MPT 1326

PERFORMANCE SPECIFICATION

Angle modulated VHF and UHF radio equipment for use at fixed and mobile station in the Private Mobile Radio Service

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FOREWORD

It is a requirement of the Wireless Telegraphy Act 1949 that no radio apparatus shall be installed or used in the United Kingdom except under the authority granted by the Secretary of State. It is a condition of this authority that the performance of the apparatus must meet certain minimum standards. These minimum standards of performance are given in specifications prepared by the Radiocommunications Agency in consultation with the relevant manufacturers.

Applicants who wish to submit equipment for type approval testing should apply to one of the accredited test houses. Guidance for applicants is given in the RA Information Sheet 'RA 207 (Rev 1): Type Approval - UK Type Approval Requirements for Land Mobile and Maritime Mobile Radiocommunications Equipment'. This is available on a single copy basis free from the RA Information & Library Service.

Equipment will be considered for approval purposes either:

a) by direct compliance with MPT 1326 or;

b) by compliance with a national standard or government regulation of any Member State of the European Community, or any Member State which is contracting party to the EEA Agreement or;

c) by compliance with any relevant international standard or regulation recognised in a member State of the European Community, or a Member Sate which is a contracting party to the EEA Agreement;

d) and, where appropriate, by compliance with manufacturing rules and procedures of a Member State of the European Communities, or a Member State which is a contracting party to the EEA Agreement, relating to quality control operations during manufacture of the equipment where they form part of a standard or technical regulations in a) or c) as above;

provided that in case b) or c) the regulation is deemed to comply with MPT 1326.

The results of tests to such a standard will be taken into consideration if carried out by authorised and accredited test houses in accordance with ISO guides 25 and 38 or EN45001 and EN45002 or a national standard conforming to these requirements.

Notwithstanding the provisions of the EMC Directive, the following sub clauses shall be applied for spectrum management:

transmitter spurious emissions, subclause 4.5
receiver spurious radiations, subclause 5.8

The EMC tests carried out on the basis of article 10.5 of the EMC Directive 89/336/EEC by the notified bodies established in other Member States would not normally be repeated for licensing purposes in the United Kingdom.

Applicants who wish to demonstrate compliance with the EMC directive are advised to refer to the RA Information sheets 'RA 200: Electromagnetic Compatibility for Radio' and 'RA 227 (Rev. 1): EMC - The EC Type Examination Route to compliance for Radiocommunication Transmission Apparatus'. These are available on a single copy basis free from the RA Information & Library Service.

It may be necessary for amendments to this specification to be issued. Amendment sheets will be available from the RA Information and Library Service.

For the latest information concerning Type Approval Status and Licensing conditions, refer to the RA Information Sheet 'RA 275: Status of Land Mobile Radio Specifications (MPT 1300 series)'. This publication also contains contact names and telephone numbers for Agency staff who are able to assist you with licensing and technical enquiries and is available on a single copy basis free from the RA Information & Library Service.

This revision was required in order to allow for;

a) This document to be updated in line with the Agency's current Standard format and layout for the MPT 1300 series specifications.

The Radiocommunications Agency has a 'web site' which can be accessed on *http://www.open.gov.uk/radiocom/rahome.htm*. It is planned that all of the MPT 1300 series of specifications will be available on here.

Radiocommunications Agency
Information & Library Service
Kings Beam House
22 Upper Ground
London
SE1 9SA

Tel: 0171 211 0211
Fax: 0171 211 0507

For further information on all radio matters please contact the Agency's 24 Hour Telephone Service: 0171 211 0211

1 GENERAL

1.1 Scope of specification

This specification covers the minimum performance requirements for angle modulated radio transmitters and receivers used at fixed and mobile stations in the Private Mobile Radio Service. It covers simple measurements only on equipment designed for use in the VHF or UHF bands up to 500 MHz. For equipment covered by this specification the nominal separation between adjacent channel carrier frequencies is 12.5 kHz.

1.2 Licensee's responsibility

The installation of equipment, either fixed or mobile, is subject to the issue of a licence by the Secretary of State. Under the conditions of the licence it will be the responsibility of the licensee to ensure that the equipment provided conforms with and is maintained to, the requirements of this specification.

1.3 Operating frequencies

The equipment shall provide for transmission and reception of frequency or phase modulated emissions on one or more carrier frequencies in the bands allocated to the Private mobile Radio Service. The precise operating frequencies will be quoted by the Secretary of State when a licence is issued. For the purposes of type testing, single channel equipment may be submitted operating on any channel in one of the above frequency bands. Multi-channel equipment shall, where possible, be equipped to operate at the centre, and the upper and lower limits of the frequency range over which channel switching is possible.

The means of channel selection shall be such that a user, by use of the channel control switch or by remote channel control in a trunked system, shall have access only to channels assigned to his service.
Transmissions shall be inhibited until the frequency has stabilised within the required limits.

1.4 Labelling

The equipment shall be provided with a clear indication of the type number and description under which it is submitted for type testing. Each type number shall be unique and in the event that the testing authority finds two manufacturers have used a similar type number, one manufacturer will be asked to change the type number.

1.5 Controls

Those controls which if maladjusted might increase the interfering potential of the equipment, shall not be easily accessible by the user.

1.6 Declaration by the manufacturer

When submitting an equipment for type testing, the manufacturer shall supply the following information.

