**Recommendation T/R 20-05 (Puerto de la Cruz 1974,
revised in Malaga-Torremolinos 1975, Stockholm 1976 and 1977, Brussels 1980 and Montpellier 1984)**

LOW-POWER PERSONAL PAGING SYSTEMS

Recommendation proposed by the "Radiocommunications" Working Group T/WG 3 (R)

Text of the revised Recommendation adopted by "Radiocommunications" Commission:

"The European Conference of Postal and Telecommunications Administrations

considering

(a) that paging systems use several frequency bands including the ISM bands.
(b) that seine of these bands are also used by other radiocommunication services and that in consequence it is desirable to avoid harmful interference as far as possible.
(c) that in some paging systems transmission is unilateral while in other systems there may be provision for using another channel for acknowledgment of receipt,
(d) that personal paging systems are in use in several countries and that it is desirable that the conditions of use and the technical characteristics of the equipment should be standardised as far as possible,
(e) that it would be advantageous for Administrations and for users and manufacturers of personal paging systems if the exchange of type-approval lest reports were to be initiated between those administrations wishing to do so.
(f) that the objective should he the mutual recognition by CEPT members of test reports and type-approval certificates,

recommends

1. that insofar as their national, regulations permit, CEPT members should aim to adopt arrangements for the approval of low power personal paging systems which are in accordance with the conditions set out in Annex I to this Recommendation,
2. that the technical specifications of such equipment and the methods of measurement used in type-approval testing should be those described in Annex II,
3. that test reports should contain sufficient detail to allow accurate identification of the equipment and of the tests carried out. For this purpose, applicants should provide. as a minimum requirement, the information specified in Annex III to this Recommendation, this information to be supplied when test reports are exchanged,
4. that when drafting test reports, Administrations should as far as possible ' follow the order of the tests and the paragraph numbering used in Annex II to this Recommendation and adopt the nomenclature used in that Annex."

Annex 1

CONDITIONS FOR THE USE OF LOW POWER PERSONAL PAGING SYSTEMS

1 . In principle, paging systems are unilateral transmission systems, which use coded signals to indicate to a particular person that they should contact another person or an office. For the purposes of these specifications, low power personal paging systems are:

   (a) intended for private users, with no connection to the public telephone network,
   (b) generally intended for calling persons within the same private premises.

2. Paging systems may include devices making it possible to transmit brief spoken messages to the person called.
3. An acknowledgement of receipt may be permissible, using a very low power transmitter, on condition that it is of very short duration. Except in cases where safety considerations are involved, a technical device must prevent the operation of this transmitter except to reply to a call.
4. The coding systems should be as sophisticated as possible in terms of operating safety and capacity.
5. Individual licences are required, and may be granted only if the equipment is in conformity with approved types and if its use is justified (e.g. if an inductive installation cannot be used).
6. The transmitter power and the type and height of the antenna must be selected so that the required objective is achieved, while covering only the essential service zone.

Annex II

TECHNICAL SPECIFICATIONS AND METHODS OF MEASUREMENT FOR TYPE APPROVAL TESTING OF LOW POWER PERSONAL PAGING SYSTEMS

1. SCOPE OFTHE SPECIFICATIONS

These technical specifications cover the performance considered necessary in order to make profitable use of the available frequencies. They do not necessarily include all the characteristics, which may be required by a user, nor do they necessarily represent the maximum performance achievable.

They apply to equipment with an external antenna connection as well as to equipment with an integral antenna. In these specifications an integral antenna is defined as one which is designed to be connected permanently to the transmitter or receiver without the use of a connector and/or cable.

1. 1. General

In the case of equipment which is designed to operate both with an integral antenna and with an external antenna and connector the equipment shall be tested as equipment intended to operate with a removable external antenna and shall meet the appropriate limits. In addition transmitter carrier power, spurious emissions from the transmitter and spurious emissions from the receiver shall be measured as for equipment with an integral antenna and the appropriate limits must be verified.

1.2. Frequencies

1.2.1. The carrier frequency of the personal paging transmitter may be selected within the Following frequency bands:

25 MHz - 41 MHz
440 MHz - 470 MHz

1.2.2. The carrier frequency of the transmitter for acknowledging receipt may be selected within the following frequency bands:

146 MHz - 174 MHz
440 MHz - 470 MHz

1.3. Channel spacing

1.3.1. For the call transmitter: 10 kHz, 12.5 kHz, 20 kHz and 25 kHz

1.3.2. For the response transmitter: 12.5 kHz and 25 kHz.

1.3.3. *Synthesisers and phase locked loop systems*

When the transmitter frequency is generated using a synthesiser and/or a phase locked loop system, transmission shall be inhibited when synchronisation is absent. Administrations wishing to verify the transient behaviour of transmitters should use the method specified in Appendix B.

1.4. The use of multi-channel equipment is not permitted. Equipment may transmit only when sending personal paging messages, for example, preamble signals, selective calling, voice frequency or coded messages.

1.5. Types of modulation

Amplitude, frequency and phase modulation are permitted

2. TEST CONDITIONS-POWER SUPPLIES 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 conditions.

The test conditions and procedures are described in Clauses 2.2. to 2.4.3. below.

2.2. **Test power source**

During type approval tests, (he power supply 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 test purposes, the supply voltage 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 measured at the points where the power cable is connected to the equipment.
In equipment with batteries incorporated, the test power source shall be connected as close to the battery terminals as practicable.
During the tests the power source voltage shall be maintained within a tolerance of ± 3% relative to the voltage level 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%
N.B. When it is impracticable to carry out the tests under tile conditions stated above, a note stating the actual temperature and relative humidity during the tests, shall be added to the test report.

2.3.2. *Normal test power supply*

2.3.2.1. Mains voltage and frequency

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of these specifications, the nominal mains voltage shall be the declared voltage or any of the declared voltages for which the equipment is stated to have been 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 on vehicles

When the equipment is designed to operate on the usual types of regulated lead-acid battery power source on vehicles, the normal test voltage shall be 1.1 times the nominal voltage of the battery (6 volts. 12 volts, etc.).

2.3.2.2. Other power sources

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

2.4. **Extreme test conditions**

2.4.1. *Extreme temperatures*

For tests at extreme temperatures, measurements shall be made in accordance with Clause 2.4.3. The upper and lower values shall be those of one or other of the following ranges:
- 25°C to + 55°C
- 10°C to + 55°C
Test reports shall specify the range selected.

