

Radio equipment used in mobile services —

Part 6: Methods of measurement for selective-calling and data equipment

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Equipment Standards Policy Committee (EEL/-) to Technical Committee EEL/25 upon which the following bodies were represented:

- British Broadcasting Corporation
- British Radio and Electronic Equipment Manufacturers' Association
- British Telecommunications plc
- Department of Trade and Industry (Radiocommunications Division)
- Independent Broadcasting Authority
- Institution of Electronic and Radio Engineers
- Radio Electrical and Television Retailers' Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- British Approvals Board for Telecommunications
- Electronic Engineering Association
- ERA Technology Ltd.
- GAMBICA (BEAMA Ltd.)
- OPTEL (Office of Telecommunications)
- Radio Society of Great Britain
- Telecommunication Engineering and Manufacturing Association
- User Standards Forum for Information Technology (Institute of Data Processing Management)

This British Standard, having been prepared under the direction of the Electronic Equipment Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 October 1989

© BSI 05-2000

The following BSI references relate to the work on this standard:
Committee reference EEL/25
Draft for comment 88/27139 DC

ISBN 0 580 17488 3

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Section 1. General	
1 Scope	1
2 Object	1
Section 2. Supplementary definitions and conditions of measurement	
3 Supplementary terms and definitions	1
4 Standard test conditions	2
5 Supplementary test conditions	2
6 Characteristics of the measuring equipment	5
Section 3. Measurements of receiver-decoder radio-frequency parameters (selective calling)	
7 Average radiation sensitivity (selective calling)	6
8 Reference sensitivity (selective calling)	7
9 Adjacent radio-frequency signal selectivity (selective calling)	8
10 Adjacent-channel selectivity (selective calling)	9
11 Co-channel interference rejection and blocking (selective calling)	9
12 Spurious response immunity (selective calling)	9
13 Intermodulation immunity (selective calling)	11
14 Sensitivity reduction under multipath propagation conditions (selective calling)	12
15 Protection from radio-frequency intermodulation false operation (selective calling)	14
16 False responses due to noise (selective calling)	15
17 Signalling attack time (selective calling)	15
18 Recovery time (selective calling)	16
19 Required protection time (selective calling)	17
20 Signal-to-residual output-power ratio (selective calling)	17
21 Impulsive-noise tolerance (selective calling)	18
Section 4. Measurements of receiver-decoder radio-frequency parameters (data)	
Clauses 22 to 31 (<i>under consideration</i>)	
Section 5. Measurements of receiver-decoder conducted and radiated spurious components (data and selective calling)	
32 Conducted spurious components (data and selective calling)	20
33 Radiated spurious components (data and selective calling)	21
Section 6. Measurements of encoder-transmitters radio-frequency parameters (data and selective calling)	
Clauses 34 to 38 (<i>under consideration</i>)	
Section 7. Audio-frequency band measurements of encoder output characteristics (selective calling)	
39 Tone pulse-rise time (selective calling)	23
40 Tone pulse duration (selective calling)	23
41 Tone pulse-decay time (selective calling)	23
42 Frequency of tone(s) (selective calling)	24
43 R.M.S. voltage of tone(s) (selective calling)	24
44 Encoder overall operate time (selective calling)	24

	Page
Section 8. Audio-frequency band measurements of decoder characteristics (selective calling)	
45 Decoder operation level range (selective calling)	25
46 Decoder attack time (selective calling)	26
47 Decoder recovery time (selective calling)	26
48 Decoder required protection time (selective calling)	27
49 Decoder alarm time (selective calling)	27
Section 9. Overall measurements in simulated systems (selective calling)	
50 General	28
51 Supplementary conditions of measurement for system response times	28
52 System overall operate time (selective calling)	28
53 System recovery time (selective calling)	30
Appendix A Examples of combining networks	31
Appendix B Recommended characteristics of the measuring equipment and its methods of test	33
Appendix C Rayleigh fading simulator	34
Appendix D Intermodulation response	39
Appendix E Guide for the construction of a 30 m radiation test site for equipment receiving radio-frequency electromagnetic energy	40
Appendix F Repeatability and accuracy of measurements of sensitivity (selective calling) and degradation measurements (selective calling)	43
Appendix G Mean time between false calling responses (M) (selective calling)	51
Appendix H Alternative test mounting arrangements for equipment which is hand-held or carried on the person while in normal operation	52
Appendix J Guide for the construction and measurement of a radio-frequency coupling device (RFCD) (<i>under consideration</i>)	53
Appendix K Guide for the construction of a 30 m radiation test site for equipment emitting radio-frequency electromagnetic energy	53
Appendix L Guide for the construction of a 3 m radiation test site for measurements above 100 MHz of equipment emitting radio-frequency electromagnetic energy	56
Appendix M General information on impulsive noise and random impulse generator	60
Appendix N Example of a mains power line impedance stabilization network	65
Appendix P Audio frequencies commonly used in tone-signalling systems	67
Figure 1 — Input-signal source test arrangement	4
Figure 2 — Example of an arrangement for testing receivers for duplex operation	5
Figure 3 — General test arrangement for receiver-decoder characteristics	10
Figure 4 — Arrangement for measuring receiver-decoder sensitivity reduction under multipath propagation conditions	13

