be recorded.

4.2.1.3.4. Method of measurement with messages under extreme test conditions

Using the test fixture in the measurement arrangement of figure 15(b), the measurement of the average usable sensitivity with messages shall also be performed under extreme test conditions.

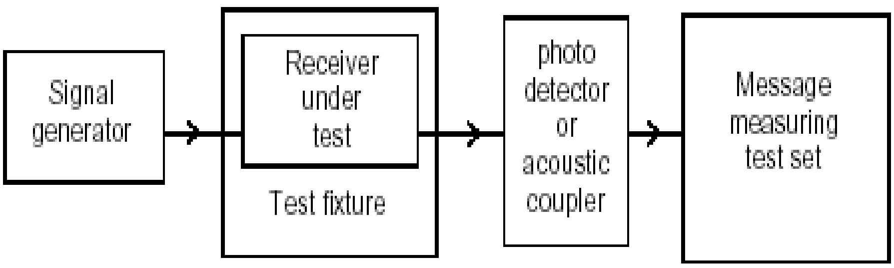


Figure 15(b): Measurement arrangement

The test signal input level providing a successful message ratio of 80 % shall be determined under extreme and under normal test conditions and the difference in dB shall be calculated. This difference shall be added to the average usable sensitivity to radiated fields expressed in dBμV/m, as calculated in subclause 5.2.1.3.3 step i), under normal test conditions, to obtain the sensitivity under extreme test conditions.

4.2.1.3.5. Reference for degradation measurements

4.2.1.3.5.1 Definition

Degradation measurements are those measurements which are made on the receiver to establish the degradation of the performance of the receiver due to the presence of (an) unwanted (interfering) signal(s). For such measurements, the level of the wanted signal shall be adjusted to a level which is 3 dB above the limit of the average usable sensitivity, according to the category of the equipment, and expressed as field strength.

Degradation measurements fall into two categories:

a) those carried out on a test site;

b) those carried out using a test fixture.

The test fixture is only used for those tests where the difference in frequency between the wanted and the unwanted test signals is very small in relation to the actual frequency, so that the coupling loss is the same for the wanted and unwanted test signals fed into the test fixture.

4.2.1.3.5.2 Procedures for measurements using the test fixture

The test fixture is coupled to the signal generators via a combining network to provide the wanted and unwanted test input signals to the receiver in the test fixture. It is necessary, therefore, to establish the output level of the wanted test signal from the signal generator that results in a signal at the receiver (in the test fixture) which corresponds with the average usable sensitivity (field strength) as specified in subclause 5.2.1.2.

This test output level from the signal generator for the wanted test signal is then used for all the receiver measurements using the test fixture.

The method for determining the test output level from the signal generator is as follows:

a) the actual average usable sensitivity of the receiver, measured in accordance with subclause 5.2.1.3 step i) and expressed as a field strength, shall be used;

b) the difference between the appropriate limit of the average usable sensitivity specified in subclause 5.2.1.2, and this actual average usable sensitivity (step a)), expressed in dB, is recorded;

c) the receiver is then mounted in the test fixture.

The signal generator providing the wanted input signal is coupled to the test fixture via a combining network. All other input ports of the combining network are terminated in 50 Ω loads.

For continuous bit streams, the output level from the signal generator with normal test signal D-M2 is adjusted so that a bit error ratio of 10^{-2} is obtained. This output level is then increased by an amount equal to the difference expressed in dB calculated in step b).

For messages, the output level from the signal generator with normal test modulation (is adjusted so that the successful message ratio of 80 % is obtained. This output level is then increased by an amount equal to the difference expressed in dB calculated in step b).

The output level of the signal generator is defined as being the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (subclause 5.2.1.2).

4.2.1.3.5.3 Procedures for measurements on a test site

When measurements are carried out on a test site, the wanted and unwanted signals shall be calibrated in terms of dBµV/m at the location of the equipment under test.

For measurements according to subclauses 5.2.4, 5.2.6 and clause A.2, the height of the test antenna and the direction (angle) of the equipment under test shall be that recorded in subclause 5.2.1.3.1 step j) or subclause 5.2.1.3.3 step j) (reference direction).

4.2.2. Co-channel rejection

*4.2.2.1. **Definition***

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

*4.2.2.2. **Limit***

The value of the co-channel rejection ratio, expressed in dB, at any frequency of the unwanted signal within the specified range, shall be between:

- 8.0 dB and 0 dB for channel separation of 25 kHz;
- 12.0 dB and 0 dB for a channel separation of 12.5 kHz.

*4.2.2.3. **Method of measurement***

4.2.2.3.1. Method of measurement with continuous bit streams

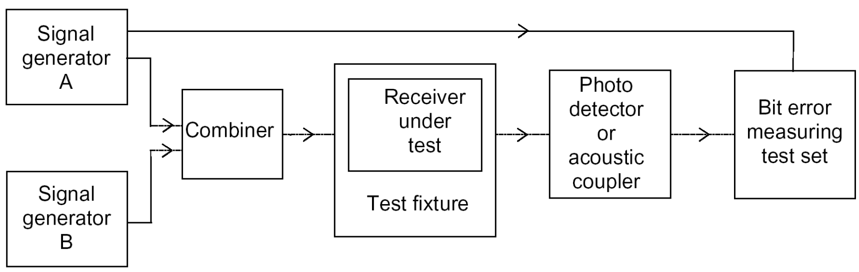


Figure 16: Measurement arrangement

a) The receiver shall be placed in the test fixture. Two signal generators A and B shall be connected to the test fixture via a combining network.

The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have the normal test signal D-M2. (subclause 4.3.1.1).

The unwanted signal, provided by signal generator B, shall be modulated with signal A-M3. (see subclause 4.3.1).

Both input signals shall be at the nominal frequency of the receiver under test.

b) Initially the unwanted signal shall be switched off (maintaining the output impedance). The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength.

c) The unwanted signal from generator B shall then be switched on, and its level shall be adjusted until a bit error ratio of approximately 10^{-1} is obtained.

d) The normal test signal D-M2 shall be transmitted whilst observing the bit error ratio.

e) The level of the unwanted signal shall 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 shall then be recorded.

f) For each frequency of the unwanted signal, the co-channel rejection ratio shall be expressed as the ratio, in dB, of the level of the unwanted signal to the level of the wanted signal. This ratio shall be recorded.

g) The measurement shall be repeated for displacements of the unwanted signal of ±12 % of the channel separation.

h) The co-channel rejection of the equipment under test shall be expressed as the lowest of the three values expressed in dB, calculated in step f).

The value of the co-channel rejection ratio, expressed in dB, is generally negative.

4.2.2.3.2. Method of measurement with messages

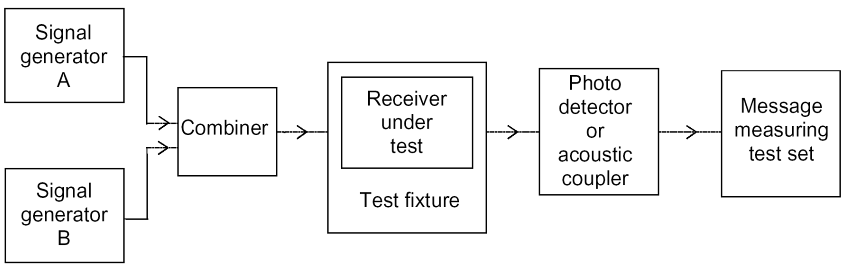


Figure 17: Measurement arrangement

a) The receiver shall be placed in the test fixture.

Two signal generators A and B shall be connected to the test fixture via a combining network;

The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have the normal test modulation D-M3. (subclause 4.3.1.2).

The unwanted signal, provided by signal generator B, shall be modulated with signal A-M3 (subclause 4.3.1).

Both input signals shall be at the nominal frequency of the receiver under test.

b) Initially, the unwanted signal shall be switched off. The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength.

c) The unwanted signal from signal generator B shall then be switched on and its level shall be adjusted until a successful message ratio of less than 10 % is obtained.

d) The normal test signal shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received.

   The level of the unwanted signal shall be reduced by 2 dB for each occasion that a message is not successfully received.

   The procedure shall be continued until three consecutive messages are successfully received. The level of the input signal shall then be recorded.

e) The level of the unwanted signal shall be increased by 1 dB and the new value recorded.

   The normal test signal shall then be transmitted 20 times. In each case, if a message is not successfully received the level of the unwanted signal shall be reduced by 1 dB and the new value recorded.

   The average of the values recorded in steps d) and e) (which provides the level corresponding to the successful message ratio of 80 %) shall be recorded.

f) For each frequency of the unwanted signal, the co-channel rejection ratio shall be expressed as the ratio, in dB, of the average level recorded in step e) to the level of the wanted signal. This ratio shall be recorded.

g) The measurement shall be repeated for displacements of the unwanted signal of ±12 % of the channel separation.

h) The co-channel rejection ratio of the equipment under test shall be expressed as the lowest of the three values expressed in dB, calculated in step f).

4.2.3. Adjacent channel selectivity

4.2.3.1. ***Definition***

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

4.2.3.2. ***Limit***

The adjacent channel selectivity of the equipment shall be such that under the specified test conditions, the given degradation shall not be exceeded for levels of the unwanted signal up to those given in table 5.6.