- Transmitter

  Nominal frequency
  Oscillator frequency and carrier generation formula
  Crystal type (if applicable)
  Single or multi-channel
  Radio frequency switching range
  Rated radio frequency output power
  Continuous or intermittent rating

- Receiver

  Nominal frequency
  Oscillator frequency and carrier generation formula
  Crystal type (if applicable)
  Single or multi-channel
  Radio frequency switching range
  Rated audio frequency output power
  Value of resistive load into which audio output is delivered

- Power supply

  Nominal supply voltage
  Type of battery
  Battery end point voltage when applicable

1.7 Synthesiser and PLL systems

Where use is made of a synthesiser and/or PLL (Phase locked loop) system for determining the transmitter frequency, the transmitter shall be inhibited when synchronisation is absent.

2 TEST CONDITIONS, POWER SOURCES AND AMBIENT TEMPERATURES

2.1 Normal and extreme test conditions

Type approval tests shall be made under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in Clauses 2.2 to 2.5

2.2 Test power source

During the approval tests 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 2.3.2. and 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.

In equipment with incorporated batteries 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 of ± 3 % relative to the voltage at the beginning of each test.

2.3 Normal test conditions

2.3.1 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	+15°C to +35°C
relative humidity	20% to 75%

NOTE: When it is impracticable to carry out the tests under these conditions, a statement giving the actual temperature and relative humidity during the tests shall be added to the test report.

2.3.2 Normal test power source

2.3.2.1 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 specification, 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 and 51 Hz.

2.3.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation from the usual type of regulated lead-acid battery source, the normal test source voltage shall be 1.1 times the nominal voltage of the battery (6 Volts, 12 volts etc.).

2.3.2.3 Nickel-cadmium battery

When the equipment is intended for operation from the usual type of nickel-cadmium battery, the normal test voltage shall be the nominal voltage of the battery (1.2V per cell).

2.3.2.4 Other power sources

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

2.4 Extreme test conditions

2.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in Clause 2.5 at an upper value of +55°C and at a lower value of -10°C

2.4.2 Extreme test source voltages

2.4.2.1 Mains voltage

The extreme test source voltages for equipment to be connected to an AC mains source shall be the nominal mains voltage ± 10 %. The frequency of the test power source shall be between 49 and 51 Hz.

2.4.2.2 Regulated lead-acid battery power sources

When the equipment is intended for operation from the usual type of regulated lead-acid power source, the extreme test voltages shall be 1.3 and 0.9 times the nominal voltage of the battery.

2.4.2.3 Nickel-cadmium battery

When the equipment is intended for operation from the usual type of nickel-cadmium battery, the extreme test voltages shall be 1.25 and 0.85 times the nominal voltage of the battery.

2.4.2.4 Other power sources

The lower extreme test voltage for equipment with power sources using primary batteries shall be as follows:

For Leclanché type of battery - 0.85 times the nominal voltage
For mercury type of battery - 0.9 times the nominal voltage

For other types of primary battery - end point voltage declared by the equipment manufacturer

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 authority and shall be recorded with the test results.

2.5 Procedure for tests and extreme temperatures

2.5.1 Test procedure

Before measurements are made, the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period.* If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such period as may be decided by the testing authority, 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.

2.5.1.1 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 temperature the equipment shall be placed in the test chamber and left until thermal balance[1] 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.

2.5.1.2 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 temperature the equipment shall be placed in the test chamber and left until thermal balance[1] 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. For tests at the lower temperatures the equipment shall be left in the test chamber until thermal balance[1] is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements.

3 ELECTRICAL TEST CONDITIONS

3.1 Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected through a network such that the impedance presented to the receiver input is 50 ohms.

This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of emf at the output terminals of the source including the associated network prior to connection to the receiver input terminals.

The effects of any intermodulation products and noise produced in the signal generators should be negligible.

3.2 Receiver mute or squelch facility

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[1] In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation 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 receiver is equipped with a mute or squelch circuit, this shall be made inoperative for the duration of the type approval tests.

3.3 Receiver rated audio output power

The rated audio output power shall be the maximum power, declared by the manufacturer, for which all the requirements of these specifications are met. With normal test modulation (Clause 3.4), the audio output power shall be measured in a resistive load, simulating the load with which the receiver normally operates. The value of this load shall be declared by the manufacturer.

3.4 Normal test modulation

For normal test modulation, the modulation frequency shall be 1 kHz and the resulting frequency deviation shall be 60 % of the maximum permissible frequency deviation (Clause 4.3.1). The test signal shall be substantially free from amplitude modulation.

3.5 Artificial antenna

Tests on the transmitter shall be carried out with a non-reactive non-radiating load of 50 ohms connected to the antenna terminals.

3.6 Equipment intended for duplex operation

This specification covers measurements for operation only in the simplex mode. Where equipment is intended to operate also in the duplex mode, using either an internal or external duplex filter, the requirements of this specification shall also be met when measurements are carried out using the antenna terminals of this filter. In this case, to ensure satisfactory duplex operation, it is recommended that the equipment should also meet the requirements of MPT 1315 “Requirements for duplex operation in the Land Mobile Service”.

3.7 Test site and general arrangements for measurements involving the use of radiated fields (see also Appendix A).

3.7.1 Test site

The test site shall be on a reasonably level surface or ground.

At one point on the site, a ground plane of at least 5 metres diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1.5 metres above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of $\lambda/2$ or 3 metres, whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurement results.

3.7.2 Test antenna

The test antenna shall be used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics. This antenna shall be mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1 to 4 metres. Preferably test antennae with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20 % of the measuring distance.

For radiation measurements, the test antenna shall be connected to a test receiver capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input. When necessary (for receiver measurements) the test receiver is replaced by a signal source.

3.7.3 Substitution antenna

The substitution antenna shall be a λ/2 dipole, resonant at the frequency under consideration, or a shortened dipole, calibrated to the λ/2 dipole. 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 external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 0.3 metre.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for radiation measurements and to a calibrated measuring receiver when the site is used for measurement of receiver characteristics. The signal generator and the receiver shall be operated at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

3.7.4 Alternative indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 metres by 7 metres and at least 2.7 metres 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 site arrangement is shown in principle in figure 1.