	Page
Figure 5 — Measuring arrangement	16
Figure 6 — Protection time	17
Figure 7 — Measuring arrangement for signal-to-residual output-power ratio (selective calling)	18
Figure 8 — Measuring arrangement for antenna terminal and a.c. power terminal conducted spurious components	20
Figure 9 — Flow chart	22
Figure 10	25
Figure 11 — Typical measuring arrangement	25
Figure 12	26
Figure 13	27
Figure 14	28
Figure 15 — Typical measuring arrangement	29
Figure 16 — System overall operate and alarm time	29
Figure A.1 — Network for combining two signals	31
Figure A.2 — Network for combining three signals	31
Figure A.3 — Example of combining network using a hybrid ring	32
Figure A.4 — Example of a matching network	33
Figure C.1 — Example of a Rayleigh fading simulator	38
Figure C.2 — Example of measuring arrangement for evaluating a Rayleigh fading simulator	39
Figure E.1 — Measuring arrangement for receivers on a radiation test site (30 m)	42
Figure F.1 — Example of measurement of average radiation sensitivity (selective calling)	47
Figure F.2 — Example of measurement of reference sensitivity (selective calling)	47
Figure F.3 — Example of measurement of selectivity (selective calling)	48
Figure F.4 — Example of measurement of radio-frequency intermodulation false operation (selective calling)	49
Figure F.5 — Calling probability versus input signal	50
Figure H.1 — Measuring arrangement for radio pagers on a radiation test site (30 m)	52
Figure K.1 — Measuring arrangement for transmitter at 30 m	55
Figure L.1 — 3 m site dimensions inside the ground screen boundary	58
Figure L.2 — Measuring arrangement for radio-frequency emission (3 m)	59
Figure M.1 — Example of a random impulse generator	64
Figure M.2 — Measuring arrangement for measurement of impulse distribution	64
Figure N.1 — Mains power line impedance stabilization network (also known as artificial mains network)	66
Figure N.2 — Vector diagram of interference voltages	66
Figure N.3 — Example of a mains power line impedance stabilization network	67
Table C.I — Limits for the cumulative number of samples at each value of decibels	37

	Page
Table C.II — Limits for the number of level crossings in the measurements	38
Table F.I	46
Table M.I	62
Table M.II	63
Table N.I	65
Publications referred to	Inside back cover

National foreword

This Part of BS 6160 has been prepared under the direction of the Electronic Equipment Standards Policy Committee. It is identical with IEC Publication 489-6:1987 *“Methods of measurement for radio equipment used in the mobile services — Part 6: Selective-calling and data equipment”* published by the International Electrotechnical Commission (IEC).

This Part of BS 6160 should be read, where applicable, in conjunction with BS 6160-1.

For the purposes of this British Standard, any references to IEC page numbers in the text should be ignored.

Cross-references

International Standard	Corresponding British Standard
	BS 4054 <i>Methods of measuring and expressing the performance of radio receivers for sound broadcasting</i>
IEC 315-1:1970	Part 1:1980 <i>General conditions</i> (Identical)
IEC 315-2:1971	Part 2:1980 <i>Measurements related to the audio-frequency part of the receiver</i> (Technically equivalent)
	BS 6160 <i>Methods of measurement for radio equipment used in the mobile services</i>
IEC 489-1:1983	^a Part 1:1989 <i>General definitions and standard conditions of measurement</i> (Identical)
IEC 489-3:1979	Part 3:1981 <i>Receivers for A3 or F3 emissions</i> (Identical)
IEC 489-5:1987	^a Part 5:1989 <i>Receivers employing single-sideband techniques (R3E, H3E or J3E)</i> (Identical)

^a In preparation.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 74, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This standard refers specifically to mobile radio receivers having audio-frequency bandwidths (the receiver does not necessarily have an audio output) generally not exceeding 10 kHz for the reception of voice and other types of signals, using:

- a) angle (Type G or F: phase or frequency) modulation, or
- b) double-sideband amplitude (Type A) modulation with full carrier, or
- c) single-sideband amplitude (Type H, J or R) modulation with full, reduced or suppressed carrier.

Selective calling is usually used to select one or a group of receivers by conditioning the receiver(s) to deliver a voice message or to activate an alarm.

Many receivers have an audio output as well as a selective-calling function. In such receivers, the radio-frequency parameters of adjacent radio-frequency signal selectivity, spurious response immunity, and intermodulation immunity are usually measured by using the methods of measurement in IEC Publications 489-3 and 489-5. Methods of measurement for the radio-frequency parameters required for selective calling are included in this standard to permit measurement of those parameters on receivers that do not have an audio output.

2 Object

The object of this standard is to standardize the definitions, conditions and methods of measurement used to ascertain the performance of selective-calling receiver-decoders (receivers operating in conjunction with decoders). To this end it is recognized that:

- 1) The decoder is sometimes built as an integral part of the radio receiver with inaccessible interface connections. This may prevent measurements being made on a receiver or decoder individually.
- 2) It is sometimes necessary to specify the performance of the receiver-decoder combination as though they were a single unit, even when the component parts are supplied by different manufacturers.

Since the equipment evaluated in this standard is used for selective calling, many of the radio-frequency parameters are evaluated in terms of selective-calling effectiveness.