Table 5.6: Adjacent channel selectivity

Channel Separation (kHz)	Adjacent channel selectivity limit (dBμV/m)			
	Unwanted frequencies ≤ 68 MHz		Unwanted frequencies > 68 MHz	
	Normal test conditions	Extreme test conditions	Normal test conditions	Extreme test conditions
25	75	65	$38.3 + 20\log_{10}(f)$	$28.3 + 20\log_{10}(f)$
12.5	65	55	$28.3 + 20\log_{10}(f)$	$18.3 + 20\log_{10}(f)$
NOTE: f is value of the carrier frequency expressed in MHz				

4.2.3.3. ***Method of measurement***

4.2.3.3.1. Method of measurement with continuous bit streams

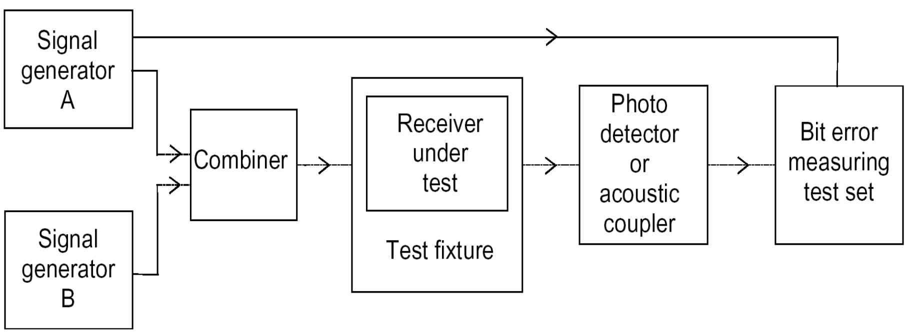


Figure 18: Measurement arrangement

a) The receiver shall be placed in the test fixture. Two signal generators A and B shall be connected to the test fixture via a combining network;

   The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have the normal test signal D-M2.

The unwanted signal, provided by signal generator B, shall be modulated with signal A-M3 and shall be at the frequency of the channel immediately above that of the wanted signal.

b) Initially the unwanted signal shall be switched off. The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength

c) The unwanted signal from generator B shall then be switched on; its level shall be adjusted until a bit error ratio of approximately 10^{-1} is obtained.

d) The normal test signal D-M2 shall be transmitted whilst observing the bit error ratio.

e) The level of the unwanted signal shall 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 shall then be recorded.

f) For each adjacent channel, the selectivity shall be expressed as the ratio in dB of the level of the unwanted signal to the level of the wanted signal. This ratio shall be recorded.

g) The measurement shall be repeated with the unwanted signal at the frequency of the channel below that of the wanted signal.

h) The adjacent channel selectivity of the equipment under test shall be expressed as the lower of the two values measured in the upper and lower adjacent channel (step f).

4.2.3.3.2. Method of measurement with messages

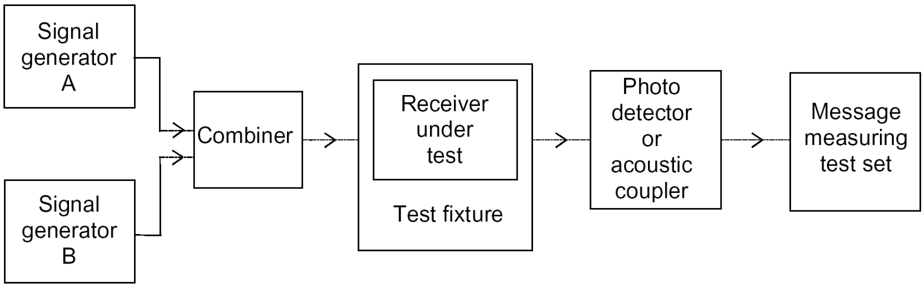


Figure 19: Measurement arrangement

a) The receiver shall be placed in the test fixture. Two signal generators, A and B, shall be connected to the test fixture via a combining network;

The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation.

The unwanted signal, provided by signal generator B, shall be modulated with signal A-M3 and shall be at the frequency of the channel immediately above that of the wanted signal.

b) Initially the unwanted signal shall be switched off. The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength.

c) The unwanted signal from generator B shall then be switched on, and its level shall be adjusted until a successful message ratio of less than 10 % is obtained.

d) The normal test signal shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received.

The level of the unwanted signal shall be reduced by 2 dB for each occasion that a message is not successfully received.

The procedure shall be continued until three consecutive messages are successfully received. The level of the input signal shall then be recorded.

e) The level of the unwanted signal shall be increased by 1 dB and the new value recorded.

The normal test signal shall then be transmitted 20 times. In each case, if a message is not successfully received the level of the unwanted signal shall be reduced by 1 dB and the new value recorded.

If a message is successfully received, the level of the unwanted signal shall not be changed until three consecutive messages have been successfully received. In this case the unwanted signal shall be increased by 1 dB and the new value recorded.

No level of the unwanted signal shall be recorded unless preceded by a change in level.

The average of the values recorded in steps d) and e) (which provides the level corresponding to the successful message ratio of 80%) shall be recorded.

f) For each adjacent channel, the selectivity shall be expressed as the ratio in dB of the average level recorded in step e) to the level of the wanted signal. This value shall be recorded.

g) The measurement shall be repeated with the unwanted signal at the frequency of the channel below that of the wanted signal.

h) The adjacent channel selectivity of the equipment under test shall be expressed as the lower of the two values measured in the upper and lower adjacent channel (step f).

4.2.4. Spurious response rejection

4.2.4.1. ***Definition***

The spurious response rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal at any other frequency at which a response is obtained.

4.2.4.2. ***Limit***

The response rejection of the equipment shall be such that under the specified test conditions, the given degradation shall not be exceeded for levels of the unwanted signal up to:

- 75 dBµV/m for unwanted frequencies $\leq$ 68 MHz;
- ($38.3 + 20 \log_{10} f$) dBµV/m for unwanted frequencies > 68 MHz, where f is the value of the frequency of the carrier expressed in MHz.

4.2.4.3. ***Method of measurement***

4.2.4.3.1. Introduction to the method of measurement

To determine the frequencies at which spurious responses can occur the following calculations shall be made:

a) calculation of the "limited frequency range":
   The limited frequency range is defined as the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver plus or minus the sum of the intermediate frequencies (f_{I1},...f_{In}) and a half of the switching range (sr) of the receiver.
   Hence the frequency f_L of the limited frequency range is:

$$f_{LO} - \sum_{j=1}^{j=n} f_{Ij} - \frac{sr}{2} \leq f_l \leq f_{LO} + \sum_{j=1}^{j=n} f_{Ij} + \frac{sr}{2}$$

b) Calculation of frequencies outside the limited frequency range:
   - A calculation of the frequencies at which spurious responses can occur outside the range determined in a) is made for the remainder of the frequency range of interest.
   - The frequencies outside the limited frequency range are equal to the harmonics of the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver plus or minus the first intermediate frequency (f_{I1}) of the receiver.
   - Hence, the frequencies of these spurious responses are $nf_{LO} \pm f_{I1}$, where n is an integer greater than or equal to 2.
   - The measurement of the first image response of the receiver shall initially be made to verify the calculation of spurious response frequencies.

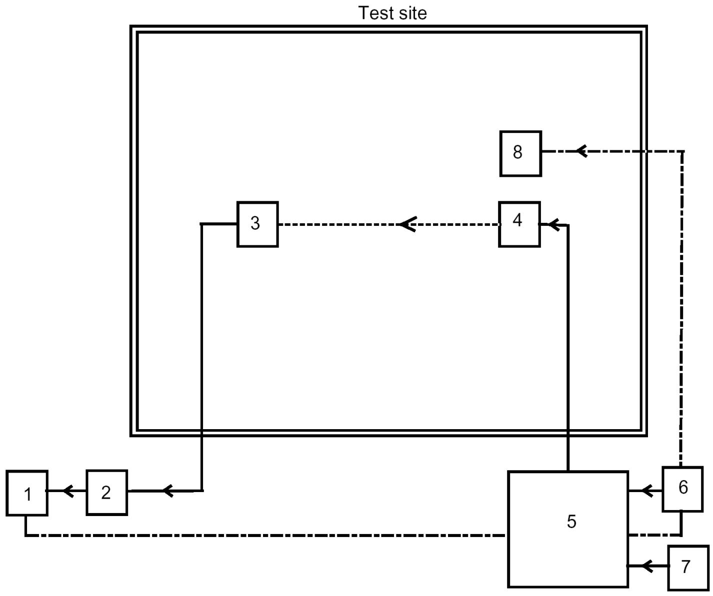
For calculations a) and b), the manufacturer shall state the frequency of the receiver, the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver, the intermediate frequencies (f_{I1}, f_{I2} etc.), and the switching range (sr) of the receiver

4.2.4.3.2. Measurement arrangement

a) A test site corresponding to that for the measurement of the average usable sensitivity shall be used (subclause 5.2.1.3).
b) The height of the wide band test antenna and the direction (angle) of the equipment under test shall be positioned as indicated in subclauses 5.2.1.3.1 and 5.2.1.3.2.
c) During the course of the measurement it may be necessary to radiate high powers in a broad frequency range, and care should be taken to avoid the signals causing interference to existing services that may be operating in the neighborhood.
d) In the presence of a reflective ground plane, the height of the wide band test antenna has to be altered to optimize the reflections from the ground plane. This cannot be done simultaneously for two different frequencies.

If vertical polarization is used, the ground floor reflection can be effectively eliminated by the use of an appropriate monopole located directly on the ground plane.

e) In case the wide band test antenna does not cover the necessary frequency range, alternatively two different and sufficiently decoupled antennas may be used.
f) The equipment under test shall be placed on the support in its standard position (clause A.2) and in the reference direction as indicated in subclauses 5.2.1.3.1 5.2.1.3.3 and 5.2.1.3.5.