2.4.2. *Extreme test power supply values*

2.4.2. 1. Mains voltage and frequency

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

2.4.2.2. Regulated lead-acid battery power sources on vehicles

When the equipment is designed to operate on the usual types of regulated lead-acid battery power sources on vehicles, the extreme test voltages shall be 1.3 and 0.9 times the nominal battery voltage (6 volts, 12 volts, etc.).

2.4.2.3. Other power sources

The lower extreme test voltage for equipment powered by primary batteries shall be as follows:

1. for the Leclanché type of battery:
   0.85 times the nominal voltage of the battery;
2. for mercury batteries:
   0.9 times the nominal voltage of the battery;
3. for lithium batteries:
   0.85 times the nominal voltage of the battery;
4. for other types of primary battery:
   the end point voltage declared by the equipment manufacturer.

For equipment using other sources, the extreme test voltages shall be those declared by the manufacturer and agreed by the testing authority. They shall be recorded with the test results.

For equipment capable of operating with a variety of power sources, the extreme test voltages must be determined for each of these sources and the upper and lower values obtained shall be taken as the extreme test voltages. These values should be specified in the test results

2.4.3. *Procedure for tests at extreme temperatures*

Before measurements are made, the equipment shall have reached thermal equilibrium in the test chamber. The equipment shall be switched off until thermal equilibrium is achieved. If the thermal equilibrium 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 tests shall be chosen and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

Before commencing tests at the upper temperatures, the equipment shall be placed in the test chamber and left until thermal equilibrium is achieved. 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 equilibrium is achieved and shall then be switched to the standby or receive condition for one minute, after which the equipment shall meet the specified requirements.

3. GENERAL CONDITIONS

3.1. **Normal test modulation (for voice frequencies)**

During normal test modulation, the modulation frequency shall be 1 kHz. In the case of equipment using frequency or phase modulation, the frequency deviation shall be as shown in the table below. The test signal shall be largely devoid of spurious amplitude modulation.

Channel separation (kHz)	Frequency deviation (kHz)
10	1
12.5	1.5
20	2.4
25	3

Table 1 (T/R 20-05).

In the case of equipment using amplitude modulation, the modulation ratio shall be 60%.

3.2. **Normal coded test signal (for calling)**

The normal coded test signal shall consist of correctly coded signals separated one from another by a time interval which shall be not less than the reset time of the receiver. This signal shall be that which occupies the widest passband, as agreed by the manufacturer and the testing authority. Information on this test signal shall be recorded in the test report.

The encoder, which shall constitute an integral part of the transmitter, shall be capable of supplying the normal coded test signal. As far as possible, modulation should be continuous throughout the duration of the tests.

3.3. **Artificial antenna**

Tests on the transmitter shall be carried out with a non-reactive, non-radiating load of 50 ohms connected to the external antenna terminals or in the case of equipment with an integral antenna, to the test fixture.

3.4. **Test fixture for equipment with an integral antenna**

In the case of equipment designed to operate with an integral antenna, the manufacturer may be required to supply a suitable test fixture permitting relative measurements to be made on the sample under test.

This test fixture shall provide a radio frequency outlet with an impedance of 50 ohms at the working frequency of the equipment.

The test fixture shall, as a minimum requirement, permit audio frequency input and output connections to be made (if required) and the power supply of the equipment to be replaced by an external source. The characteristics of this test fixture under normal and extreme conditions shall be subject to the approval of the testing authority.

The testing authority shall concern itself with the following characteristics:

(a) coupling losses shall not be excessively high, that is, not greater than 30 dB:

(b) the variation of coupling loss with frequency shall not cause errors in measurement using the test fixture greater than 2 dB;

(c) the coupling device shall not incorporate any non-linear elements.

The testing authority may provide its own test fixture.

3.5. **Test site and general arrangements for measurements involving the use of radiated fields**

(For *general advice,* see also Appendix A.)

3.5.1. *Outdoor test site*

3.5.1.1. The test site shall be located on a surface or ground which is reasonably level.

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 support, capable of rotation through 360' in the horizontal plane, shall be used to locate the test sample at a *height of* 1.5 metres above the ground plane. For equipment operating on frequencies above 50 MHz this support shall be non-conducting.

For equipment operating at frequencies up to 50 MHz, this support shall consist of a plastic tube filled with salt water (9 grammes NaC1 per litre), this tube having a length of 1.5 *metres and* an internal diameter of 10 ± 0.5 centimetres. The upper end of the tube is closed by a metal plate with a diameter of 15 em in contact with the water. The sample shall be placed on this plate so that:

- its antenna is vertical,
- its side of largest area is resting on the metal plate.

If these two *requirements cannot* be met at the same time, a second metal plate 10 x 15 em in size should be used. This plate shall be hinged to the first plate alone its 10 em edge in such a way that the angle *between* them can be varied *between* 0° and 90°. The hinge point shall be adjustable so that the centre of the sample can be placed above the *centre of* the circular plate (″first plate″).

Samples whose length along the antenna axis is less than 15 em shall be arranged so that the base of the antenna is at the edge of the hinged plate.

The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of not less than λ 2 or 3 metres from the equipment whichever is greater. The distance actually used shall be recorded with the results of the tests.

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

3.5.1.2. Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna when radiation measurements are being made. Where necessary, it shall serve as a transmitting antenna when the test site is used for the measurement of receiver characteristics. This antenna shall be mounted on a support capable of allowing the antenna to be used either horizontally or vertically polarised and the height of its centre above ground to be varied over the range 1-4 metres. For preference, a test antenna of high directivity should be used. The length of the test antenna along the measurement axis shall not exceed 20% of the distance from the test antenna to the test sample.

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For radiation measurements, the test antenna shall be connected to a measuring 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 measuring receiver shall be replaced by a signal source.

3.5.1.3. Substitution antenna

The substitution antenna shall be a λ. 2 dipole, resonant at the frequency under investigation, or a shortened antenna, or a horn calibrated against the $\lambda/2$ dipole. The centre of this antenna shall coincide with the reference point of the test sample which it replaces. This reference point shall be the volume centre of the test sample, when the sample has its antenna mounted inside the cabinet, or the point at which an external antenna is connected to the cabinet.

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

The substitution antenna shall be connected to a calibrated signal generator, when the test 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 tuned to the frequency under investigation and shall be connected to the antenna through suitable matching and balancing networks.