To differentiate between the radio-frequency parameters measured in this standard and those measured in other parts of IEC Publication 489, the bracketed term (selective calling) is appended to the name of each parameter.

Section 2. Supplementary definitions and conditions of measurement

3 Supplementary terms and definitions

For the purposes of this standard, the following supplementary terms and definitions apply.

3.1 standard calling probability

an 80 % probability of successful calling

3.2 modulation depth

for double-sided amplitude modulation, the modulation depth, in percent, is given by the following:

$$\text{Modulation depth} = \frac{(V_{\max} - V_{\min})}{(V_{\max} + V_{\min})} \times 100\%$$

where:

$V_{\max}$ is the peak-to-peak voltage at the crest of modulation

$V_{\min}$ is the peak-to-peak voltage at the valley of modulation

3.3 signal

a physical phenomenon or characteristic quantity of such a phenomenon, whose time variation represents information

3.4 coded signal

that signal or group of signals that enables the performance of a unique calling function

3.5 standard coded test signal (SCTS)

for the purpose of these measurements, the standard coded test signal shall be defined in the equipment specification and will usually be generated by an encoder of the type associated with the decoder under test. The parameters of the coded test signal (e.g., frequencies, pulse duration, pulse timing, etc.) shall have tolerances small enough to ensure that the results are not significantly influenced by them.

In addition to any other parameters, the equipment specification shall define the appropriate values for the permissible:

- maximum usable modulation depth of Type A modulation, or

- frequency/phase deviation of Type G or F modulation, or
- amplitude relationships between the carrier and the sidebands produced by Type H or R modulation.

3.6 coding system

a system that permits the transmission of unique information from one point to another. Present techniques include phase coding, pulse coding, frequency coding and a combination of these

3.7 encoder

the apparatus in a selective-calling system that generates the coded signal for transmission

3.8 decoder

the apparatus in a selective-calling system which is intended to respond exclusively to a specific coded signal

3.9 alarm

in a selective-calling system, an alarm is any indication that any or all receivers and their associated decoders have received their intended coded signals

NOTE The alarm may be a lamp, a “bleep” generated within the decoder, a vibrator, or only the opening of a mute or squelch circuit. The latter is usually indicated by an increase in the residual noise level at the output of the receiver.

3.10 selective-calling system

a system whereby the transmission of a signal code from a station enables another predetermined station or group of stations to be called exclusively

3.11 standard unwanted signal

if the wanted signal has Type A modulation, then the standard unwanted signal should be modulated with 400 Hz at the modulation depth of 60 %

if the wanted signal has Type F or G modulation, then the standard unwanted signal should be modulated with 400 Hz at 60 % of the maximum permissible frequency deviation

for all other types of modulation of the wanted signal, the standard unwanted signal is not modulated

3.12 selective-calling equipment

apparatus consisting of at least an encoder, decoder and the power supplies for the operation of the equipment

if it is not possible to isolate the associated transmitter and receiver circuits from the encoder and decoder, they shall be considered as part of the selective-calling system

3.13 radio pager

a small radio receiver-decoder, which provides an alarm following reception of a selective call. It is intended to be worn on a person and usually has an integral antenna

4 Standard test conditions

Unless otherwise stated, measurements shall be performed under the general test conditions stated in IEC Publication 489-1 and the supplementary test conditions given below:

5 Supplementary test conditions

5.1 Receiver-decoder having an integral antenna

A receiver having an integral antenna requires different measurement arrangements from a receiver having antenna terminals. Therefore, all measurements on receivers having integral antennas, except those measurements to determine average radiation sensitivity (selective calling) and spurious response immunity (selective calling), will be made in a suitable radio-frequency coupling device (RFCD). The RFCD may be a radio-frequency test fixture or a specific configuration of striplines or waveguides.

The method of measurement will be the same whether the input signal level recorded is that introduced at the receiver antenna terminals or the RFCD input terminals.

It should be noted that the measurement for RFCD reference sensitivity (selective calling) is identical to the measurement of reference sensitivity (selective calling); therefore, when the measurement of RFCD reference sensitivity (selective calling) is required, the measurement in Clause 8 should be used. An RFCD reference sensitivity (selective calling) measurement is necessary for determining many parameter values (see Clauses 8, 9, 12, 13, 14 and 15) when the receiver-decoder is measured in an RFCD.

NOTE 1 The measurements for sensitivity (selective calling) and measurements involving an unwanted signal, noise and variation of signal amplitude have been designed for non-automatic use; the number of trials in these measurements has been reduced to the minimum required to obtain the necessary accuracy. Various automatic measurement procedures may be used, but it is not proposed that they be standardized in this standard at this time.

NOTE 2 The measurements in this standard can be used for continuous signal (e.g., continuous tone controlled squelch systems) provided that a time for the operation of the decoder is specified (e.g. 300 ms).

NOTE 3 The measurement of spurious response immunity (selective calling) for receivers having integral antenna is under consideration.

5.2 Input-signal arrangements for testing receivers equipped with suitable antenna terminals

The nominal radio-frequency input impedance (R_n) is that value stated by the manufacturer for which the equipment performance will be optimum when connected to an antenna of the same impedance.