1) Bit error or message measuring test set.
2) Photo detector/acoustic coupler
3) Receiver under test
4) Wide band test antenna
5) Combining network (used only when one antenna is used).
6) Signal generator A.
7) Signal generator B
8) Test antenna for the wanted signal.

Figure 20. Measurement arrangement

4.2.4.3.3. Method of the search over the limited frequency range with continuous bit streams

a) Two signal generators, A and B, shall be connected to the wide band test antenna via a combining network, where appropriate, or alternatively to two different antennas in accordance with subclause 5.2.4.3.2. (step e).
The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have the normal test signal D-M2 (subclause 4.3.1)
The unwanted signal, provided by signal generator B, shall be modulated with a frequency of 400 Hz at a level producing a deviation of ±5 kHz.
b) Initially, the unwanted signal shall be switched off (maintaining the output impedance).
The level of the wanted signal from signal generator A shall be adjusted to a level which is 3 dB above the level of the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (subclause 5.2.1.2).
c) The unwanted signal from generator B shall then be switched on and its level shall be adjusted to provide a field strength, which is at least 10 dB above.

d) The normal test signal D-M2 shall then be transmitted whilst observing the bit error ratio.

e) If the bit error ratio is better than 10^{-2}, then no spurious response effects have been detected and the search shall be continued on the next increment of frequency.

f) If the bit error ratio is worse than 10^{-2} then a spurious response effect has been detected and the search shall be continued on the next increment of frequency.

g) The frequency of any spurious response detected during the search, and the antenna position and its height shall be recorded for the use in measurements in accordance with subclause 5.2.4.3.5.

4.2.4.3.4. Method of the search over the limited frequency range with messages

a) Two signal generators, A and B, shall be connected to the wide band test antenna via a combining network. The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation. The unwanted signal, provided by signal generator B, shall be modulated with a frequency of 400 Hz at a level producing a deviation of ±5 kHz.

b) initially the unwanted signal shall be switched off.

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level of the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength (subclause 5.2.1).

c) the unwanted signal from generator B shall then be switched on and its level shall be adjusted to provide a field strength, which is at least 10 dB above.

d) the normal test signal (subclause 4.3.1.2) shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received;

e) if the successful message ratio is higher than 80 %, then no spurious response effects have been detected and the search shall be continued on the next increment of frequency;

f) if three consecutive successful messages cannot be received then a spurious response effect has been detected and the search shall be continued on the next increment of frequency;

g) the frequency of any spurious response detected during the search, and the antenna position and its height shall be recorded for the use in measurements in accordance with subclause 5.2.4.3.5.

4.2.4.3.5. Method of measurement with continuous bit streams

a) the measurement arrangement is identical to that in subclause 5.2.4.3.3. The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have the normal test signal D-M2 (subclause 4.3.1.1).

   The unwanted signal, provided by signal generator B, shall be modulated with a frequency of 400 Hz with a deviation of 12 % of the channel separation and shall be at the frequency of that spurious response being considered.

b) Initially the unwanted signal shall be switched off from generator B.

   The level of the wanted signal from signal generator A shall be adjusted to a level which is 3 dB above the level of the limit of the average usable sensitivity, for the category of equipment used, expressed in field strength when measured at the receiver location (subclause 5.2.1).

c) the unwanted signal from generator B shall then be switched on and its level shall be adjusted until a bit error ratio of approximately 10^{-1} is obtained;

d) the normal test signal D-M2 shall then be transmitted whilst observing the bit error ratio;

e) the level of the unwanted signal shall 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 shall then be recorded;

f) the frequency of the unwanted signal shall be stepped up and down in increments of 20 % of the channel separation and steps c) to e) shall be repeated until the lowest level recorded in step e) is obtained;

g) the measurement shall be repeated at all spurious response frequencies found during the search over the limited frequency range, subclauses 5.2.4.3.1 and 5.2.4.3.2. and at frequencies calculated for the remainder of the spurious response frequencies in the frequency range $f_{Rx}/3,2$ or 30 MHz, whichever is higher, to $3.2 \times f_{Rx}$, where f_{Rx} is the nominal frequency of the receiver, with the antenna position and height recorded in 5.2.4.3.3. step g) if appropriate;

h) the spurious response rejection of the equipment under test shall be expressed as the level in dBµV/m of the field strength of the unwanted signal, at the receiver location, corresponding to the lowest value recorded in step f).

4.2.4.3.6. Method of measurement with messages

a) The wanted signal, provided by signal generator A (subclause 5.2.4.3.4), shall be at the nominal frequency of the receiver and shall have normal test modulation (subclause 4.3.1.2.).

   The unwanted signal, provided by signal generator B, shall be modulated with a frequency of 400 Hz with a deviation of 12% of the channel separation and shall be at the frequency of that spurious response being considered.

b) Initially the unwanted signal shall be switched off from generator B.

   The level of the wanted signal from signal generator A shall be adjusted to a level which is 3 dB above the level of the limit of the average usable sensitivity, for the category of equipment used (subclause 5.2.1.), expressed in field strength when measured at the receiver location.

c) the unwanted signal from generator B shall then be switched on and its level shall be adjusted until a successful message ratio of less than 10 % is obtained;

d) the normal test signal (subclause 4.3.1.2.) shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received;

   The level of the unwanted signal shall be reduced by 2 dB for each occasion that a message is not successfully received. The procedure shall be continued until three consecutive messages are successfully received. The level of the input signal shall then be recorded.

e) The level of the unwanted signal shall be increased by 1 dB and the new value recorded;

   The normal test signal shall then be transmitted 20 times. In each case, if a message is not successfully received, the level of the unwanted signal shall be reduced by 1 dB and the new value recorded.

   If a message is successfully received the level of the unwanted signal shall not be changed until three consecutive messages have been successfully received. In this case the unwanted signal shall be increased by 1 dB and the new value recorded.

   No level of the unwanted signal level shall be recorded unless preceded by a change in level.

   The average of the values recorded in steps d) and e) (which provides the level corresponding to the successful message ratio of 80 %) shall be recorded.

f) the frequency of the unwanted signal shall be stepped up and down in increments of 20 % of the channel separation and steps d) and e) shall be repeated until the lowest average level recorded in step e) is obtained;

g) the measurement shall be repeated at all spurious response frequencies found during the search over the limited frequency range, subclauses 5.2.4.3.1 and 5.2.4.3.4, and at frequencies calculated for the remainder of the spurious response frequencies in the frequency range $f_{Rx}/3.2$ or 30 MHz, whichever is higher, to $3.2 \times f_{Rx}$, where f_{Rx} is the nominal frequency of the receiver, with the antenna position and height recorded in 5.2.4.3.4. step g) if appropriate;

h) the spurious response rejection of the equipment under test shall be expressed as the level in dBμV/m of the field strength of the unwanted signal, at the receiver location, corresponding to the lowest value recorded in step f).

4.2.5. Intermodulation response rejection

4.2.5.1. ***Definition***

The intermodulation response rejection is a measure of the capability of the receiver to receive a wanted modulated 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.

4.2.5.2. ***Limit***

The intermodulation response rejection of the equipment shall be such that under the specified test conditions, the given degradation shall not be exceeded for levels of the unwanted signal up to:

- 70 dBμV/m for unwanted frequencies ≤ 68 MHz;
- ($33.3 + 20 \log_{10} f$) dBμV/m for unwanted frequencies > 68 MHz, where f is the value of the frequency of the carrier expressed in MHz.

4.2.5.3. ***Method of measurement***

4.2.5.3.1. Method of measurement with continuous bit streams

a) The receiver shall be placed in the test fixture. Three signal generators, A, B and C, shall be connected to the test fixture via a combining network.

   The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test signal D-M2. (subclause 4.3.1.1.)

   The first unwanted signal, provided by signal generator B, shall be unmodulated and adjusted to a frequency 50 kHz above the nominal frequency of the receiver.

   The second unwanted signal, provided by signal generator C, shall be modulated with signal A-M3 and adjusted to a frequency 100 kHz above the nominal frequency of the receiver.

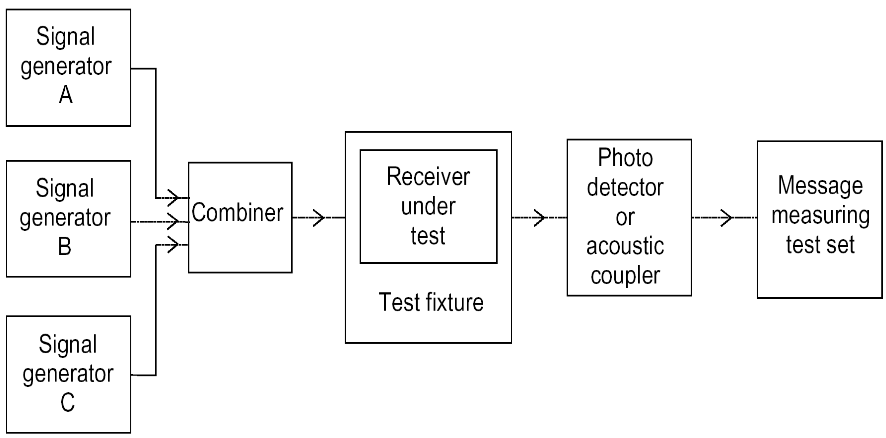


Figure 21: Measurement arrangement

b) Initially, the unwanted signals shall be switched off .
The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity, for the category of equipment used, expressed as a field strength. (subclause 5.2.1.)
c) The two unwanted signals from signal generators B and C shall then be switched on. Their levels shall be maintained equal and shall be adjusted until a bit error ratio of 10^{-1} or worse is obtained.
d) The test signal D-M2 shall then be transmitted whilst observing the bit error ratio.
e) The level of the unwanted signals shall be reduced in steps of 1 dB until a bit error ratio of 10^{-2} or better is obtained. The level of the unwanted signals shall then be recorded.
f) For each configuration of the unwanted signals, the intermodulation response rejection shall be expressed as the ratio, in dB, of the level of the unwanted signals to the level of the wanted signal. This ratio shall be recorded.
g) The measurements shall 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.
h) The intermodulation response rejection of the equipment under test shall be expressed as the lower of the two values calculated in step f).