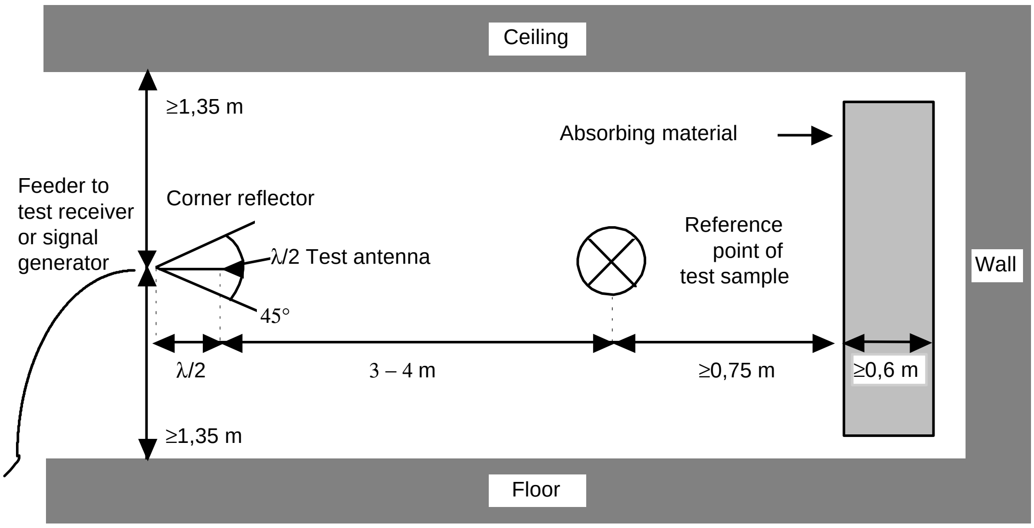

Figure 1: Indoor Site arrangement (shown for horizontal polarisation)

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 polarised measurements.

Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarised 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 λ/2 antenna in figure 1 may be replaced by an antenna of constant length, provided that this length is between λ/4 and λ/2 at the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of λ/2 to the apex may be varied.

The test antenna, test receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

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 0.1 metre in the direction of the test antenna as well 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 resited until a change of less than 2 dB is obtained.

3.8 Arrangement for test signals at the input of the transmitter

For the purpose of this specification, the transmitter audio frequency modulating signal shall be supplied by a signal generator applied at the microphone input, unless otherwise stated.

4 TRANSMITTER

4.1 Frequency error

4.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

4.1.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna (Clause 3.5). The measurement shall be made under normal test conditions (Clause 2.3) and repeated under extreme test conditions (Clauses 2.4.1 and 2.4.2 applied simultaneously).

4.1.3 Limit

The frequency error, under both normal and extreme test conditions, shall not exceed the values given below:

Table 1: Frequency error (kHz)

50 to 100 MHz	100 to 300 MHz	300 to 500 MHz
± 1.0	± 1.0 (Fixed) ± 1.5 (Mobile)	± 1.0 (Fixed) ± 1.5 (Mobile)

NOTE: For portable equipment having integral power supplies, the tolerance given shall not be exceeded over a temperature range of 0-30°C. Under extreme conditions, (Clause 2.4.1 and 2.4.2 applied simultaneously) the frequency error shall not exceed ± 2.5 kHz.

4.2 Carrier power

The maximum value of the effective radiated power of the carrier in an operating system will be a condition of the licence.

4.2.1 Definition

The transmitter carrier power is the mean power delivered to the artificial antenna during a radio frequency cycle, without modulation.

The rated output power is the carrier power declared by the manufacturer.

4.2.2 Method of measurement

The transmitter shall be connected to an artificial antenna (Clause 3.5) and the power delivered to this artificial antenna shall be measured.

The measurements shall be made under normal test conditions (Clause 2.3) and repeated under extreme test conditions (Clauses 2.4.1 and 2.4.2 applied simultaneously).

4.2.3 Limits

The carrier output power under normal test conditions shall be within ± 1.5 dB of the rated output power.

The carrier output power under extreme test conditions shall be within + 2 dB and - 3 dB of the rated output power.

NOTE 1: If the equipment is designed to operate with different carrier powers, the rated power for each power level or range of levels must be declared by the manufacturer. The power adjustment control shall not be accessible to the user.

NOTE 2: The requirements of this specification must be met for all power levels at which the transmitter can operate.

4.3 Frequency deviation

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

4.3.1 Maximum permissible frequency deviation

4.3.1.1 Definition

The maximum permissible frequency deviation is the maximum value of deviation under any condition of modulation.

4.3.1.2 Method of measurement

The frequency deviation shall be measured at the output of the transmitter connected to an artificial antenna (Clause 3.5) by means of a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and intermodulation products which may be generated in the transmitter.

The modulation frequency shall be varied between the lowest frequency considered to be appropriate and 2.55 kHz. The level of this test shall be 20 dB above the level of the normal test modulation (Clause 3.4).

4.3.1.3 Limits

At any modulating frequency, the frequency deviation shall not exceed 2.5 kHz.

4.3.2 Response of the transmitter to modulation frequencies exceeding 2.55 kHz

4.3.2.1 Definition

The response of the transmitter to modulation frequencies exceeding 2.55 kHz is the expression of the frequency deviation in relation to modulation frequencies exceeding 2.55 kHz.