3.5.2. *Indoor test site*

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

The test site may be a laboratory room having 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 test site arrangement is in principle as shown in Figure 1 (T R 20-05).

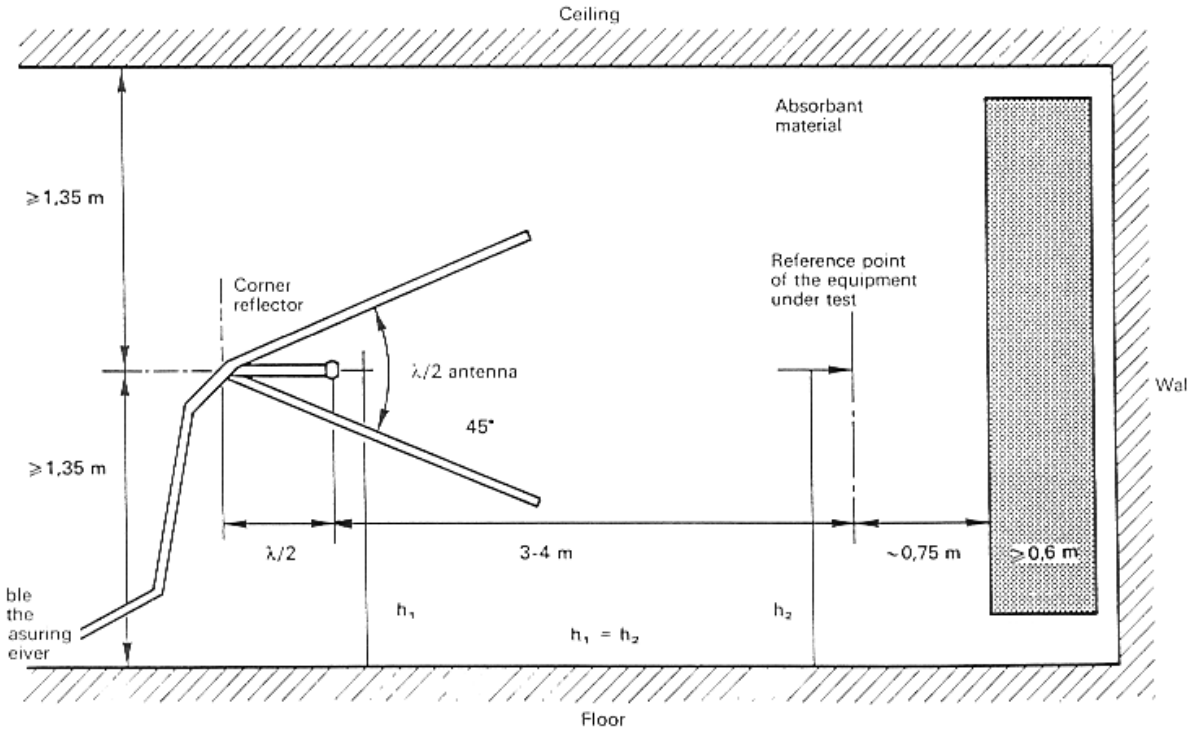

Figure 1 (T R 20-05). Indoor site arrangement (shown for horizontal polarization).

Potential reflections from the wall behind the equipment under test are reduced by placing an absorbing material in front of this wall. 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 sidewalls for vertically polarised measurements.
For the lower part of the frequency range (below approximately 175 MHz) the corner reflector and absorbing barrier are not necessary. For the upper part of the frequency range, the corner reflector is not required if a horn or a parabolic antenna is used. For practical reasons, the 112 antenna in Figure 1 T/R 20-05) may be replaced by an antenna of constant length, provided that the length is between the values of k/4 and corresponding to the measurement frequency and that the sensitivity of the measuring apparatus is sufficient. Similarly, the distance of $\lambda/2$ to the apex (of the corner reflector) may be varied.
The test antenna, the measuring receiver, the substitution antenna and the signal generator shall be used in the same way as in the general method. To ensure that errors are not caused by propagation paths approaching the point at which phase cancellation between the 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 perpendicular directions. If these changes of distance cause a signal change of greater than 2 dB, the test sample shall be re-sited until a change of less than.2 dB is obtained.

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 (if possible), with the transmitter connected to an arti6cial antenna (Clause 3.3.). Equipment with integral antennae shall be placed in a test fixture (Clause 3.4.2.) connected to the artificial antenna. The measurement shall be made under normal test conditions (Clause 2.3.) and under extreme test conditions (Clause 2.4.) (Clauses 2.4.l.. and 2.4.2. applied simultaneously).

4.1.3. Limits
The frequency error shall not exceed the values given in Table II T/R 20-05) in both normal and extreme test conditions or in any intermediate set of conditions.

Channel spacing (kHz)	Frequency error (kHz)		
	25-41 MHz	146-174 MHz	440-470 MHz
20 and 25	± 0.6	± 2.0	± 2.5
10 and 12.5	± 0.6	± 1.5[a)]	± 1.5[b)]

Table II (T/R 20-05).

a) Even closer tolerances are desirable.
b) The tolerance shown in the table is provisional and must not be exceeded within the temperature range 0' to +30'. Under extreme temperature conditions (Clause 2.4.1.) the frequency error must not exceed ± 2.5 kHz.

4.2. Transmitter carrier power

4.2.1. *Definition*

The transmitter carrier power is the mean power delivered to the artificial antenna during a radio frequency cycle or, in the case of equipment with an integral antenna, the effective radiated power in the direction of maximum field strength under specified conditions of measurement (Clause 3.5.) in the absence of modulation (if possible).
The rated output power is the carrier power declared by the manufacturer.

4.2.2. *Method* of *measurement for equipment with a connection for an external antenna*
The transmitter shall be connected to an artificial antenna (Clause *3.1)* and the power delivered to this artificial antenna shall be measured.
The measurements shall be made under normal test conditions (Clause *2.1)* and extreme test conditions (Clause 2.4.) (Clauses 2.4.1. and 2.4.2. applied simultaneously).