4.2.5.3.2. Method of measurement with messages

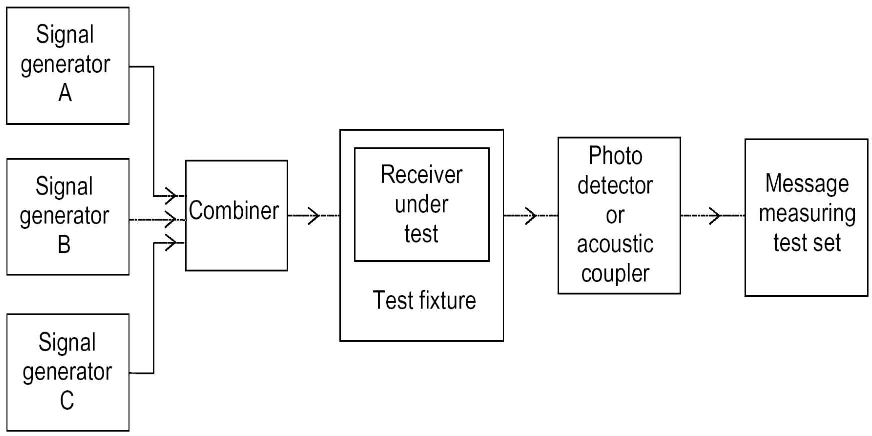


Figure 22: Measurement arrangement

a) The receiver shall be placed in the test fixture.
Three signal generators, A, B and C, shall be connected to the test fixture via a combining network. The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation. (subclause 4.3.1.2.)
The first unwanted signal, provided by signal generator B, shall be unmodulated and adjusted to a frequency 50 kHz above the nominal frequency of the receiver.

The second unwanted signal, provided by signal generator C, shall be modulated with signal A-M3 (subclause 4.3.1) and adjusted to a frequency 100 kHz above the nominal frequency of the receiver.

b) Initially, the unwanted signals shall be switched off (maintaining the output impedances).

   The level of the wanted signal from generator A shall be adjusted to a level which is 3 dB above the level equivalent to the limit of the average usable sensitivity.

c) The two unwanted signals from signal generators B and C shall then be switched on. Their levels shall be maintained equal and shall be adjusted until a successful message ratio of less than 10 % is obtained.

d) The normal test signal (subclause 4.3.1.2.) shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received. The level of the unwanted signals shall be reduced by 2 dB for each occasion that a message is not successfully received.

   The procedure shall be continued until three consecutive messages are successfully received. The level of the input signals shall then be recorded.

e) The level of the unwanted signals shall be increased by 1 dB and the new value recorded.

   The normal test signal (subclause 4.3.1.2.) shall then be transmitted 20 times. In each case, if a message is not successfully received, the level of the unwanted signals shall be reduced by 1 dB and the new value recorded.

   If a message is successfully received, the input level of the unwanted signals shall not be changed until three consecutive messages have been successfully received. In this case the level of the unwanted signals shall be increased by 1 dB and the new value recorded.

   No level of the unwanted signals shall be recorded unless preceded by a change in level.

   The average of the values recorded in steps d) and e) (which provides the level corresponding to the successful message ratio of 80%) shall be recorded.

f) For each configuration of the unwanted signals, the intermodulation response rejection shall be expressed as the ratio in dB of the average level recorded in step e) to the level of the wanted signal. This ratio shall be recorded.

g) The measurement shall 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.

h) The intermodulation response rejection of the equipment under test shall be expressed as the lower of the two values calculated in step f).

4.2.6. Blocking or desensitization

*4.2.6.1. **Definition***

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal at any frequencies other than those of the spurious responses or the adjacent channels.

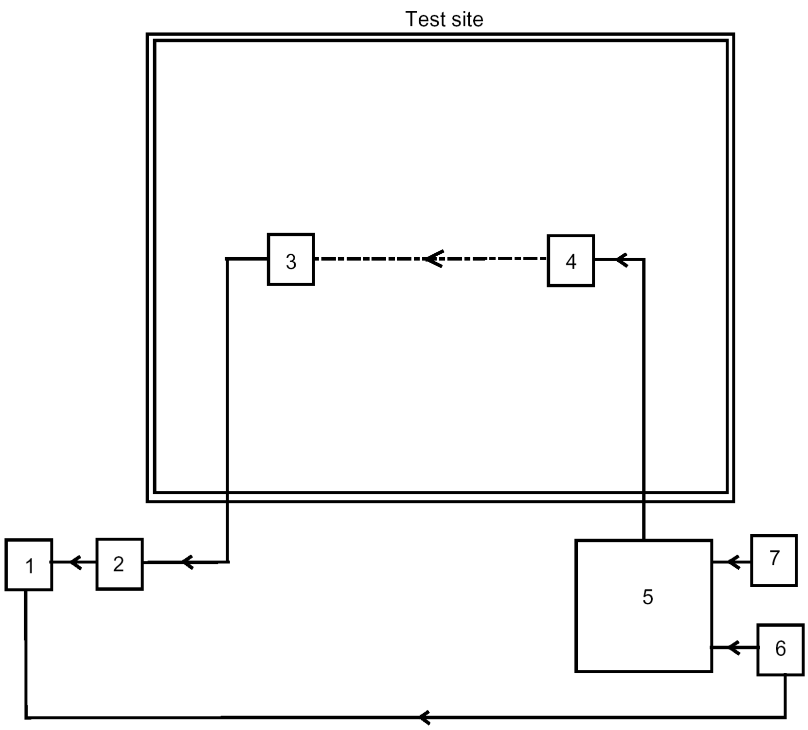
*4.2.6.2. **Limit***

The blocking level, for any frequency within the specified ranges, shall be:

- $\geq$ 89 dBµV/m for unwanted frequencies $\leq$ 68 MHz;
- $\geq$ (52.3 + 20 $\log_{10} f$) dBµV/m for unwanted frequencies > 68 MHz, where f is the value of the frequency of the carrier expressed in MHz.

*4.2.6.3. **Method of measurement***

4.2.6.3.1. Method of measurement with continuous bit streams



1) Bit error measuring test set. 2) Photo detector/acoustic coupler. 3) Receiver under test. 4) Wide band test antenna. 5) Combining network. 6) Signal generator A. 7) Signal generator B.

Figure 23: Measurement arrangement

a) two signal generators, A and B, shall be connected to the wide band test antenna via a combining network;

   The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test signal D-M2.

The unwanted signal, provided by signal generator B, shall be unmodulated and shall be at a frequency from 1 MHz to 10 MHz away from the nominal frequency of the receiver.

For practical reasons the measurements shall be carried out at frequencies of the unwanted signal at approximately ±1 MHz, ±2 MHz, ±5 MHz and ±10 MHz, avoiding those frequencies at which spurious responses occur. (subclause 5.2.4)

b) initially the unwanted signal shall be switched off;

   The level of the wanted signal from generator A shall be adjusted to a level, which is 3 dB above the level of the limit of the average usable sensitivity.

c) the unwanted signal from generator B shall then be switched on and its level shall be adjusted until a bit error ratio of approximately 10^{-1} is obtained;

d) the normal test signal D-M2 shall then be transmitted whilst observing the bit error ratio;

e) the level of the unwanted signal shall 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 shall then be recorded;

f) for each frequency, the blocking or desensitization shall be expressed as the level in dBµV/m of the field strength of the unwanted signal at the receiver location. This value shall be recorded;

g) the measurement shall be repeated for all the frequencies defined in step a);

h) the blocking or desensitization of the equipment under test shall be expressed as the level in dBµV/m of the field strength of the unwanted signal, at the receiver location, corresponding to the lowest value recorded in step f).

4.2.6.3.2. Method of measurement with messages

a) two signal generators A and B shall be connected to the wide band test antenna via a combining network;

   The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation. (subclause 4.3.1.2).

   The unwanted signal, provided by signal generator B, shall be unmodulated and shall be at a frequency from 1 MHz to 10 MHz away from the nominal frequency of the receiver.