4.3.2.2 Method of measurement

The transmitter shall be operated under normal test conditions (Clause 2.3) and loaded in accordance with Clause 3.5. The transmitter shall be modulated by normal test modulation (Clause 3.4). With a constant input level of the modulation signal, the modulation frequency shall be varied between 2.55 kHz and a frequency equal to the channel separation for which the equipment is intended, and the frequency deviation shall be measured by means of a deviation meter as described in Clause 4.3.1.2.

4.3.2.3 Limits

The frequency deviation at modulation frequencies between 2.55 kHz and 6.0 kHz shall not exceed the frequency deviation at a modulation frequency of 2.55 kHz. At 6 kHz the deviation shall be at least 6 dB below the deviation at a modulation frequency of 1 kHz. The frequency deviation at modulation frequencies between 6 kHz and a frequency equal to the channel separation for which the equipment is intended shall not exceed that which would be given by a linear representation of the frequency deviation (dB) in relation to the modulation frequency, starting at a point where the modulation frequency is 6 kHz and the deviation 6 dB below the value at 1 kHz and having a slope of 14 dB per octave, the frequency deviation diminishing as the modulation frequency is increased.

4.4 Adjacent channel power

4.4.1 Definition

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

4.4.2 Method of measurement

4.4.2.1 Method of measurement using a power measuring receiver

The adjacent channel power may be measured with a power measuring receiver which conforms with Clause 4.4.2.2 (referred to in this clause as the 'receiver').

a) The transmitter shall be operated at the carrier power determined in Clause 4.2 under normal test conditions (Clause 2.3). The output of the transmitter shall be linked to the input of the 'receiver' by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the 'receiver' input is appropriate.

b) With the transmitter unmodulated[2] , the tuning of the 'receiver' shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The 'receiver' attenuator setting and the reading of the meter shall be recorded.

c) The tuning of the 'receiver shall be adjusted away from the carrier so that the 'receiver' -6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in the table which follows.

Table 2

Specified necessary bandwidth (kHz)	Displacement of the 6 dB point (kHz)
8.5	8.25

d) The transmitter shall be modulated with 1250 Hz at a level which is 20 dB higher than that required to produce 60 % of the maximum permissible deviation (Clause 4.3.1).

e) The 'receiver' variable attenuator shall be adjusted to obtain the same meter reading as in step (b) or a known relation to it.

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

g) The measurement shall be repeated with the 'receiver' tuned to the other side of the carrier.

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[2] The measurement may be made with the transmitter modulated with normal test modulation (Clause 3.4) in which case this fact shall be recorded with the test result

4.4.2.2 Power measuring receiver specification

The power measuring receiver consists of a mixer, an IF filter, an oscillator, an amplifier, a variable attenuator and an rms value indicator. Instead of the variable attenuator with the rms value indicators it is also possible to use an rms voltmeter calibrated in dB. The technical characteristics of the power measuring receiver are given below.

4.4.2.2.1 IF filter

The IF filter shall be within the limits of the following selectivity characteristic:

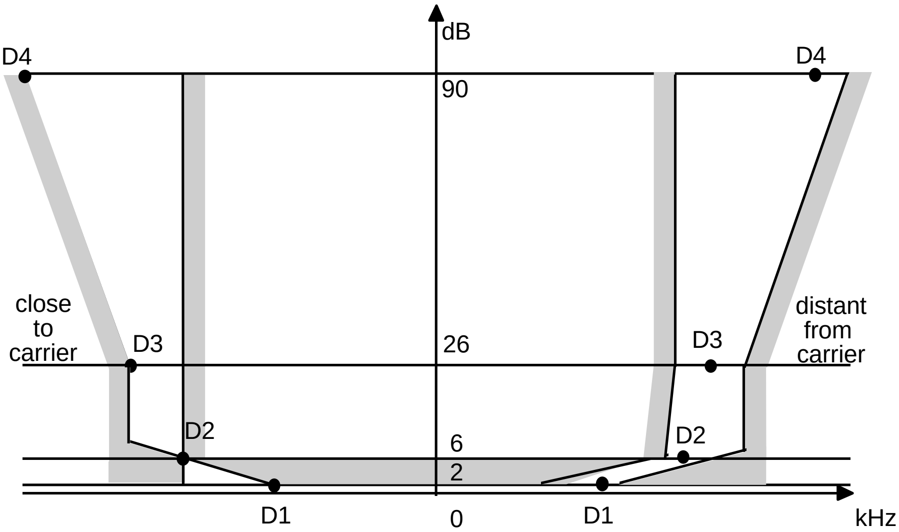

Figure 2

The selectivity characteristic of the filter shall be defined by values of frequency separation given in the following table:

Table 3: Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)

D1	D2	D3	D4
3.00	4.25	5.50	9.50

The attenuation points shall not exceed the following tolerances:

Table 4: Attenuation points close to the carrier

Tolerance range (kHz)			
D1	**D2**	**D3**	**D4**
+ 1.35	± 0.1	- 1.35	- 5.35

Table 5: Attenuation points distant from the carrier

Tolerance range (kHz)			
D1	**D2**	**D3**	**D4**
± 2.0	± 2.0	± 2.0	+ 2.0 - 6.0

The minimum attenuation of the filter outside the 90 dB attenuation points must be equal to or greater than 90 dB.

4.4.2.2.2 Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations and attenuation of 90 dB or more is recommended.

4.4.2.2.3 Rms value indicator

The instrument shall indicate accurately non-sinusoidal signals in a ratio of up to 10:1 between peak value and rms value.

4.4.2.2.4 Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low noise unmodulated transmitter, whose self noise has a negligible influence on the measurement result, yields a measured value of ≤-80 dB referred to the carrier of the oscillator.

4.4.3 Limits

The adjacent channel power shall not exceed a value of 60 dB below the transmitter carrier power without the need to be below 0.2 microwatt.