4.2.3. *Method of measurement for equipment with integral antenna*

4.2.3.1. Method *of* measurement under normal test conditions
On a test site, which fulfils the requirements of Clause 3.5., the test sample shall be place on the support in the following position:
(a) For equipment with an internal antenna, it shall stand vertically, with that axis vertical which is closest to vertical in normal use.
(b) For equipment with a rigid external antenna, the antenna shall be vertical.
(c) For equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.
The transmitter shall be switched on, without modulation (if possible) and the test receiver tuned to the frequency of the signal to be measured. The test antenna shall be orientated for vertical polarisation and shall be raised or lowered through the specified height range until a maximum signal level is detected by the measuring receiver.
The transmitter shall then be rotated through 360° until the maximum signal is received.
N..B. This maximum may be a lower value than the value obtainable at heights outside the specified limits.

The transmitter shall be replaced by the substitution antenna, as defined in Clause 3.5., and the test antenna raised or lowered as necessary to ensure that the maximum signal is still received. The level of the input signal applied to the substitution antenna shall be adjusted until the level in the measuring receiver is the same as that from the transmitter or is in a known relationship to it.
The transmitter carrier power shall be equal to the power supplied to the substitution antenna, increased if necessary in the known relationship.
The measurement shall be repeated for any alternative antenna supplied by the manufacturer.
A check should be made in other planes of polarisation to ensure that the value obtained above is the maximum value. If greater values are obtained, this fact shall be recorded in the test report.

4.2.3.2. Method of measurement under extreme conditions
The sample shall be placed in the test fixture (Clause *3A.)* and the power delivered to the artificial antenna measured. The measurements shall be made under normal test conditions (Clause *2.1)* and under extreme test conditions (Clause *2A.)* (Clauses *2.4. 1.* and *2.4.2.* applied simultaneously).

4.2.4. *Limits*
The carrier output power under normal and extreme test conditions shall not exceed the following values:
(a) For call transmitters: 5 W.
(b) For response transmitters: 50 mW

4.3. **Adjacent channel power**

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

4.3.2. *Method of measurement*
4.3.2.1. *General*
Two methods are proposed which give equivalent results. The member Administrations of the CEPT are invited to use either or both of these methods. The method used shall be stated in the test reports.
N.B. When using the test fixture for these measurements, it is important to ensure that direct radiation from the transmitter to the power measuring receiver or the spectrum analyser does not affect the results *of*' the measurements.

4.3.2.2. Method of measurement using a power measuring receiver

The adjacent channel power may be measured with a power measuring receiver, which fulfils the requirements of Clause 4.3.2.2.2. (this equipment is referred to in Clause 4.3. as the "receiver").

4.3.2.2.1. Operations

(a) The transmitter shall be operated at the 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 input is appropriate.

In the case of equipment with an integral antenna, the equipment shall be placed in the text fixture (Clause 3.4.2) and operated at the carrier power (see Clause 4.2.) under normal test conditions (Clause 2.3.). The radio frequency output of the test fixture shall be connected to the input of the "receiver" with an appropriate level of signal at the input.

(b) With the transmitter unmodulated[1)], the "receiver" shall be tuned to the frequency, which gives a maximum response. This shall be the 0 dB point. The attenuation of the "receiver" and the reading on the measuring apparatus shall be recorded.

(c) The "receiver" shall be tuned to a frequency such that the -6 dB response at the "receiver" corresponding to the frequency closest to the transmitter carrier frequency, is displaced from the nominal carrier frequency as indicated in Table III (T/R 20-05).

Adjacent channel Spacing (kHz)	Specified necessary bandwidth (kHz)	Displacement of the 6 dB point
25	16	17
20	14	13
12.5	8.5	8.25
10	8.5	5.75

Table III (T/R 20-05).

(d) The transmitter shall be modulated:

1. For voice frequency messages, with a signal at 1.250 Hz at a level 20 dB* greater than the level producing the frequency deviation or the modulation depth indicated in Clause 3.1. (normal test modulation), and
2. For coded messages, with the normal coded test signal (Clause 3.2.).

(e) The variable attenuator of the "receiver" shall be adjusted so as to obtain the same meter reading as in (b) or one in a known relationship to it.

(f) The ratio of adjacent channel power to the carrier power is given by the difference between the attenuator settings recorded in (b) and (c) corrected for any difference in the meter readings.

(g) The measurement shall be repeated for the other adjacent channel.

4.3.2.2.2. Power measuring receiver specification

The power measuring receiver shall comprise a mixer, an intermediate frequency filter, and an oscillator, an amplifier, a variable attenuator and an r.m.s. indicator. Instead of using the variable attenuator with the r.m.s. indicator, a dB-calibrated r.m.s. voltmeter may be used. The technical characteristics of the power measuring receiver are given below.

[1)] Measurements may be made with [he transmitter modulated with the normal coded test signal (Clause 3.2.) or the normal test modulation (Clause 3.1.), in which case this fact shall be recorded with the test results.

[*)] For equipment incorporating a microphone, and where acoustic coupling is required, a value of 10 dB may be used. This must be recorded in the test report.

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4.3.2.2.2.1. IF-filter

The IF-filter selectivity characteristic shall be as given by Figure 2 (T/R 20-05) below:

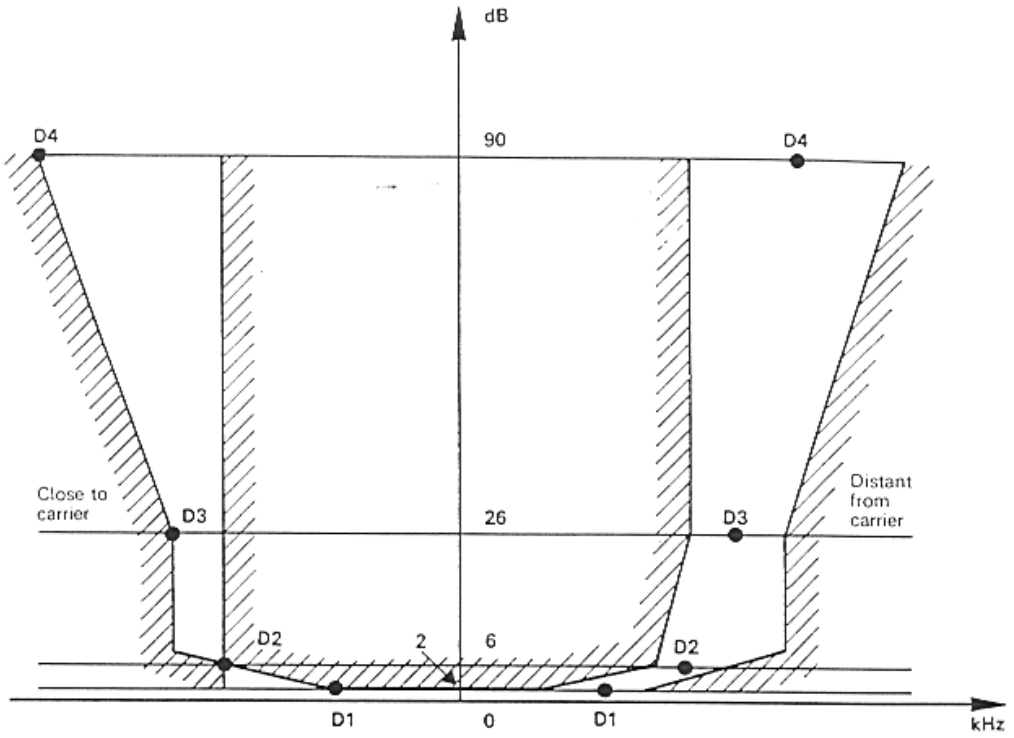

Figure 2 (T/R 20-05). Selectivity characteristic of the "receiver".

Depending on the channel spacing, the selectivity characteristic shall keep the following frequency separations from the nominal centre frequency of the adjacent channel:

Channel spacing (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
10/12.5	3	4.25	5.5	9.5
20	4	7.0	8.25	12.25
25	5	8.0	9.25	13.25

Table IV (T/R 20-05).

Depending on the channel spacing, the attenuation points shall not exceed the following tolerances for frequency error:

Channel spacing (kHz)	Tolerances range (kHz)			
	D1	D2	D3	D4
10/12.5	+1.35	±0.1	−1.35	−5.35
20	+3.1	±0.1	−1.35	−5.35
25	+3.1	±0.1	−1.35	−5.35

Table V (T/R 20-05). Attenuation points close to carrier.

Channel spacing (kHz)	Tolerances range (kHz)			
	D1	D2	D3	D4
10/12.5	± 2.0	± 2.0	± 2.0	+ 2.0 – 6.0
20	± 3.0	± 3.0	± 3.0	+ 3.0 – 7.0
25	± 3.0	± 3.5	± 3.5	+ 3.5 – 7.5

Table VI (T/R 20-05). Attenuation points distant from carrier.

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

4.3.2.2.2.2. 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 requirements an attenuation of 90 dB or more is recommended.

4.3.2.2.2.3. R.m.s. indicator

The instrument shall have an accurate indication of the r.m.s. value of non-sinusoidal signals with a peak amplitude to r.m.s. value ratio of up to at least 10:1.

4.3.2.2.2.4. Oscillator and amplifier

The oscillator and the amplifier shall be so designed that the measurement of the adjacent channel power of an unmodulated transmitter whose self-noise has a negligible influence on the measurement result yields a value of ≤ -90 dB for channel spacing of 20 and 25 ± and ≤ -80 dB for channel spacing of 10 and 12.5 kHz referred to the transmitter carrier power.

4.3.2.3. Method of measurement using a spectrum analyser

4.3.2.3.1. The adjacent channel power may be measured with a spectrum analyser, which fulfils the requirements of Clause 4.3.2.5. 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 spectrum analyser by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the analyser input is appropriate. The transmitter shall be modulated:

1. For voice frequency messages, with a signal at 1.250 Hz at a level 20 dB* greater than the level producing
   the frequency deviation or the modulation depth indicated in Clause 3.1. (normal test modulation), and
2. For coded messages, with the normal coded test signal (Clause 3.2.).

The spectrum analyser shall be so adjusted that the spectrum of the transmitter output, including that part which lies within the adjacent channels, is displayed.

For the purpose of this test, the bandwidth of a receiver of the type normally used in the system shall be selected from the following values:

(a) 16 kHz for a channel spacing of 25 kHz:
(b) 14 kHz for a channel spacing of 20 kHz
(c) 8.5 kHz for a channel spacing of 10/12.5 kHz

with a tolerance of ±: 10%.

The central frequency or the band within which measurements are to be made shall have a separation from the normal from the nominal carrier frequency of the transmitter equal cc the channel separation for which the equipment is intended.

The adjacent channel power is the sum of the power relative to the wanted signal and of the noise in the band under investigation.

This sum may be calculated or an automatic power level integrating device may be used to obtain it (see Clause 4.3.2.3 3).

In the latter case, the relative power level of the unmodulated transmitter carrier is measured initially by integration within the band under consideration, centred on the nominal frequency. The integration is repeated with the transmitter modulated by the signal described above, in the same band centred on the adjacent channel, and the input level of the carrier signal increased until the same power level is obtained at the output of the integrating device.

The difference in the input levels, expressed in dB, is the ratio, in dB, of the adjacent channel power to the carrier power.

* For equipment incorporating, a microphone, and where acoustic coupling is required, a value of 10 dB may be used. This must be recorded in the test report

The adjacent channel power is determined by applying this ratio to the carrier output power as measured in Clause 4.2. or by a direct substitution measurement using a calibrated source.
The measurement shall be repeated for the other adjacent channel.

4.3.2.3.2. Spectrum analyser specification
The specification shall fulfil the following requirements:
It shall be possible, using a resolution bandwidth of 1 kHz, to measure the amplitude of a signal of noise at a level of 3 dB or more above the noise level of the spectrum analyser, as displayed on the screen, to an accuracy of approximately: ±2 dB in the presence of a signal with a frequency displacement of:
(a) 10 kHz for channel spacings of 20 and 25 kHz, at a level 90 dB above the level of the signal to be measured;
(b) 6.25 kHz for a channel spacing of 12.5 kHz, at a level 80 dB above the level of the signal to be measured (c) 5 kHz for a channel spacing of 10 kHz, at a level 80 dB above the level of the signal to be measured. The reading accuracy of the frequency marker shall be within ± 2% of the adjacent channel separation. The accuracy of relative amplitude measurements shall be within ± 1 dB.
It shall be possible to adjust the spectrum analyser to allow the separation on the screen of two components with a frequency difference of 1 kHz.

4.3.2.3.3. Integrating and power summing device
The integrating and power summing device is connected to the video output of the spectrum analyser described in clause 4.3.2.3.2.
It shall be possible to summate the effective power of each of the discrete components and the noise power in the selected bandwidth and to express this as a ratio to the transmitter carrier power.
The position and the width of the integration ranges selected may be indicated on the spectrum analyser by brightening the trace.
When power levels of 50 nanowatts or less are measured, the output of the device shall exceed the internal noise level by 10 dB. The dynamic range of the device shall permit measurement of the values required under Clause 4.3.3. with a margin of at least 10 dB.