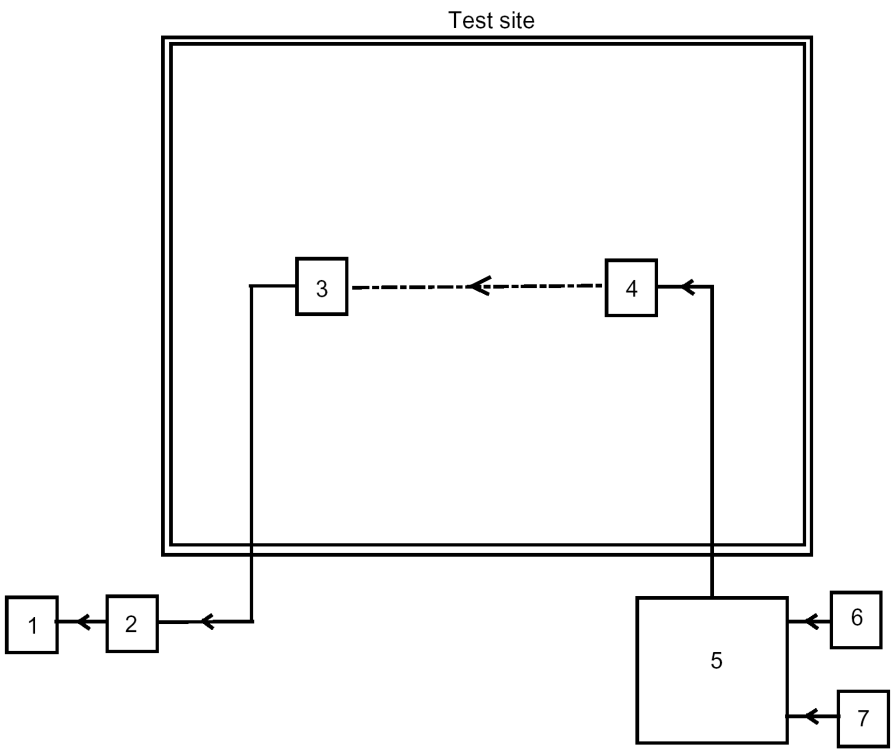
   For practical reasons the measurements shall be carried out at frequencies of the unwanted signal at approximately ±1 MHz, ±2 MHz, ±5 MHz and ±10 MHz, avoiding those frequencies at which spurious responses occur.

b) Initially, the unwanted signal shall be switched off;

   The level of the wanted signal from generator A shall be adjusted to a level, which is 3 dB above the level of the limit of the average usable sensitivity.

c) the unwanted signal from generator B shall then be switched on and its level shall be adjusted until a successful message ratio of less than 10% is obtained;

d) the normal test signal shall be transmitted repeatedly whilst observing in each case whether or not a message is successfully received;
The level of the unwanted signal shall be reduced by 2 dB for each occasion that a message is not successfully received.
The procedure shall be continued until three consecutive messages are successfully received.
The level of the input signal shall then be recorded.
e) the level of the unwanted signal shall be increased by 1 dB and the new value recorded;
The normal test signal (subclause 4.3.1.2.) shall then be transmitted 20 times. In each case if a message is not successfully received, the level of the unwanted signal shall be reduced by 1 dB and the new value recorded.
If a message is successfully received the level of the unwanted signal shall not be changed until three consecutive messages have been successfully received.
In this case the unwanted signal level shall be increased by 1 dB and the new value recorded.
No level of the unwanted signal shall be recorded unless preceded by a change in level.
The average of the values recorded in steps d) and e) (which provides the level corresponding to the successful message ratio of 80%) shall be recorded.



1) Message measuring test set. 2) Photo detector/acoustic coupler. 3) Receiver under test.
4) Wide band test antenna. 5) Combining network. 6) Signal generator A . 7) Signal generator B.

Figure 24: Measurement arrangement

f) for each frequency, the blocking or desensitization shall be expressed as the level in dBµV/m of the field strength of the unwanted signal at the receiver location, corresponding to the average value recorded in step e). For each frequency, the level shall be recorded;

g) the measurement shall be repeated for all the frequencies defined in step a);

h) the blocking or desensitization of the equipment under test shall be expressed as the level in dBµV/m of the field strength of the unwanted signal, at the receiver location, corresponding to the lowest value recorded in step f).

4.2.7. Spurious radiations

4.2.7.1. ***Definition***

Spurious radiations from the receiver are components at any frequency radiated by the equipment and its antenna.

They are specified as the radiated power of any discrete signal.

4.2.7.2. ***Limit***

The power of any spurious radiation shall not exceed the values given in table 5.7.

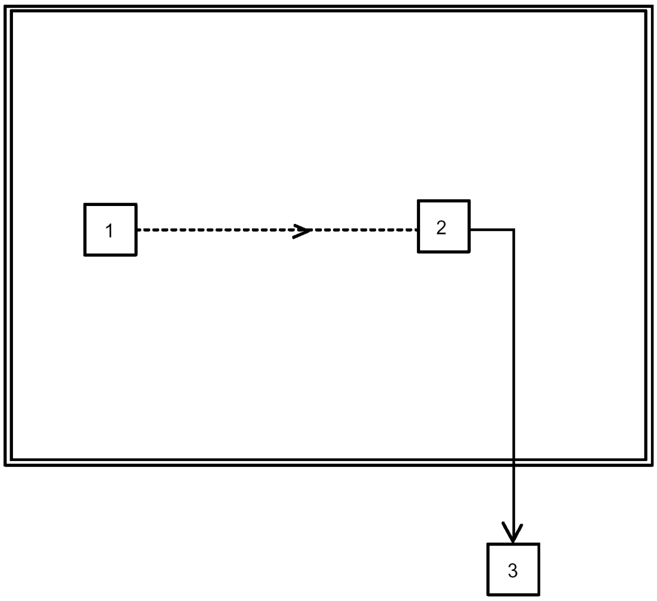
Table 5.7: Radiated components

Frequency range	Limit
30 MHz to 1 GHz	2.0 nW (-57.0 dBm)
Above 1 GHz to 12.75 GHz	20.0 nW (-47.0 dBm)

4.2.7.3. ***Method of measurement***

a) The test antenna shall be orientated for vertical polarization and connected to a spectrum analyzer or a selective voltmeter. The resolution bandwidth of the spectrum analyzer or selective voltmeter shall be the smallest bandwidth available which is greater than the spectral width of the spurious component being measured.
b) The receiver under test shall be placed on the support in its standard position (clause A.2).The radiation of any spurious component shall be detected by the test antenna and the spectrum analyzer or selective voltmeter over the frequency range 30 MHz to 4 GHz. In addition, for equipment operating on frequencies above 470 MHz, measurements shall be repeated over the frequency range 4 GHz to 12.75 GHz.
c) At each frequency at which a component has been detected, the spectrum analyzer or selective voltmeter shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyzer or selective voltmeter.
d) The receiver shall be rotated through 360° about a vertical axis, until a higher maximum signal is received.

Test site

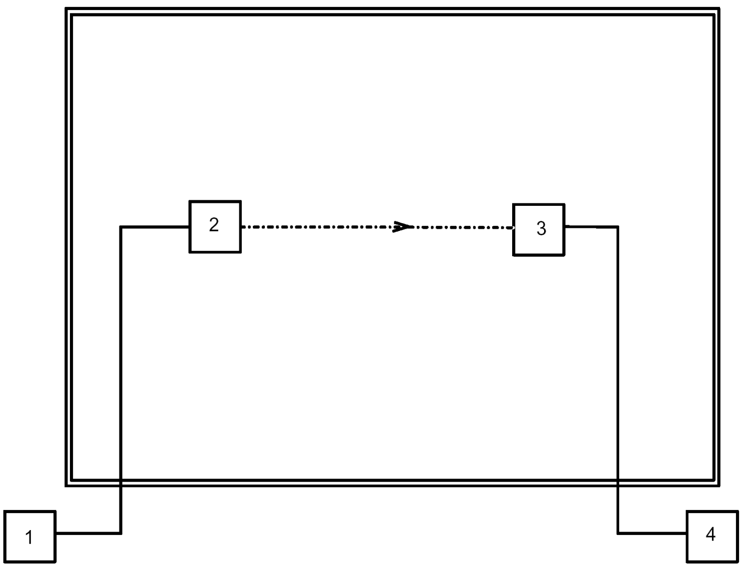


1) Receiver under test. 2) Test antenna. 3) Spectrum analyzer or selective voltmeter.

Figure 25: Measurement arrangement

e) The test antenna shall be raised or lowered again through the specified height range until a maximum signal is obtained. This signal level shall be recorded.
f) Using the measurement arrangement in figure 26, the substitution antenna shall replace the receiver antenna in the same position and in vertical polarization. It shall be connected to the signal generator.
g) For each frequency at which a component has been detected, the signal generator and spectrum analyzer or selective voltmeter shall be tuned and the test antenna shall be raised or lowered through the specified height range until the maximum signal level is detected on the spectrum analyzer or selective voltmeter.

Test site



1) Signal generator. 2) Substitution antenna. 3) Test antenna. 4) Spectrum analyzer or selective voltmeter.

Figure 26: Measurement arrangement

The test antenna may not need to be raised or lowered if the measurement is carried out on a test site according to subclause A.1.2.

The level of the signal generator giving the same signal level on the spectrum analyser or selective voltmeter as in step e) above shall be recorded. This value, after correction due to the gain of the substitution antenna and the cable loss between the signal generator and the substitution antenna, is the radiated spurious component at this frequency.

h) Measurements of step b) to step g) shall be repeated with the test antenna orientated in horizontal polarization.