The input-signal level should preferably be expressed as: the electromotive force (e.m.f.) present at the output of the unterminated input-signal source (e.m.f. of Figure 1), when the input-signal source impedance (R_s) is equal to the nominal radio-frequency input impedance (R_n) of the receiver.

Alternatively, the input-signal level may be expressed as the matched-load voltage (V_{ml}) measured across an impedance having a value equal to R_n , when the source impedance (R_s) is equal to the nominal radio-frequency input impedance (R_n).

The matched-load voltage (V_{ml}) is one-half the value of the e.m.f.

When the meter that indicates the value of e_g is not in close proximity to the receiver input terminals, the transmission line loss shall be taken into account in addition to the loss of the impedance matching network.

5.2.1 Input-signal source for receivers requiring a specified source resistance

This sub-clause applies to receivers which are connected to the antenna by means of a transmission line (which is synonymous with "feeder line").

The input-signal source shall consist of a radio-frequency signal generator, a transmission line, and an impedance matching network (pad) placed as close as practicable to the receiver under test (see Figure 1, page 4).

5.2.2 Input-signal source for receivers tested with the aid of an artificial antenna

This sub-clause applies to receivers intended to operate with an antenna having a complex impedance.

The input-signal source shall consist of a radio-frequency signal generator, a transmission line, an impedance matching network and an artificial antenna. The characteristics of the artificial antenna shall be specified by the manufacturer of the receiver.

5.2.3 Receivers tested with the aid of an artificial antenna

The input-signal level is the e.m.f. of the source connected to the input terminals of an artificial antenna. It should be expressed in μV or dB (μV).

5.3 Input-signal level

5.3.1 Input signal type characteristics

In this standard the input-signal level of the wanted and the unwanted signals shall be expressed in terms of r.m.s. values as follows:

- for angle (Type G or F: phase or frequency) modulation, including frequency-shift and phase-shift modulation or keying: the r.m.s. voltage of the signal, either modulated or unmodulated;
- for on-off modulation, or keying of a sinusoidal carrier which may or may not be modulated with an additional signal: the r.m.s. voltage of the continuous carrier, without modulation;
- for double-sideband amplitude (Type A) modulation with full carrier: the r.m.s. voltage of the unmodulated carrier;
- for single-sideband amplitude (Type H, J or R) modulation with full, reduced or suppressed carrier: the r.m.s. value of a sinusoidal voltage, the peak value of which is equal to the amplitude of one radio-frequency cycle at the crest of the envelope of the modulated wave.

The input-signal levels may be expressed in μV or dB (μV) and shall be determined in accordance with Sub-clause 5.2.

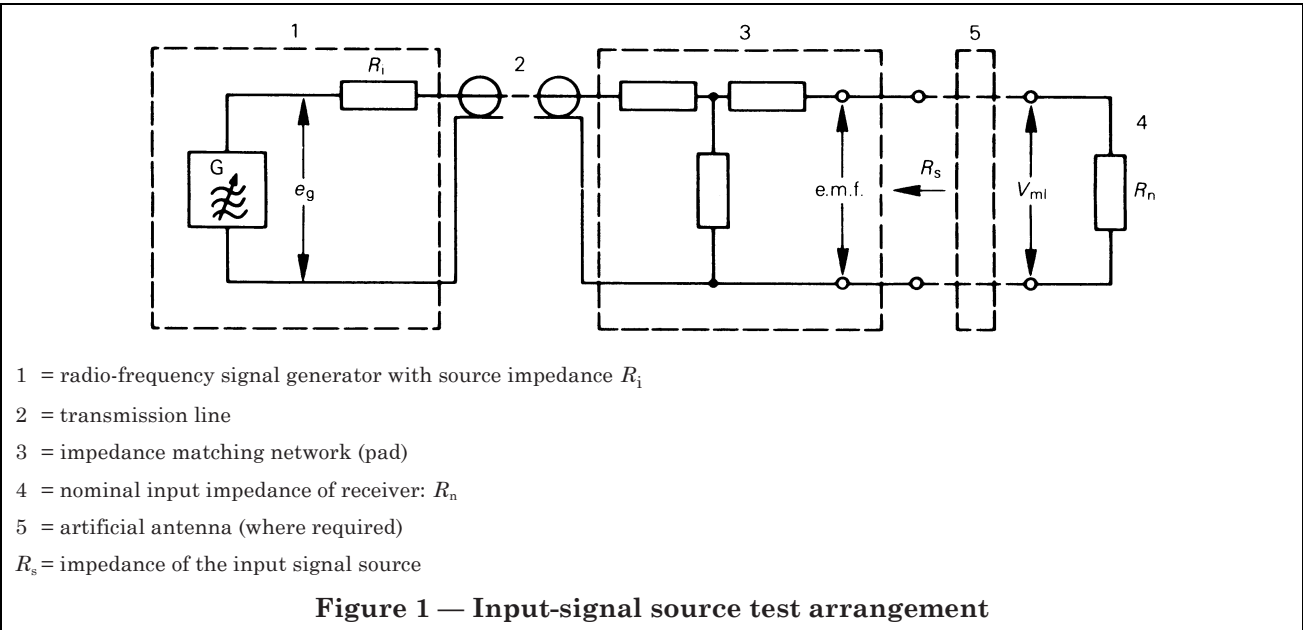
5.3.2 Receivers having a specified source resistance

The presentation of results should state whether the electromotive force of the source or the matched-load voltage (V_{ml}) has been recorded, for example, 2 μV (e.m.f.) or 1 μV (m.l). The source resistance (R_s) should be stated. (See Figure 1.)