4.3.3. *Limits*
The power in the adjacent channel shall not exceed the values shown in Table VII (T/R 20-05).

Channel spacing (kHz)	Adjacent channel power (μW)
	20 μW. 60 dB below the carrier power. It shall not be necessary to achieve a value below 0.2 μW. 70 dB below the carrier power. It shall not be necessary to achieve value below 0.2 μW

Table VII (T/R 20-05).

4.4. **Spurious emissions of the transmitter**

4.4.1. *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 transmission line or antenna, and
(b) their effective radiated power when radiated by the cabinet and structure of' the equipment.
(b) is also known as "cabinet radiation".
For equipment which can only be used with an integral antenna, only the measurements mentioned under (b) apply.

4.4.2 *Method of measuring the power level (a)*

Spurious emissions shall be measured as the power level of any discrete signal delivered into a 50 ohm load. This may be done by connecting the transmitter output through an attenuator to a spectrum analyse selective voltmeter, or by monitoring the relative levels of the spurious signals delivered to an artificial antenna (Clause 3.3.).

The transmitter shall be unmodulated (if possible) and measurements made over the frequency range 100 kHz to 4.000 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 the normal coded test signal (Clause 3.2.) and/or the normal test modulation (Clause 3.1.).

The measurements shall be repeated with the transmitter in the standby mode.

4.4.3. *Method of measuring the effective radiated power (b)*

On a test site, fulfilling the requirements of Clause 3.5., the test sample shall be placed at the specified height on the support described in Clause 3.5.1.1. The transmitter shall be operated at output power connected to an artificial antenna (Clause 3.3.), and shall be unmodulated if possible.

Radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 25 MHz to 4.000 MHz, excluding the channel on which the transmitter is intended to operate and its adjacent channels.

At each frequency at which an emission is detected, the test sample shall be orientated to obtain a maximum field-strength response and the effective radiated power of each component determined by a substitution measurement.

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

The measurements shall be repeated with the transmitter modulated with the normal coded test signal (Clause 3.2.) and/or normal test modulation (Clause 3.1.).

The measurements shall be repeated with the transmitter in the "standby" position.

4.4.4. *Limits*

The power of any spurious emission shall not exceed the values shown in Table VIII (T/R 20-05).

	100 kHz to 1.000 MHz	1.000 MHz to 4.000 MHz
Transmit	0.25 μW	1 μW
Standbv	2 nW	10 nW

Table VIII (T/R 20-05).

5. RECEIVER

5.1. Spurious emissions

5.1.1 *Definition*

Spurious emissions are any emissions from the receiver. The level of spurious emissions shall be measured by:

(a) their power level in a transmission line or antenna, and

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

(b) is also known "cabinet radiation".

5.1.2. *Method* of m*easuring the power level (a)*

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 component shall be determined by a substitution method using a signal generator. The measurements shall extend over a frequency range of 100 kHz to 4.000 kHz.

5.1.3. *Method of measuring the effective radiated power (b)*

On a test site fulfilling the requirements of Clause 3.5.1., the test sample shall be placed at the specified height on the support. The receiver shall he operated from a power source via a radio Frequency filter to avoid radiation from the power leads.

The receiver shall be connected to a non-reactive, non-radiating load of 50 ohms (the measurements shall be repeated with the receiver connected to a real antenna).
The emission of any spurious components shall be detected with the test antenna and the receiver over a range of 25 MHz to 4.000 MHz.
At each frequency at which an emission is detected, the test sample shall be orientated to obtain maximum response and the effective radiated power of each component determined by a substitution measurement.
The measurements shall be repeated with the test antenna in the orthogonal polarised plane.

5.1.4. *Limits*
The power of any spurious emission in the specified range of frequencies shall not exceed.
- 2 nW between 100 kHz and 1.000 kHz:
- 20 nW between 1.000 kHz and 4.000 kHz.

6. ACCURACY OF.MEASUREMEN1

The tolerances for the measurement of the following parameters shall be as given below

6.1.1.	DC voltage	± 3%
6.1.2.	AC mains voltage	± 3%
6.1.3.	AC mains frequency	± 0.5%
6.2.1.	Audio frequency voltage, power	± 0.5 dB
6.2.2.	Audio frequency	± 1%
6.2.3.	Distortion and noise of audio frequency generators	1%
6.3.1.	Radio frequency	± 50 Hz
6.3.2.	Radio-frequency voltage	± 2 dB
6.3.3.	Radio frequency held strength	± 3 dB
6.3.4.	Radio-frequency carrier power	± 10%
6.3.5.	Adjacent channel power	± 3 dB
6.4.1.	Impedance of artificial loads, combining units, cables, plugs, attenuators, etc.	± 5%
6.4.2.	Source impedance of generators and input impedance of measuring receivers	± 10%
6.4.3.	Attenuation of attenuators	± 0.5 dB
6.5.1.	Temperature	± 1°C
6.5.2.	Humidity	± 5%

Appendix A

GUIDANCE ON THE USE OF TEST SITES FOR RADIATED FIELD MEASUREMENTS

The test site may be used for radiation measurements in accordance with the requirements of Clause 3.5. of this Annex, in which case the following conditions shall be observed to ensure the validity of the results obtained.

A.1. Test site

It has been shown that the measuring distance is not critical and does not significantly affect the results, provided that the distance is not less than $\lambda/2$ for the frequency of measurement and that the precautions described in this Annex 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 1-4 metres is essential in order to determine the height corresponding to maximum radiation.

Height variation of the test antenna may not be necessary for measurements at low frequencies such as those below 100 MHz.

A.3. Substitution antenna

At still lower frequencies, below about 80 MHz, variations in the measuring result may be observed with the use of different types of substitution antennae. Where a shortened dipole antenna is used, the characteristics of the (type of) antenna used should be included with the results of the tests.

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.

In this case the artificial antenna should be connected directly to the test sample.

In cases where it is necessary to use a connecting cable, steps should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores.

A. 5. Auxiliary cables

Variations in the measuring results may be caused by the position of auxiliary cables, which are not adequately decoupled. In order to ensure reproducible results, cables and wires of auxiliaries shall be mounted vertically downwards (through a hole in the isolating support or in the base plate of the salt water column) and shall be fitted at the upper part with a radio frequency stop filter (for example, using ferrite cores).