4.5 Spurious emission

4.5.1 Definition

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

The level of spurious emissions shall be measured as:

a) their power level in a specified load, and

b) their effective radiated power when radiated by the cabinet and structure of the equipment.

NOTE: b) is also known as ‘cabinet radiation’.

4.5.2 Methods of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal delivered into a 50 ohms load. This may be done by connecting the transmitter output through an attenuator to a spectrum analyser or selective voltmeter, or by monitoring the relative levels of the spurious signals delivered to an artificial antenna (Clause 3.5).

The transmitter shall be unmodulated and the measurements made over the frequency range 100 kHz to 2000 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

The measurements shall be repeated with the transmitter modulated with normal test modulation (Clause 3.4). The measurements shall be repeated with the transmitter in standby.

4.5.3 Method of measuring the effective radiated power.

On a test site, fulfilling the requirements of Clause 3.7, the sample shall be placed at the specified height on a non-conducting support. The transmitter shall be operated at the carrier power as specified under Clause 4.2, delivered to an artificial antenna (Clause 3.5) without modulation.

Radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 30 to 2000 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement. The measurement shall be repeated with the test antenna in the orthogonal polarisation plane.

The measurements shall be repeated with the transmitter modulated by normal test modulation (Clause 3.4). The measurements shall be repeated with the transmitter in standby.

4.5.4 Limits

The power of any spurious emissions shall not exceed the following values.

For conducted spurious emissions - fixed equipment, mobile and portable equipment, and for radiated spurious emissions - fixed equipment.

Table 6

TX Mode	100 kHz to 1000 MHz	1000 MHz to 2000 MHz
Operating	0.25 microwatt	1 microwatt
Standby	2 nanowatt	20 nanowatt

For radiated spurious emissions - mobile and portable equipment

Table 7

TX Mode	30 MHz to 2000 MHz
Operating	2.5 microwatt
Standby	20 nanowatt

4.6 Intermodulation attenuation

This requirement applies only to transmitters to be used in fixed stations.

4.6.1 Definition

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

4.6.2 Method of measurement

The output of the transmitter under test shall be connected to a signal source via a coupling device, presenting to the transmitter a load with an impedance of 50 ohms.

The coupling device can consist of a circulator, one port of which is to be connected by a coaxial cable to the output terminal of the transmitter, the second port is to be correctly terminated (nominal value 50 ohms). This termination is to be provided with means for connection to a selective measuring device (e.g. a spectrum analyser). The third port of the circulator is to be connected to the test signal source by means of an isolator.

Alternatively, the coupling device may consist of a resistive attenuator, which may be combined with an isolator, one end to be connected to the output terminal of the transmitter by coaxial cable and the other end to be connected to the test signal source. A selective measuring device is to be connected to the transmitter end of the attenuator by means of a sampling probe, giving the required attenuation.

The transmitter under test and the test signal source shall be physically separated in such a way that the measurement is not influenced by direct radiation. The test signal shall be unmodulated and the frequency shall be within 1 to 4 neighbouring channels above the frequency of the transmitter under test. The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious emissions. The test signal power level shall be adjusted to -30 dB relative to the carrier power level of the transmitter (Clause 4.2), both levels being measured at the output of the transmitter. The power level of the test signal shall be measured at the transmitter end of the coaxial cable, when disconnected from the transmitter and then correctly terminated (nominal value 50 ohms)[1].

The output power of the transmitter shall be measured directly at the output terminal connected to an artificial antenna (Clause 3.5).

With the transmitter switched on in an unmodulated condition the levels of the transmitter carrier and the intermodulation components are compared by means of the selective measuring device.

The length of the coaxial cable between the transmitter output and the coupling device shall be varied until the maximum level of the intermodulation component considered is obtained.

This measurement shall be repeated with the test signal at a frequency within 1 to 4 neighbouring channels below the transmitter frequency.

When the above measurements are performed, precautions must be taken, so that non-linearities in the selective measuring device do not influence the results appreciably. Furthermore, it should be ensured that the intermodulation components, which may be generated in the test signal source, are sufficiently reduced, e.g. by means of a circulator.

The intermodulation attenuation is expressed as the ratio in dB of the test signal power level to the power level of an intermodulation component.

4.6.3 Limit

The intermodulation attenuation shall be at least 15 dB for any intermodulation component.

For fixed station equipment to be used in special services (e.g. at communal sites) the intermodulation attenuation shall be at least 40 dB for any intermodulation component.

This may be achieved by means of isolating devices, such as circulators which must be supplied at the time of type approval.

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[1] The impedance that the transmitter presents to the test signal being unknown, the test signal level cannot be measured or its amplitude compared with that of the intermodulation components, while the transmitter is connected

5 RECEIVER

5.1 Maximum usable sensitivity

5.1.1 Definition

The maximum usable sensitivity of the receiver is the minimum level of signal (emf) at the receiver input, at the nominal frequency of the receiver, with normal test modulation (Clause 3.4), which will produce:

In all cases, an audio frequency output power of at least 50 % of the rated power output (Clause 3.3),

and

A SND/ND ratio[2] of 20 dB, measured at the receiver output through a telephone psophometric weighting network as described in CCITT Recommendation P.53A.

The characteristics of the 1 kHz band-stop filter used in SND/ND measurements shall be such that at the output the attenuation at 1 kHz will be at least 40 dB and at 2 kHz will not exceed 0.6 dB. The filter characteristic shall be flat within 0.6 dB over the ranges of 20 Hz to 500 Hz and 2 kHz to 4 kHz. In the absence of modulation, the filter must not cause more than 1 dB attenuation of the total noise power at the audio frequency output of the receiver under test.