Annex A (normative): Radiated measurements

A.1 Test sites and general arrangements for measurement the use of radiated fields

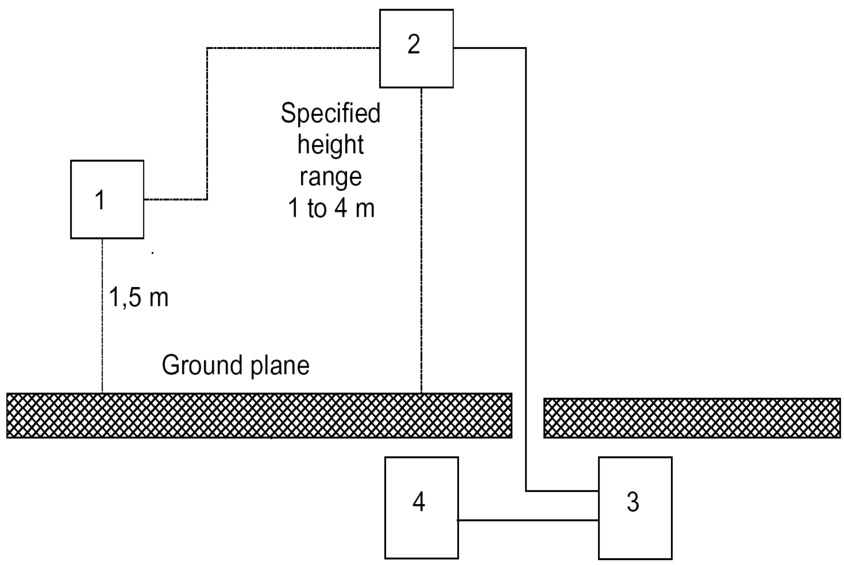
A.1.1 Open air test site

A.1.1.1 Description

An open air test site may be used to perform the measurements using the radiated measurement methods. Absolute or relative measurements can be performed on transmitters or on receivers;

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurement results, in particular:

- No extraneous conducting objects having any dimension in excess of a quarter wavelength of the highest frequency tested shall be in the immediate vicinity of the site;
- All cables shall be as short as possible; as much of the cables as possible shall be on the ground plane or preferably below; and the low impedance cables shall be screened.

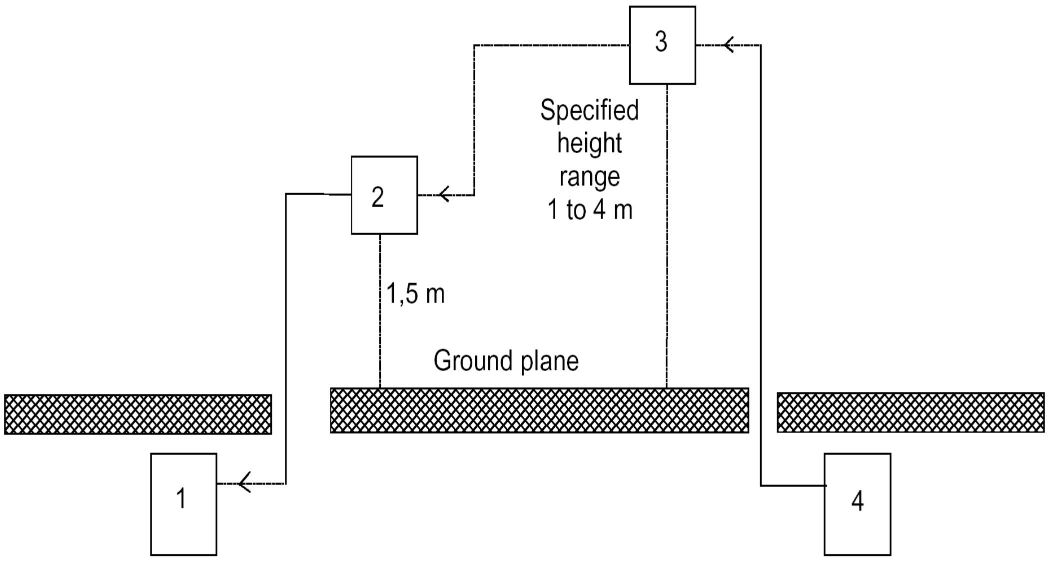


1) Equipment under test.
2) Test antenna.
3) High pass filter (necessary for strong fundamental Tx radiation).
4) Spectrum analyser or measuring receiver.

Figure A.1: Measuring arrangement

A.1.1.2 Establishment of a relationship between signal levels and field strength

This procedure allows the creation, in a given place, of a known field strength by the means of a signal generator connected to a test antenna. It is valid only at a given frequency for a given polarization and for the exact position of the test antenna.



1) Selective voltmeter.
2) Substitution antenna.
3) Test antenna.
4) Signal generator.

Figure A.2: Measuring arrangement

All the equipment shall be adjusted to the frequency used. The test antenna and the substitution antenna shall have the same polarization. The substitution antenna connected to the selective voltmeter constitutes a calibrated field strength meter:

a) the signal generator level shall be adjusted to produce the required field strength as measured on the selective voltmeter;

b) the test antenna shall be raised or lowered through the specified range until the maximum signal level is detected on the selective voltmeter;

c) the signal generator level shall be readjusted to produce the required field strength as measured on the selective voltmeter. Thus a relationship has been established between the signal generator level and the field strength.

A.1.2 Anechoic chamber

A.1.2.1 General

An anechoic chamber is a well-shielded chamber covered inside with radio frequency absorbing material and simulating a free space environment. It is an alternative site on which to perform the measurements using the radiated measurement methods.

Absolute or relative measurements can be performed on transmitters or on receivers. Absolute measurements of field strength require a calibration of the anechoic chamber. The test antenna, equipment under test and substitution antenna are used in a way similar to that at the open air test site, but are all located at the same fixed height above the floor.

A.1.2.2 Description

An anechoic chamber should meet the requirements for shielding loss and wall return loss.

Figure A.3 shows an example of the construction of an anechoic chamber having a base area of 5 m by 10 m and a height of 5 m. The ceiling and walls are coated with pyramidally formed absorbers approximately 1 m high. The base is covered with special absorbers, which form the floor. The available internal dimensions of the chamber are 3 m x 8 m x 3 m, so that a maximum measuring distance of 5 m in the middle axis of this chamber is available. The floor absorbers reject floor reflections so that the antenna height need not be changed. Anechoic chambers of other dimensions may be used.

At 100 MHz the measuring distance can be extended up to a maximum of 2 wavelengths.