Appendix B

GUIDANCE ON MEASUREMENT FOR THE TRANSIENT BEHAVIOUR OF TRANSMITTERS

B.1. **Definition**

The transient behaviour of transmitters is determined by the relationship between time, transmitter frequency and transmitter powers when the transmitter is switched on, off, etc. The present specification covers only the transient behaviour of the transmitter frequency.

The frequency tolerances and the different transient phases are defined as follows:

Δf_0: Frequency tolerance in the steady state.

Δf_1: Frequency error, which may be greater than half the channel spacing.

Δf_2: Frequency error which must not be greater than half the channel spacing.

t_1, t_3: Period of time during which frequency tolerance Δf_1 applies.

t_2: Period of time during which frequency tolerance Δf_2 applies.

For the purposes of the method of measurement described in Clause B.2., the following are also defined:

t_{on}: Instant of transmitter switch-on: the instant when the output power, measured at the antenna terminal, exceeds 10% of the nominal power of 100 mW, whichever is less.

t_{off}: Instant of transmitter switch-off: the instant when the power falls below the above limit.

The following cases have to be considered:

B.1.1. *Criterion to be used when switching on*

The duration of the different transient phases and the frequency tolerances are shown in Figure A (T/R 20-05).

B.1.2. *Criterion to be used when switching off*

The transient period is not subdivided: the frequency tolerance is shown in Figure B (T/R 20-05)

B.1.3. *Other cases*

These include all combined switching situations such as switching the equipment on or off with the "transmit" key depressed.

Such switching operations can always be related to the operations described in Clauses B.1.1. and B.1.2.

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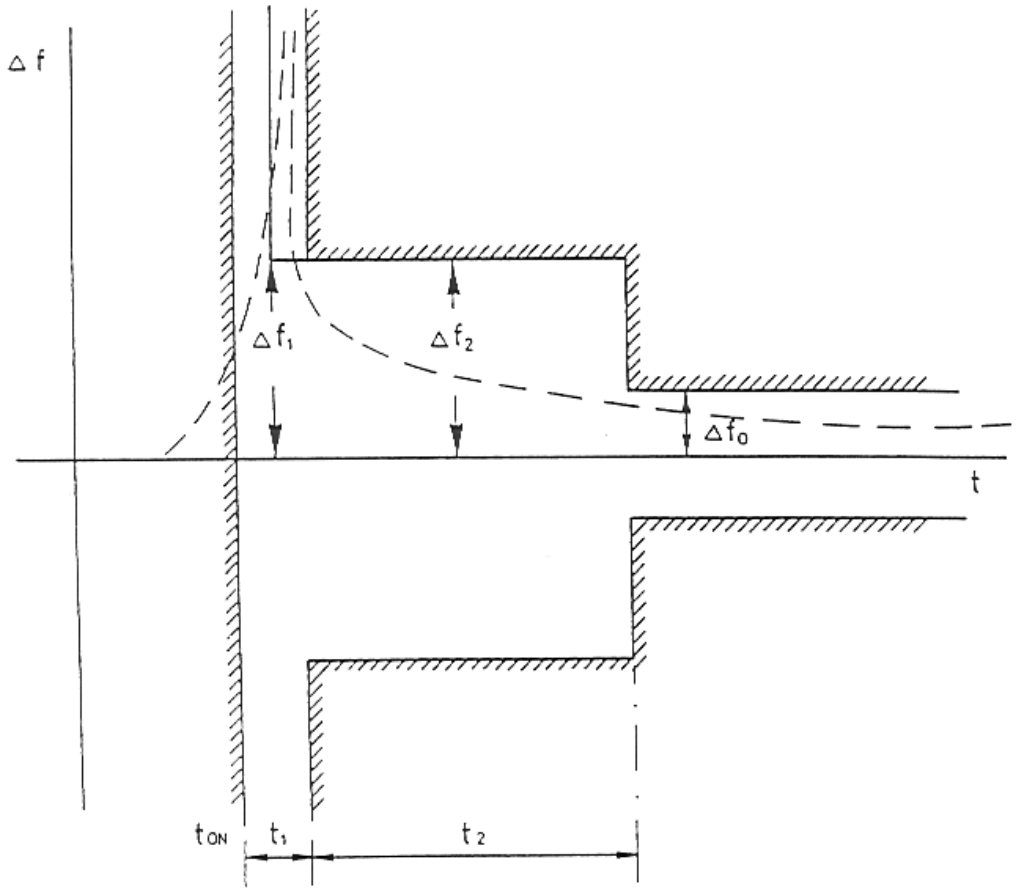

Figure A (T/R 20-05). Transient behaviour at switch-on (Clauses B.1.1. and B.1.3.).

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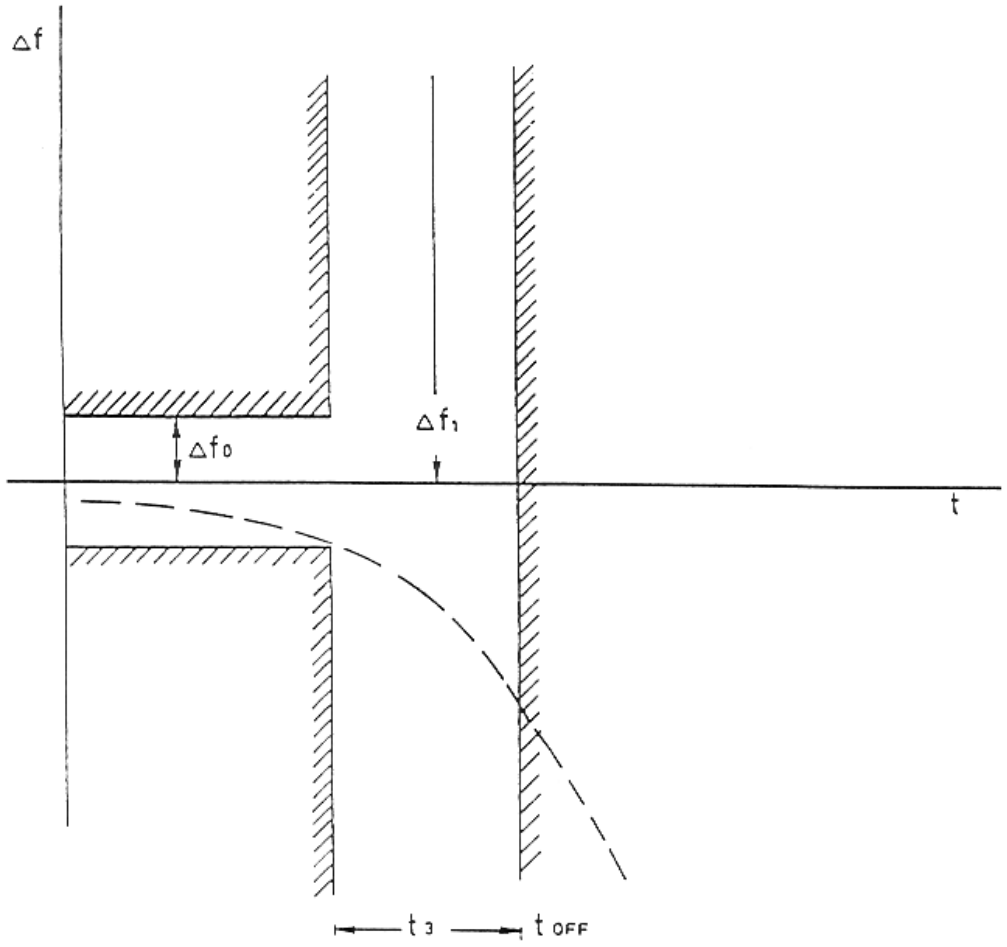