5.1.2 Method of measuring the SND/ND ratio

A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 3.4 shall be applied to the receiver input terminals. An audio frequency output load and a distortion factor meter, incorporating a 1 kHz band-stop filter and psophometric telephone weighting network as mentioned in Clause 5.1.1.2 shall be connected to the receiver output terminals. Where possible, the receiver volume control shall be adjusted to give at least 50 % of the rated output power (Clause 3.3) and, in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated output power.

The test signal input level shall be reduced until a SND/ND ratio of 20 dB is obtained. The test signal input level under these conditions is the value of the maximum usable sensitivity. The measurement shall be made under normal test conditions (Clause 2.3) and repeated under extreme test conditions (Clauses 2.4.1 and 2.4.2 applied simultaneously).

Under extreme test conditions, a variation of the receiver output power of ± 3 dB from the value obtained under normal test conditions may be allowed.

5.1.3 Limit

The maximum usable sensitivity shall not exceed + 6 dB relative to an emf of one microvolt under normal test conditions, and + 12 dB relative to an emf of one microvolt under extreme test conditions.

5.2 Amplitude characteristic of receiver

5.2.1 Definition

The amplitude characteristic of the receiver is the relationship between the radio frequency input level of a specified modulated signal and the audio frequency level at the receiver output.

5.2.2 Method of measurement

A test signal at the nominal frequency of the receiver, with normal test modulation (Clause 3.4), at a level of + 6 dB relative to an emf of one microvolt, shall be applied to the receiver input and the audio output shall be adjusted to give a level of approximately 25 % of the rated output power (Clause 3.3). The input signal shall be increased to + 100 dB relative to an emf of one microvolt and the level of the audio output shall again be measured.

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[2] S = Signal
N = Noise
D = Distortion

5.2.3 Limit

For the specified change in radio frequency input level, the change of audio output level shall not exceed 3 dB between the minimum and maximum output levels.

5.3 Co-channel rejection

5.3.1 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.

5.3.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network (see also Clause 3.1). The wanted signal shall have normal test modulation (Clause 3.4). The unwanted signal shall be modulated with a frequency of 400 Hz with a deviation of 60 % of the maximum permissible frequency deviation (Clause 4.3.1.3). Both input signals shall be at the nominal frequency of the receiver under test and the measurement repeated for displacements of the unwanted signal of up to ± 3000 Hz.

The amplitude of the wanted input signal (emf) shall be adjusted to a level of + 6 dB relative to an emf of one microvolt (Clause 5.1). The amplitude of the unwanted input signal shall then be adjusted until either the SND/ND ratio or the SND/N ratio (psophometrically weighted) at the output of the receiver is reduced to 14 dB.

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 at the output of the receiver input for which the specified reduction in SND/ND ratio or SND/N ratio occurs.

5.3.3 Limit

The co-channel rejection ratio at any frequency of the unwanted signal within the specified range shall be greater than - 12 dB.

5.4 Adjacent channel selectivity

5.4.1 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 modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

5.4.2 Method of Measurement

The two input signals shall be applied to the receiver input via a combining network (see also Clause 3.1). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4). The unwanted signal shall be modulated by a frequency of 400 Hz with a deviation of 60 % of the maximum permissible frequency deviation (Clause 4.3.1.3), and shall be at the frequency of the channel immediately above that of the wanted signal.

The amplitude of the wanted input signal (emf) shall be adjusted to + 6 dB relative to an emf of one microvolt. The amplitude of the unwanted input signal shall then be adjusted until either the SND/ND ratio or the SND/N ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The measurement shall be repeated with an unwanted signal at the frequency of the channel below that of the wanted signal. The adjacent channel selectivity shall be expressed as the lower value of the ratios in dB for the upper and lower adjacent channels of the level of the unwanted signal to the level of the wanted signal.

The measurements shall be repeated under extreme test conditions (Clauses 2.4.1 and 2.4.2 applied simultaneously).

5.4.3 Limits

The adjacent channel selectivity shall not be less than 60 dB under normal test conditions, and no less than 50 dB under extreme test conditions.

5.5 Spurious response rejection

5.5.1 Definition

The spurious response rejection is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

5.5.2 Method of measurement

Two input signals shall be applied to the receiver input via a combining network (see also Clause 3.1). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4).

The unwanted signal shall be modulated with a frequency of 400 Hz with a deviation of 60 % of the maximum permissible frequency deviation (Clause 4.3.1.3).

The amplitude (emf) of the wanted input signal shall be adjusted to + 6 dB relative to an emf of one microvolt. The amplitude of the unwanted input signal shall be adjusted to a level of + 86 dB relative to an emf of one microvolt. The frequency shall then be varied over the frequency range from 100 kHz to 2000 MHz.

At any frequency at which a response is obtained, the input level shall be adjusted until the SND/ND ratio psophometrically weighted, is reduced to 14 dB.

The spurious response rejection ratio shall then be expressed as the ratio in dB between the unwanted signal and the wanted signal at the receiver input when the specified reduction in the SND/ND ratio is obtained.

NOTE: If the test equipment is not suitable for measuring at frequencies below 10 MHz, a note to this effect shall be made on the test report.

5.5.3 Limit

At any frequency separated from the nominal frequency of the receiver by an amount exceeding one channel separation, the spurious response rejection ratio shall be greater than 70 dB.

5.6 Intermodulation response

5.6.1 Definition

The intermodulation response is a measure of the capability of a 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.