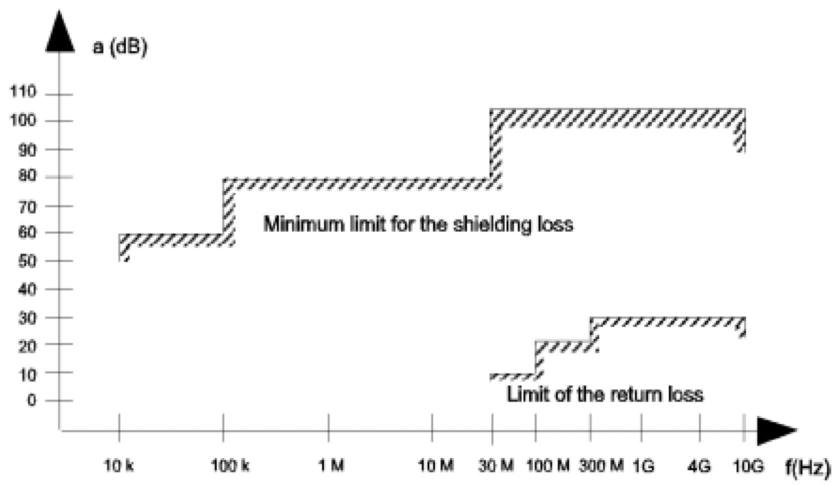


Figure A.3: Specification for shielding and reflections

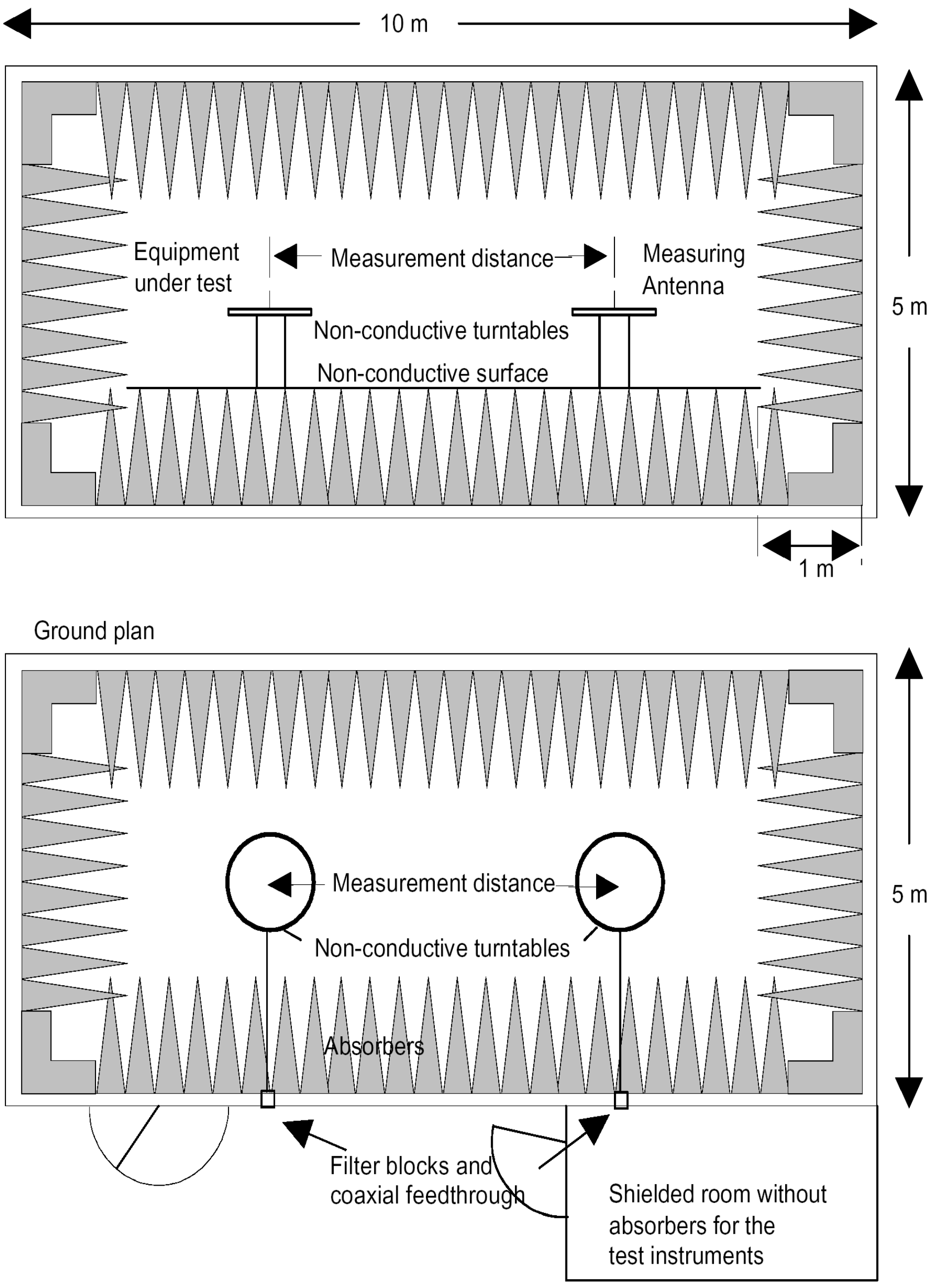


Figure A.4: Anechoic shielded chamber for simulated free space measurements

A.1.2.3 Influence of parasitic reflections

For free-space propagation in the far field the relationship of the field strength E and the distance R is given by E = Eo (R_0/R), where E_0 is the reference field strength and R_0 is the reference distance. This relationship allows relative measurements to be made as all constants are eliminated within the ratio and neither cable attenuation nor antenna mismatch or antenna dimensions are of importance.

If the logarithm of the foregoing equation is used, the deviation from the ideal curve can be easily seen because the ideal correlation of field strength and distance appears as a straight line. The deviations occurring in practice are then clearly visible. This indirect method shows quickly and easily any disturbances due to reflections and is far less difficult than the direct measurement of reflection attenuation.

With an anechoic chamber of the dimensions given above at low frequencies below 100 MHz there are no far field conditions, but the wall reflections are stronger, so that careful calibration is necessary. In the medium frequency range from 100 MHz to 1 GHz the dependence of the field strength to the distance meets the expectations very well. Above 1 GHz, because more reflections will occur, the dependence of the field strength to the distance will not correlate so closely.

A.1.2.4. Mode of use

The mode of use is the same as for an open air test site, the only difference being that the test antenna does not need to be raised and lowered whilst searching for a maximum, which simplifies the method of measurement.

A.1.3 Stripline arrangement

A.1.3.1 General

The stripline arrangement is a RF coupling device for coupling the integral antenna of an equipment to a 50 Ω Radio frequency terminal. This allows the radiated measurements to be performed without an open air test site but in a restricted frequency range. Absolute or relative measurements can be performed; absolute measurements require a calibration of the stripline arrangement.

A.1.3.2 Description

The stripline is made of three highly conductive sheets forming part of a transmission line, which allows the equipment under test to be placed within a known electric field. They shall be sufficiently rigid to support the equipment under test.

Two examples of stripline characteristics are given below:

	IEC 60489-3	J FTZ No. 512 TB 9

Useful frequency range (MHz)		1 to 200	0,1 to 4 000
Equipment size limits	length	200 mm	1 200 mm
(antenna included):	width	200 mm	1 200 mm
	height	250 mm	400 mm

A.1.3.3 Calibration

The aim of calibration is to establish at any frequency a relationship between the voltage applied by the signal generator and the field strength at the designated test area inside the stripline.

A.1.3.4 Mode of use

The stripline arrangement may be used for all radiated measurements within its calibrated frequency range.

The method of measurement is the same as the method using a open air test site with the following change. The stripline arrangement input socket is used instead of the test antenna.

A.1.4 Indoor test site

A.1.4.1 Description

An indoor test site is a partially screened site, where the wall located behind the test sample is covered with a radio frequency absorbing material and a corner reflector is used with the test antenna. It may be used when the frequency of the signals being measured is greater than 80 MHz.

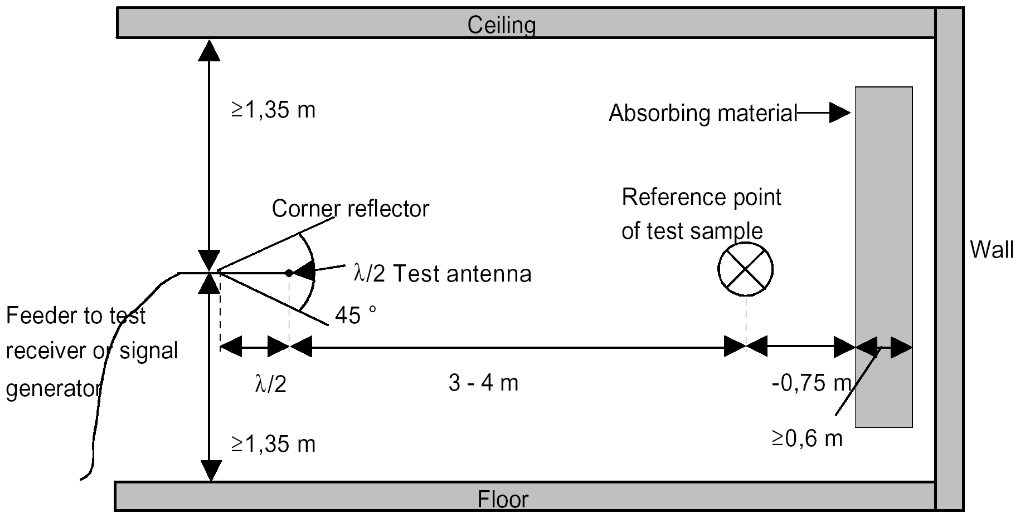


Figure A.5: Indoor test site arrangement (shown for horizontal polarization)

The measurement site may be a laboratory room with a minimum area of 6 m by 7 m and at least 2.7 m in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarized measurements. Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarized measurements. For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed. For practical reasons, the half wavelength antenna in figure A.5 may be replaced by an antenna of constant length, provided that this length is between a quarter wavelength and one wavelength at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of half wavelength to the apex may be varied.

A.1.4.2 Test for parasitic reflections

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ±10 cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction.

If these changes of distance cause a signal change of greater than 2 dB, the test sample should be repositioned until a change of less than 2 dB is obtained.

A.1.4.3 Mode of use

The mode of use is the same as for an open air test site, the only difference being that the test antenna does not need to be raised and lowered whilst searching for a maximum, which simplifies the method of measurement.

A.2 Standard position

The standard position in all test sites, except the stripline arrangement, for equipment which is not intended to be worn on a person, including hand-held equipment, shall be on a non-conducting support, height 1.5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be the following:

For equipment with an integral antenna, it shall be placed in the position closest to normal use as declared by the manufacturer;

For equipment with a rigid external antenna, the antenna shall be vertical;

For equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

Equipment which is intended to be worn on a person may be tested using a simulated man as support. The simulated man comprises a rotatable acrylic tube filled with salt water, placed on the ground. The container shall have the following dimensions:

- height 1.7 ± 0.1 m;
- inside diameter 300 ± 5 mm;
- sidewall thickness 5 ± 0.5 mm.

The container shall be filled with a salt (NaCl) solution of 1.5 g per litre of distilled water.

The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment.

NOTE: To reduce the weight of the simulated man it may be possible to use an alternative tube, which has a hollow centre of 220 mm maximum diameter.

In the stripline arrangement the equipment under test or the substitution antenna is placed in the designated test area in the normal operational position, relative to the applied field, on a pedestal made of a low dielectric material (dielectric constant less than 2).

A.3. Acoustic coupler

A.3.1 General

When radiation measurements are performed, on the receiver, the audio output voltage should be conducted from the receiver to the measuring equipment, without perturbing the field near the receiver.

This perturbation can be minimized by using wires with high resistivity associated to a test equipment with a high input impedance.

When this situation is not applicable, an acoustic coupler shall be used.

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

A.3.2 Description

The acoustic coupler comprises a plastic funnel, an acoustic pipe and a microphone with a suitable amplifier.

The acoustic pipe shall be long enough (e.g. 2 m) to reach from the equipment under test to the microphone which is located in a position that will not disturb the RF field. The acoustic pipe shall have an inner diameter of about 6 mm and a wall thickness of about 1.5 mm and should be sufficiently flexible to allow the platform to rotate.

The plastic funnel shall have a diameter appropriate to the size of the loudspeaker in the equipment under test, with soft foam rubber glued to its edge, it shall be fitted to one end of the acoustic pipe and the microphone shall be fitted to the other end. It is very important to fix the centre of the funnel in a reproducible position relative to the equipment under test, 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 equipment in a close fitting acoustic mounting jig, supplied by the manufacturer, of which the funnel is an integral part.

The microphone shall 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 shall be suitable to measure a signal to noise ratio of at least 40 dB at the nominal audio output level of the equipment under test. Its size should be sufficiently small to couple to the acoustic pipe.

A.3.3 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.