Figure B (T R 20-05). Transient behaviour at switch-off (Clauses B.1.2. and B.1.3.).

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B.2. Method of measurement

The duration of the various transient phases and the frequency differences occurring during these phases can be measured by means of a test discriminator which satisfies the requirements in Clause B.2.1.

The transmitter is connected to the set-up shown in Figure C (T/R 20-05), and its output connected to the input of the test discriminator via a matched attenuator representing the transmitter load. The attenuation of the attenuator must be dimensioned in such a way that the input of the test discriminator is protected against overload and the limiting amplifier of the discriminator operates correctly as a limiter when the power condition corresponding to the point t_{on} is reached.

This test set-up is calibrated, and the transmitter is then operated, unmodulated if possible, as indicated in Clauses B.1.1. to B.1.3.

The calibration of the test discriminator is checked by feeding in RF signals with defined frequency differences after it has been correctly set to the nominal transmitter frequency.

A triggering pulse is generated by appropriate means, either at the instant when the transmitter is switched on and off or when the power supply to the radio equipment is switched on and off while the "transmit" key is held down. The discriminator output voltage must be recorded as a function of time on a storage oscilloscope or a transient recorder. The voltage deviation is a measure of the frequency deviation. The duration of the frequency deviations can be measured using the time base of the oscilloscope.

B.2.1. *Specification of the test discriminator*

The test discriminator consists of a local oscillator and a mixer to convert the transmitter frequency into a frequency signal suitable for the limiter amplifier (broadband) and the following broadband discriminator.

— The effective bandwidth of measuring equipment shall be sufficiently wide to allow accurate measurement of frequency differences of the order of 5 times the channel spacing.
— The test discriminator must be capable of displaying the frequency deviations adequately fast (approximately 100 kHz/100 µs).
— The test discriminator output must be d.c. coupled.

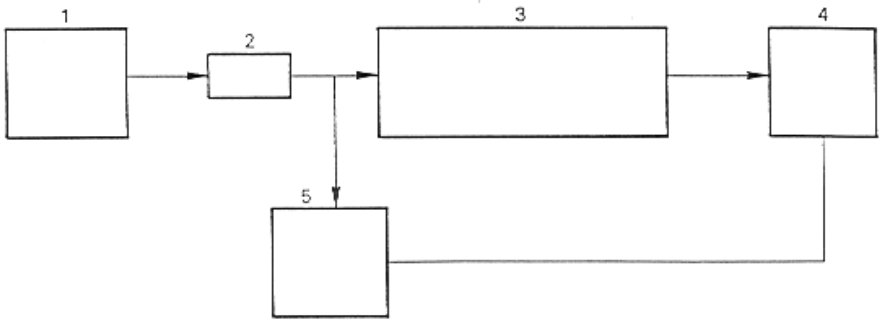

Figure C (T/R 20-05). Arrangement for measuring transmitter transient frequencies.

Key:
1 Transmitter under test.
2 Attenuator.
3 Broadband test discrimination
4 Storage oscilloscope or transient recorder.
5 Triggering device.

B.3. Limits

The duration of the various phases of the transient state shall not exceed the following values:

	Below 50 MHz	50-100 MHz	100-300 MHz	300-500 MHz	500-1,000 MHz
t_1 (ms)	5	5	5	10	20
t_2 (ms)	20	20	20	25	50
t_3 (ms)	5	5	5	10	10

Annex III

INFORMATION TO BE PROVIDED BY APPLICANTS FOR THE TYPE-APPROVAL OF LOW-POWER PERSONAL PAGING SYSTEMS

General

— Applicant: name, address, telephone number and telex.
— Action officer for the applicant: name, address and telephone number.
— Manufacturer: name and address.
— Type designation and trade name (if shown on the equipment).
— Countries in which the appliance, or equipment from which it derives, has already been submitted for type approval and the results obtained.
— Type of equipment: call transmitter, call receiver, response transmitter, response receiver or a combination.
— Coding system and total capacity of this system.
— Capacity of the paging system submitted for test.
— Provision for transmission of brief spoken messages to the person called (yes/no): if affirmative, indicate duration of messages.
— Response:
  — Coded/spoken;
  — Limitation on duration;
  — Device preventing operation except in response to a call (yes/no).
* — Options for use: fixed, mobile, portable.
* — Additional connections and/or devices.
* — Power source: integral or external: using batteries, accumulators, mains.
* — Antenna:
  — Type of terminals;
  — Input impedance;
  — Integral antenna: type, length.
* — Class of emission: type(s) of modulation.
* — Operating frequency band.
* — Channel spacing.
* — Carrier wave frequency available on equipment during testing.

Transmitter

— Nominal output power of call transmitter.
— Nominal effective radiated power of response transmitter.
* — Relationship between transmission frequency and oscillator frequency.

Receiver

* — Frequency-change formula(e).
* — Number and values of intermediate frequencies.

Test conditions

— Lower extreme temperature.
— Upper extreme temperature.
*— Nominal supply voltage(s).

* Information to be given separately for call and response equipment.