5.4 Standard input signal

5.4.1 Standard input signal (Type A, G or F modulation)

A radio-frequency signal at standard input-signal level with standard modulation, at the standard input-signal frequency.



5.4.2 Standard input signal (Type H, J or R modulation)

A radio-frequency signal or linear combination of two radio-frequency signals from a signal source that simulates the single-sideband emission from a transmitter when it is modulated with an audio-frequency signal of 1 000 Hz.

The frequencies and the levels of the input signal are dependent upon the class of emission they represent. Two frequencies, one of which represents the carrier and the other the sideband, are chosen such that when demodulated they will produce an audio output at a frequency of 1 000 Hz.

The standard input-signal levels are:

Class of emission	Signal representing the	
	Carrier	Sideband
R3E	+ 42 dB (μV)	+ 60 dB (μV)
H3E	+ 54 dB (μV)	+ 54 dB (μV)
J3E	Omit or < + 20 dB (μV) as specified	+ 60 dB (μV)

5.5 Standard input-signal level

Unless otherwise specified, the standard input-signal level for a receiver of the type considered in this standard is 60 dB (μV) (e.m.f.) or 54 dB (μV) (m.l.).

5.6 Standard input-signal frequency

For all tests, except where otherwise specified, the standard input-signal frequency is one of the specified nominal frequencies. For S.S.B. type of modulation, the nominal frequency is the frequency of the carrier which may be suppressed.

5.7 Standard modulation of an input signal

The modulation due to an input signal of 1 000 Hz at a level to produce:

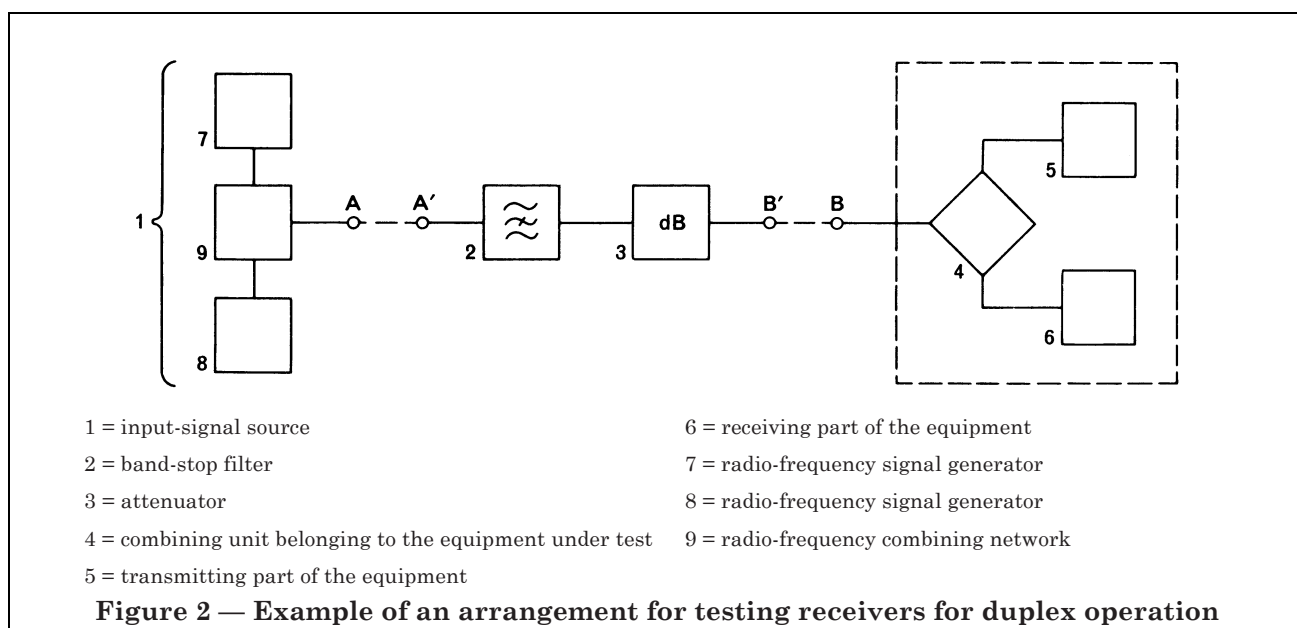
- a modulation depth of 30 %;
- 60 % of maximum permissible frequency (or phase) deviation.

5.8 Input-signal arrangements for testing the receiving part of equipment for duplex operation

When the performance of the receiving part of equipment for duplex operating is to be evaluated while the associated transmitting part is operating, precautions should be taken in order to ensure that the operation of the signal generator or generators used for testing the receiving part is not affected by the radio-frequency signal of the transmitting part and that the latter is terminated by its proper load impedance.

5.8.1 Input-signal source

An example of a suitable arrangement for making measurements on receivers of equipment for duplex operation is shown in Figure 2, page 5.



Connect the input-signal source (1) (levels adjusted in accordance with Sub-clause 5.3) to point A'. The centre frequency of the band-stop filter (2) is adjusted to the operating frequency of the transmitter under test.