5.6.2 Method of measurement

Three signal generators, A, B and C shall be connected to the receiver via a combining network (see Clause 3.1). The wanted signal, represented by signal generator A shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4). The unwanted signal from signal generator B shall be unmodulated and adjusted to the frequency separated by four times the channel separation above (or below) the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated with a frequency of 400 Hz with a deviation of 60 % of the maximum permissible frequency deviation (Clause 4.3.1.3), and adjusted to the frequency separated by eight times the channel separations above (or below) the nominal frequency of the receiver.

The amplitude of the wanted input signal (emf) shall be adjusted to the level of the limit for the maximum usable sensitivity (Clause 5.1). The amplitude of the two unwanted signals shall be maintained equal and shall be adjusted until the SND/ND ratio or SND/N ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The frequency of signal generator B shall be adjusted slightly to produce the maximum degradation of the SND/ND ratio or SND/N ratio. The level of the two unwanted test signals shall be readjusted to restore the SND/ND ratio or SND/N ratio of 14 dB.

The intermodulation response level is the receiver input level in dB produced by each of the two unwanted signal generators relative to an emf of one microvolt.

5.6.3 Limit

The intermodulation response level shall be greater than 70 dB relative to an emf of one microvolt for fixed station equipment, and 65 dB relative to an emf of one microvolt for mobile and portable equipment.

5.7 Blocking or desensitisation

5.7.1 Definition

Blocking is a change (generally a reduction) in the wanted output power of a receiver or a reduction of the SND/ND ratio or SND/N ratio due to an unwanted signal on another frequency.

5.7.2 Method of measurement

Two input signals shall be applied to the receiver via a combining network (see also Clause 3.1). The modulated wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4). Initially the unwanted signal shall be switched off and the input level of the wanted signal adjusted to + 6 dB relative to an emf of one microvolt.

The output power of the wanted signal shall be adjusted, where possible, to 50 % of the rated 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 output power. The unwanted signal shall be unmodulated, and the frequency shall be varied between +1 MHz and to +10 MHz, and also between - 1 MHz and - 10 MHz, relative to the nominal frequency of the receiver. The input level of the unwanted signal, at all frequencies in the specified ranges, shall be so adjusted that the unwanted signal causes:

> a reduction of 3 dB in the output level of the wanted signal

or

> a reduction to 14 dB of the SND/ND ratio at the receiver output (with a psophometric filter),

whichever occurs first.

This input level is the blocking level for the frequency concerned.

5.7.3 Limit

The blocking level for any frequency within the specified ranges, shall be not less than + 90 dB relative to an emf of one microvolt, except at frequencies on which spurious responses are found (Clause 5.5).

5.8 Spurious emissions

5.8.1 Definition

Spurious emissions are any emissions from the receiver.

The level of spurious emissions shall be measured by:

a) their power level in a specified load

and

b) their effective radiated power when radiated by the cabinet and structure of the equipment.

NOTE: b) is also known as 'cabinet radiation'

5.8.2 Method of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyser or selective voltmeter having an input Impedance of 50 ohms and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over a frequency range of 100 kHz to 2000 MHz.

5.8.3 Method of measuring the effective radiated power

On a test site fulfilling the requirements of Clause 3.7, the sample shall be placed at the specified height on a non-conducting support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads.

Radiation of any spurious components shall be detected by the test antenna and receiver over the frequency range 30 to 2000 MHz.

At each frequency at which a component is detected, the sample shall be rotated to obtain a maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

5.8.4 Limits

The power of any spurious emission shall not exceed the values given in the table which follows.

Table 8

100 kHz to 1000 MHz	**1000 MHz to 2000 MHz**
2 nanowatt	20 nanowatt

1 %

*	Radio frequency	± 50 Hz
*	Radio frequency voltage	± 2 dB
*	Radio frequency field strength	± 3 dB
*	Radio frequency carrier power	± 10 %
*	Adjacent channel power	± 3 dB
*	Impedance of artificial loads, combining units, cables, plugs, attenuators etc.	± 5 %
*	Source of impedance of generators and input impedance of measuring receivers	± 10 %
*	Attenuation of attenuators	± 0.5 dB
*	Temperature	± 1 °C
*	Humidity	± 5 %

7 INTERPRETATION OF THIS SPECIFICATION

In cases of doubt about the interpretation of this specification, the methods of carrying out the tests and the validity of statements made by the manufacturers of the equipment, the decision of the Radiocommunications Agency shall be final.

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ANNEX A: GUIDANCE ON THE USE OF RADIATION TEST SITES

For measurements involving the use of radiated fields, use may be made of a test site in conformity with the requirements of subclause 3.7 of this specification. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

A.1 Measuring distance

Practical experience has shown that the distance is not critical and does not significantly affect the results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and provided that the guidelines given in this Appendix are observed.

Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in the CEPT countries.

A.2 Test antenna

Different types of test antenna may be used since, in performing substitution measurements, calibration errors of the test antenna do not affect the measuring results.

Height variation of the test antenna over a range of 1 to 4 m is essential in order to find the point at which the radiation is a maximum.

Height variation of the test antenna may not be necessary at frequencies below approximately 100 MHz.

A.3 Substitution antenna

Variations in the measured results may occur with the use of different types of substitution antenna at frequencies below approximately 80 MHz. Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used should be included with the results of the tests carried out on the site.

A.4 Artificial antenna

The dimensions of the artificial antenna used during case radiation measurements should be small in relation to the sample under test.

Where possible, a direct connection should be used between the artificial antenna and the test sample. In cases where it is necessary to use a connecting cable, precautions should be taken to reduce the radiation from this cable by, for example, by the use of ferrite cores.

A.5 Auxiliary cables

The position of auxiliary cables (power supply and microphone cables, etc.) which are not adequately decoupled may cause variations in the measured results. In order to get reproducible results, cables and wires of auxiliaries should be routed vertically downwards from the non-conducting support.