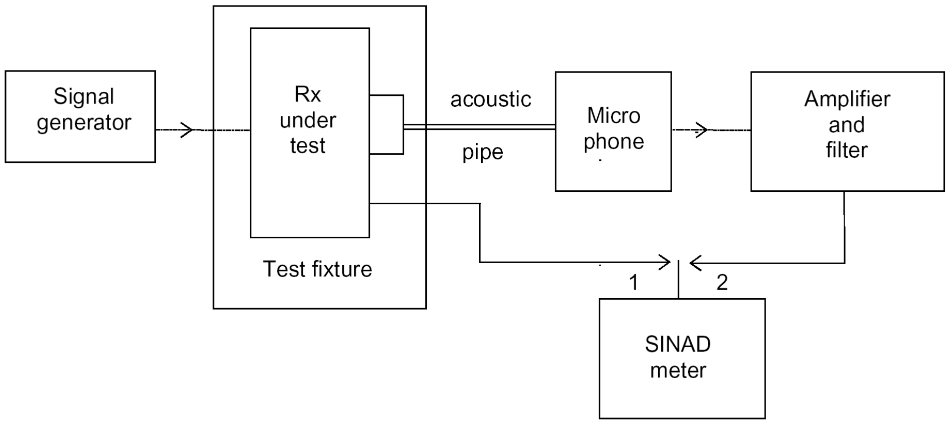


Figure A.6: Measuring arrangement for calibration

a) The acoustic coupler shall be mounted to the equipment, if necessary using a test fixture. A direct electrical connection to the terminals of the output transducer will be made. A signal generator shall be connected to the receiver input (or to the test fixture input). The signal generator shall be at the nominal frequency of the receiver and shall be modulated by the normal test modulation;
b) Where possible, the receiver volume control shall 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 shall be reduced until an electrical SINAD ratio of 20 dB is obtained, the connection being in position 1. The signal input level shall be recorded;
d) With the same signal input level, the acoustic equivalent SINAD ratio shall be measured and recorded, the connection being in position 2;
e) Steps c) and d) above shall be repeated for an electrical SINAD ratio of 14 dB, and the acoustic equivalent SINAD ratio measured and recorded.

A.4 Test antenna

When the test site is used for radiation measurements the test antenna is used to detect the field from both the test sample and the substitution antenna. When the test site is used for the measurement of receiver characteristics the antenna is used as a transmitting antenna. This antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and for the height of its centre above the ground to be varied over the specified range. Preferably test antennas with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

A.5 Substitution antenna

The substitution antenna is used to replace the equipment under test. For measurements below 1 GHz the substitution antenna shall be a half wavelength dipole resonant at the frequency under consideration, or a shortened dipole, calibrated to the half wavelength dipole. For measurements between 1 GHz and 4 GHz either a half wavelength dipole or a horn radiator may be used. For measurements above 4 GHz a horn radiator shall be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an outside antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.

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

A.6 Test fixture

A.6.1 Description

The test fixture is a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using the conducted measurement methods. Only relative measurements may be performed and only those at or near frequencies for which the test fixture has been calibrated.

In addition, the test fixture shall provide:

a) a connection to an external power supply;
b) an audio interface either by direct connection or by an acoustic coupler.

The test fixture normally shall be provided by the manufacturer.

The performance characteristics of the test fixture shall be approved by the testing laboratory and shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;
b) a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;
c) circuitry associated with the RF coupling shall contain no active or non linear devices;

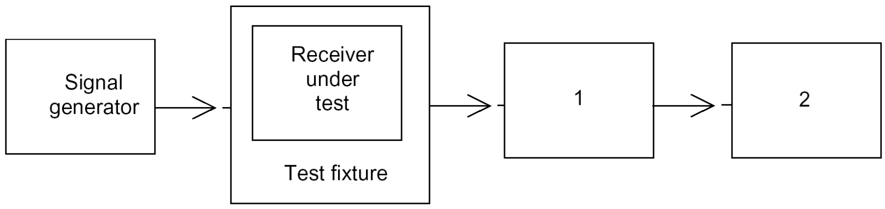
d) the VSWR at the 50 Ω socket shall not be greater than 1.5 over the frequency range of the measurements;
e) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced;
f) the coupling loss shall remain substantially constant when the environmental conditions are varied.

The characteristics and calibration shall be included in the test report.

A.6.2 Calibration

The calibration of the test fixture establishes a relationship between the output of the signal generator and the field strength applied to the equipment inside the test fixture.

The calibration is valid only at a given frequency and for a given polarization of the reference field.



1) AF load/acoustic coupler. 2) Distortion factor/audio level meter and psophometric filter.

Figure A.7: Measuring arrangement for calibration

a) Using the method described in subclause 5.2.1, measure the sensitivity expressed as field strength, and note the value of this field strength in dBµV/m and the polarization used;
b) The receiver is now placed in the test fixture, which is connected to the signal generator. The level of the signal generator producing a SINAD of 20 dB shall be recorded.
c) The calibration of the test fixture is thus the linear relationship between the field strength in dBµV/m and the signal generator level in dBµV emf.

A.6.3 Mode of use

The test fixture may be used to facilitate some of the measurements in clauses 5.1 and 5.2 on equipment with an integral antenna.

It is used in the radiated carrier power and measured usable sensitivity expressed as a field strength measurements in clauses 5.1 and 5.2 to enable a measurement to be made under extreme test conditions.

For the transmitter measurements calibration is not required.

For the receiver measurements calibration is necessary.

To apply the specified wanted signal level expressed in field strength, convert it into the signal generator level (emf) using the calibration of the test fixture. Apply this value with the signal generator.

Annex B (normative): Specifications for adjacent channel power measurement arrangements

B.1 Power measuring receiver specification

B.1.1 General

The power measuring receiver is used for the measurement of the transmitter adjacent channel power. It consists of a mixer and oscillator, an IF filter, an amplifier, a variable attenuator and a level indicator as shown figure B.1.

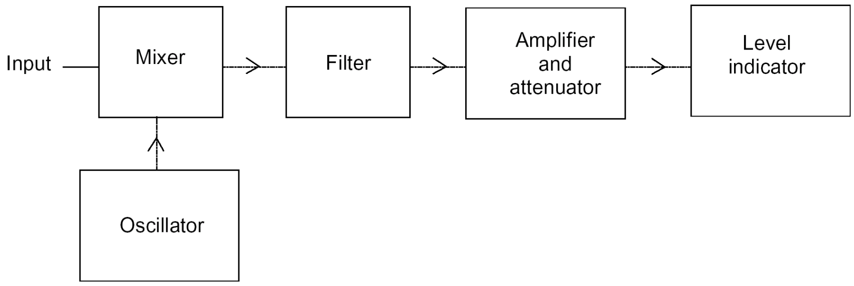


Figure B.1: The power measuring receiver

The technical characteristics of the power measuring receiver are given below.

B.1.2 IF filter

The IF filter shall be within the limits of the selectivity characteristics given in the following diagram B.2. Depending on the channel separation, the selectivity characteristics shall keep the frequency separations and tolerances given in the following table B.1. The minimum attenuation of the filter outside the 90 dB attenuation points shall be equal to or greater than 90 dB.

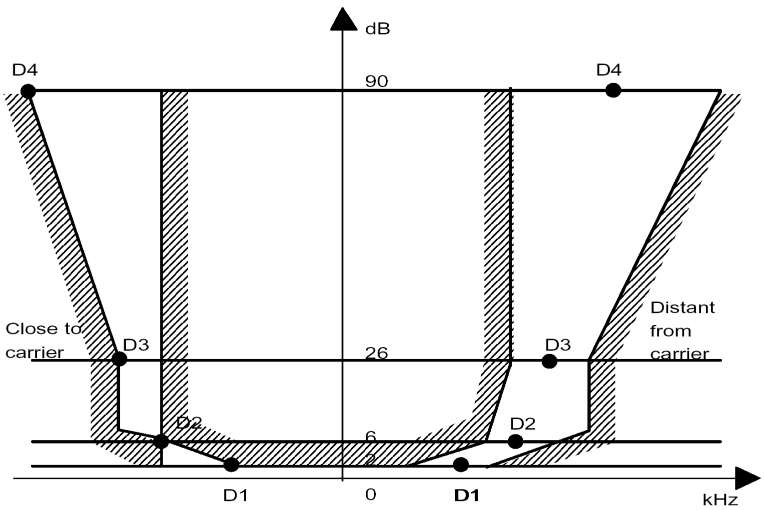


Figure B.2: Limits of the selectivity characteristic

NOTE: A symmetrical filter may be used provided that each side meets the tighter tolerances and the D2 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.

Table B.1: Selectivity characteristic

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	3	4.25	5.5	9.5
25	5	8.0	9.25	13.25

Depending on the channel separation, the attenuation points shall not exceed the tolerances given in table B.2 and table B.3.

Table B.2: Attenuation points close to carrier

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	+ 1.35	± 0.1	- 1.35	- 5.35
25	+ 3.1	± 0.1	- 1.35	- 5.35

Table B.3: Attenuation points distant from the carrier

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	± 2.0	± 2.0	± 2.0	± 2.0 - 6.0
25	± 3.5	± 3.5	± 3.5	± 3.5 - 7.5

The minimum attenuation of the filter outside the 90 dB attenuation points shall be ≥ 90 dB.

Table B.4: Frequency displacement

Channel separation (kHz)	Specified necessary bandwidth (kHz)	Displacement from the -6 dB point (kHz)
12.5	8.5	8.25
25	16	17

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

B.1.3 Oscillator and amplifier

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

The mixer, oscillator and the amplifier shall 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, fields a measured value of ≤ -90 dB for channel separation of 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 shall be such that an error in the reading of no more than 1.5 dB is obtained over an input level variation of 100 dB.

B.1.4 Attenuation indicator

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

B.1.5 Level indicators

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

B.1.5.1 rms level indicator

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

B.1.5.2 Peak level indicator

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

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