The impedance at point B' shall be such that the transmitting part is operating under the specified matched conditions. To ensure that the V.S.W.R. will be less than 1.25, irrespective of any mismatch caused by the band-stop filter (2) and the combining unit (4), the attenuation of the attenuator (3) should be at least 30 dB. It should be noted that the attenuator will dissipate nearly all of the power from the transmitting part and therefore shall have suitable power-handling capability.

5.8.2 Input-signal level

The level of the radio-frequency input signal shall be determined at point B' of Figure 2.

5.9 Input-signal arrangements for testing receivers having an integral antenna

For receivers provided with an integral antenna and for equipment which has no facilities suitable for connecting the measuring equipment, the input-signal source will include the antenna specified by the manufacturer. For absolute measurements, a radiation test site where the field strength of the test signals is known should be used. For relative measurements, an RFCD may be used.

5.10 Connections of the measuring equipment

Care shall be taken that the input impedance of the measuring equipment does not affect the loading conditions specified for the receiver.

6 Characteristics of the measuring equipment

Where necessary (for measuring equipment which may not be commercially available), and to ensure that different operators at different locations will obtain similar results when measuring the same receiver, certain characteristics of the measuring equipment and test sites have been specified. Procedures for verifying that the measuring equipment meets these specifications are also given.

6.1 Signal generator intermodulation characteristics

A method for identifying intermodulation between signal generators, the outputs of which are combined, is given in Appendix B.

6.2 Signal generator noise characteristics

A method for identifying signal generator noise is given in Appendix B.

6.3 Selective measuring device

The selective measuring device may be a frequency selective voltmeter, a spectrum analyzer, or a calibrated field-strength meter. The bandwidth of the measuring device shall be appropriate for the measurement being made or shall be adjusted to the value stated in the method of measurement.

6.4 Radio-frequency coupling device (RFCD) characteristics and measurements

The measurements in this standard are applicable to receivers having either antenna terminals or an integral antenna.

Measurements of the radio-frequency parameters of receivers having an integral antenna are performed in an RFCD. When making these measurements, precautions shall be taken to ensure that:

- the receiver is adequately shielded from electromagnetic disturbance;
- the attenuation of the coupling between the radiation source and the receiver being measured is sufficiently low, stable and constant throughout the measuring frequency range.

The coupling loss depends on the particular measuring arrangement, the frequency being used, and the receiver being measured. Normally it is not precisely measured as it will only be useful for a particular measuring arrangement and frequency.

The coupling loss shall be sufficiently low so that the output power requirements of the signal generators used in this standard will not exceed the power output capability of commercially available signal generators.

To ensure measurement repeatability, an RFCD which includes the following should be used in the measurement arrangement:

- a radiating element;
- a radio-frequency input terminal connected to the radiating element through a transmission line;
- a means to ensure that the input impedance of the RFCD be the same as the impedance of the transmission line from the radio-frequency signal generator;
- a means for positioning the receiver being measured in a precise, repeatable and stable manner;
- a means to ensure that the presence of the person making the measurement does not affect the results.

It shall also have the following characteristics:

- a coupling loss between the radio-frequency input terminal and the receiver being measured of less than 30 dB;
- a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;
- no non-linear elements which can affect the measurement results.

6.5 Combining networks

Examples of combining networks are given in Appendix A.

6.6 Rayleigh fading simulator characteristics

Appendix C contains the following items:

- an example of a Rayleigh fading simulator;

- specifications for the required parameters;
- a method of measurement for the required parameters.

6.7 Characteristics of radiation test sites

Appendix E provides a guide for the construction of a 30 m radiation test site for equipment receiving radio-frequency electromagnetic energy and a method for calibrating the test site.

Appendix K provides a guide for the construction of a 30 m radiation test site for equipment emitting radio-frequency electromagnetic energy.

Appendix L provides a guide for the construction of a 3 m radiation test site for measurements above 100 MHz of equipment emitting radio-frequency electromagnetic energy.

6.8 Simulated man

A simulated man is required when the average radiation sensitivity (selective calling) of a radio pager is measured. A description of a simulated man and its use is given in Appendix H.

Section 3. Measurements of receiver-decoder radio-frequency parameters (selective calling)

7 Average radiation sensitivity (selective calling)

This measurement is only applicable to receivers with integral antennas.

7.1 Definition

The average of eight field strength measurements at a specified frequency with standard coded test signals (SCTS) each producing the standard calling probability when the receiver under test is rotated in 45° azimuth increments starting at the reference azimuth.

NOTE This parameter is sometimes called “signalling sensitivity”.

7.2 Method of measurement

This measurement shall be made on a suitable radiation test site. See Appendix E for details and test site calibration procedure.

- a) Calibrate the radiation test site at the standard input-signal frequency in accordance with Appendix E (Sub-clauses **E.10.1** to **E.10.4**) for a field strength of 100 $\mu\text{V/m}$ [40 dB ($\mu\text{V/m}$)].
- b) Connect the equipment as illustrated in Figure E.1b, page 42.

NOTE For receivers normally worn on the body (e.g. radio pagers) use the simulated-man test fixture of Appendix H.