ANNEX B

B.1 Method for testing the intermodulation characteristics of the signal generators

The intermodulation in the signal generators may be tested by the following procedure.

Insert a variable attenuator between the combining network and the receiver under test.

Increase the attenuation in steps of 1 dB and increase the output voltages of the generators by the same amounts, thus maintaining a constant signal level at the input to the receiver.

Since the intermodulation products in the output should remain constant, any increase in receiver output is caused by intermodulation in the signal generators.

B.2 Signal generator noise performance

The measurement of certain receiver characteristics, for example adjacent channel selectivity, can be inaccurate when the signal generator used as the unwanted signal source has an output signal with a high noise content.

Signal generator manufacturers normally state the attenuation of the spectral noise in terms of the noise power measured in a 1Hz bandwidth (dB/Hz) relative to the unmodulated carrier output power of the signal generator. The attenuation must be modified to take into account the total noise power which will appear in the IF passband of the receiver. Assuming that the spectral noise produced by the signal generator in the passband of the receiver IF filter is flat, a simple formula can be used to estimate the limit of the adjacent channel selectivity measurement due to the signal generator spectral noise.

A receiver characteristic which must be included in the calculation is the co-channel rejection. The portion of the noise spectrum of the signal generator appearing at the input of the receiver, although not a coherent signal, has a similar effect to a co-channel signal. A further 10 dB must be included in the calculation to allow for this characteristic.

If, for example, a 12.5 kHz channel spaced receiver is considered, the IF passband (6 dB points) for this type of receiver is normally 8 kHz, and assuming that the adjacent channel selectivity to be measured is 80 dB, then:

x = the adjacent channel selectivity to be measured, (dB)

y = the receiver IF passband (6 dB points, in Hz)

and

z = 10 dB (to allow for the effect of the co-channel signal)

Therefore,

The minimum attenuation of the noise power (dB/Hz) with respect to the carrier output power of the signal generator at its nominal frequency.

$$= x + (10 \log_{10} y) + Z \text{ dB/Hz}$$
$$= 80 + (10 \log_{10} 8000) + 10 \text{ dB/Hz}$$
$$= 129 \text{ dB/Hz}$$

NOTE 1: A further 3 dB should be allowed for measurement tolerances.

NOTE 2: The receiver IF passband is centred on the adjacent channel frequency and therefore allowance must be made for the portion (half) of the IF passband which extends towards the signal generator carrier frequency (Fc). Therefore, in the above example the attenuation of 129 dB/Hz is necessary at a frequency Fc ± (12.5 - 4) kHz = Fc ± 8.5 kHz.

ANNEX C: EXAMPLE OF COMBINING NETWORK

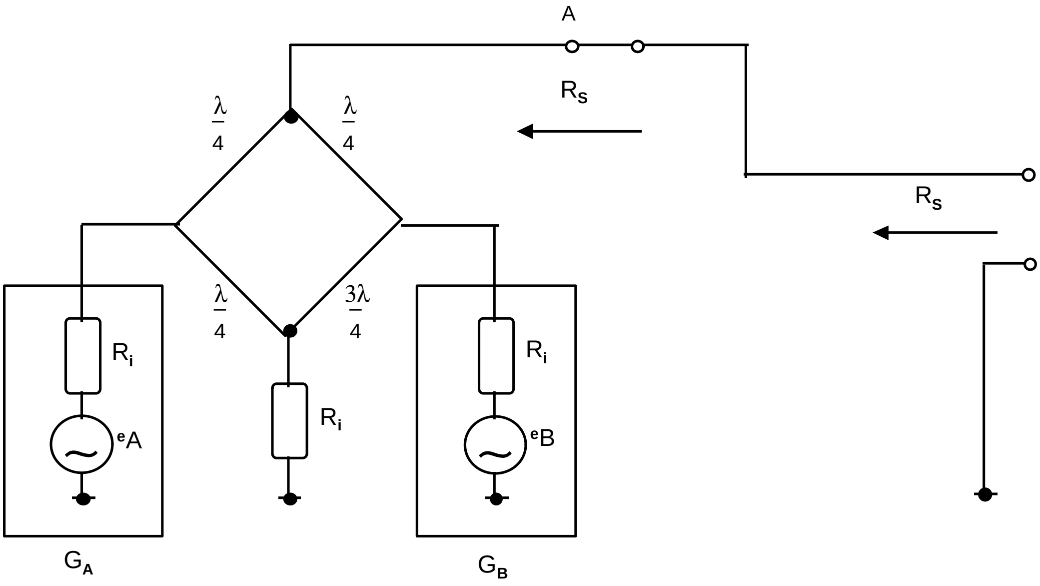
An example of a combining network using a hybrid ring is shown in Figure 3. The operation of this device is as follows:

The coaxial cable of the hybrid ring is cut to length of multiples of a quarter wavelength of the median frequency. The power from signal generator G_a will then be divided equally between the termination point A (provided the network is loaded at that point by a resistance R_i) and the resistor R_i) the value of which is equal to R_i. The signals from signal generator G_B at the output terminals of signal generator G_B will cancel each other since the two paths differ by half a wavelength.

The power from signal generator G_B is similarly divided and its signal at the output of the signal generator G_A cancelled.

Because the coaxial cable of the hybrid ring has a relatively low quality factor (Q), the cancellation will be effective over a wide range of frequency difference between the frequencies of the generators G_A and G_B.

The source impedance R_S, of the left-hand part of the network at point A is equal to R_i (for example 50 ohms) if the characteristic impedance of the cable is $\sqrt{2} \times R_i$ (for example 71 ohms).



G_A and G_B = Signal generators

Figure C1: Example of combining network using a hybrid ring