- c) Modulate the radio-frequency signal generator (1) with the SCTS.

d) Orient the equipment so that a face is normal to the direction of the transmitting antenna (2) (see Appendix E, Clause E.3). This determines the reference azimuth.

e) Transmit the SCTS and confirm that the receiver-decoder is functioning.

f) Set step attenuator (5) to a value which will produce a low calling probability (e.g. less than 10 %).

g) Transmit the SCTS repeatedly and adjust the step attenuator (5) according to the following rules:

h)

1) Transmit the SCTS a maximum of four times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (5) according to Step h) 2) or h) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second, third, or fourth SCTS, decrease the attenuation of step attenuator (5) by 1 dB, and repeat Step h) 1).

3) If the receiver-decoder recognizes the four SCTSs, record the attenuation value of step attenuator (5) in decibels, and proceed to Step i).

NOTE A careful study of the example in Figure F.1, page 47, of Appendix F, is recommended to avoid the possibility of misunderstanding Step h).

i) Change the azimuth by 45° and repeat Steps f) to h).

j) Repeat Step i) until attenuation values have been recorded for eight different positions.

7.3 Presentation of results

a) Convert the eight attenuation values to field strength values using:

$$\mu\text{V} = 100 \cdot 10^{(20 - \text{“dB”})/20} \mu\text{V/m}$$

where “dB” is the attenuation value recorded in Step h) 3) of Sub-clause 7.2.

b) Calculate the arithmetic mean of the eight field strength values. This is the average radiation sensitivity (selective calling) which may be expressed as $\mu\text{V/m}$ or $\text{dB}(\mu\text{V/m})$.

8 Reference sensitivity (selective calling)

8.1 Definition

The reference sensitivity (selective calling) is the level of the receiver-decoder input signal at a specified frequency, modulated with the SCTS, which will result in the standard calling probability.

RFCD reference sensitivity (selective-calling) is the level of the RFCD input signal at a specified frequency, modulated with the standard coded test signal, which will result in the standard calling probability.

8.2 Method of measurement

In this standard, reference sensitivity (selective calling) will be interchanged with RFCD reference sensitivity (selective calling) when the receiver-decoder is measured in an RFCD. The reference sensitivity (selective calling) shall be determined before the measurements in Clauses 10, 12, 13, 14, 15 and 16 can be made. An RFCD should be used for those measurements that require a ratio of two input signal levels and for those where the receiver-decoder being measured has an integral antenna. It is essential that the receiver remain in exactly the same position in the RFCD for all RFCD measurements. The measuring arrangement required for Clauses 9, 12, 13, 14 and 15 should be set up at the same time and should not be changed until the measurements are completed. The measuring procedure is as follows:

a) Connect the equipment as illustrated in Figure 3, page 10, with the switches in position b.

b) Modulate the radio-frequency signal generator (2) with the SCTS.

c) Apply to the step attenuator (3) a signal having the standard input-signal frequency at a level of approximately 60 dB (μV). Record this level.

If an RFCD is being used, the level in dB (μV), at the input of the RFCD, should be 60 dB greater than the coupling loss.

d) Set the step attenuator (3) to a low value, transmit the SCTS and confirm that the decoder is functioning.

e) Increase the step attenuator (3) to a value which will produce a low calling probability (e.g., less than 10 %).

f) Transmit the SCTS repeatedly and adjust the step attenuator (3) according to the following rules:

g)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (3) according to Step g) 2) or g) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second or third SCTS, decrease the attenuation of (3) by 1 dB, and repeat Step g) 1).

3) If the receiver-decoder recognizes the three SCTSs, record the attenuation value in decibels, increase the attenuation of (3) by 1 dB, record the new attenuation value in decibels, and proceed to Step h) 1).

h)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (3), according to Step h) 2) or h) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second or third SCTS, decrease the attenuation of (3) by 1 dB, record the new attenuation value in decibels, and repeat Step h) 1).

3) If the receiver-decoder recognizes the three SCTSs, increase the attenuation of (3) by 1 dB, record the new attenuation value in decibels, and continue the SCTS transmission procedure in Step h) 1) until the total number of Step h) 1) transmissions is 20.

NOTE A careful study of the example in Figure F.2, page 47, of Appendix F, is recommended to avoid the possibility of misunderstanding Steps g) and h).

8.3 Presentation of results

a) Calculate the average of the attenuation values recorded in decibels in Steps g) and h) of Sub-clause 8.2.

b) The reference sensitivity (selective calling) is:

Reference sensitivity (selective calling) = $A - B - C$ dB (μ V)

If the measurement is made in an RFCD, the RFCD reference sensitivity (selective calling) = $A - B - C$ dB (μ V)

where:

A is the output level of the radio-frequency signal generator (2) in dB (μ V)

B is the loss of the combining network (4) in decibels

C is the average of the attenuation values calculated in Step a) in decibels

9 Adjacent radio-frequency signal selectivity (selective calling)

9.1 Definition

The ability of the receiver-decoder to prevent an unwanted adjacent signal from degrading the desired response at the output of the receiver-decoder.

It is the ratio, expressed in decibels of:

a) the level of an unwanted input signal that causes a wanted input signal, which is 3 dB in excess of the reference sensitivity (selective calling), to produce a calling probability equal to the standard calling probability, to

b) the reference sensitivity (selective calling).

9.2 Method of measurement

NOTE The value of the reference sensitivity (selective calling) determined in Sub-clause 8.3 is required for this measurement.

a) Connect the equipment as illustrated in Figure 3, page 10, with the switches in position b.

b) Modulate the radio-frequency signal generator (2) with the SCTS.

c) In the absence of the unwanted signal, apply a signal from the radio-frequency signal generator (2) at the standard input-signal frequency so that the level at the input of the receiver-decoder is 3 dB in excess of the reference sensitivity (selective calling) determined in Sub-clause 8.3. Record this value.

d) Adjust the radio-frequency signal generator (6) and the audio-frequency generator (5) to produce standard modulation of the unwanted signal in accordance with Sub-clause 3.11.

If 400 Hz is present in the encoded signal (1) and if the unwanted signal is modulated with 400 Hz, use some other frequency between 300 Hz and 500 Hz to modulate the unwanted signal (see Sub-clause 3.11).

e) Adjust the level of the radio-frequency signal generator (6) to a high value, for example, 80 dB (μ V), and set its frequency to a specified increment higher or lower than the standard input-signal frequency. Record this level in dB (μ V).

f) Decrease the step attenuator (9) to a value which will produce a low calling probability (e.g., less than 10 %).

g) Transmit the SCTS repeatedly and adjust the step attenuator (9) according to the following rules:

h)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9) according to Step h) 2) or h) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second or third SCTS, increase the attenuation of (9) by 2 dB, and repeat Step h) 1).

3) If the receiver-decoder recognizes the three SCTSs, record the attenuation value in decibels, decrease the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and proceed to Step i) 1).

i)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9), according to Step i) 2) or i) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second, or third SCTS, increase the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and repeat Step i) 1).

3) If the receiver-decoder recognizes the three SCTSs, decrease the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and repeat the SCTS transmission procedure in Step i) 1) until the total number of Step i) 1) transmissions is 40.

NOTE 1 A careful study of the example in Figure F.4, page 49, of Appendix F is recommended to avoid the possibility of misunderstanding Steps h) and i).

NOTE 2 In this step the SCTS is transmitted 40 times.

j) Steps e) to i) may be repeated for other unwanted signal frequencies.

9.3 Presentation of results

a) Calculate the average of the attenuation values recorded in Steps h) and i) of Sub-clause 9.2.

b) The adjacent radio-frequency signal selectivity (selective calling), in decibels is:

$$A - B - C - D - E$$

where:

A is the output level of the radio-frequency signal generator (6) recorded in Step e) of Sub-clause 9.2 in dB (μV)

B is the loss of the combining network (7) in decibels

C is the loss of the combining network (4) in decibels

D is the average attenuation value calculated in Step a) of this Sub-clause in decibels

E is the reference sensitivity (selective calling) in dB (μV) determined in Sub-clause 8.3

c) Record in a table the values of the departure from the standard input signal frequency of the unwanted signal frequency and the adjacent radio-frequency signal selectivity (selective calling).

d) Record the reference sensitivity (selective calling) in dB (μV), the standard input-signal frequency, and the characteristics of the standard unwanted signal used. If 400 Hz is not used to modulate the unwanted signal, record the frequency used.

10 Adjacent-channel selectivity (selective calling)

When mobile radio services use discrete channel spacings, the value of adjacent radio-frequency signal selectivity (selective calling) measured for a signal spacing equal to the discrete channel spacing may be quoted as the value of the adjacent-channel selectivity (selective calling). Adjacent-channel selectivity (selective calling) is measured using the method of measurement given in Clause 9.

11 Co-channel interference rejection and blocking (selective calling)

Co-channel interference rejection (selective calling) is a particular case of adjacent radio-frequency signal selectivity (selective calling) where the difference between the unwanted signal frequency and the standard input-signal frequency is a specified amount less than 300 Hz. It is measured using the method of measurement given in Clause 9.

Blocking (selective calling) is a particular case of co-channel interference rejection (selective calling) where the difference between the unwanted signal frequency and the standard input-signal frequency is a specified amount greater than 1 % of the standard input-signal frequency. It is measured using the method of measurement given in Clause 9.

12 Spurious response immunity (selective calling)

NOTE This method is under consideration for receivers having an integral antenna using an RFCD.

12.1 Definition

The ability of the receiver-decoder to prevent a single unwanted spurious signal from degrading the desired response at the output of the receiver-decoder.

It is the ratio, expressed in decibels, of:

a) the level of an unwanted input signal that causes a wanted input signal, which is 3 dB in excess of the reference sensitivity (selective calling), to produce a calling probability equal to the standard calling probability, to

b) the reference sensitivity (selective calling).

12.2 Method of measurement

NOTE The value of the reference sensitivity (selective calling) determined in Sub-clause 8.3 is required for this measurement.

a) Connect the equipment as illustrated in Figure 3, with the switches in position b.

b) Modulate the radio-frequency signal generator (2) with the SCTS.

c) In the absence of the unwanted signal, apply a signal from the radio-frequency signal generator (2) at the standard input-signal frequency so that the level at the input of the receiver-decoder is 3 dB in excess of the reference sensitivity (selective calling) determined in Sub-clause 8.3. Record this value.

d) Adjust the radio-frequency signal generator (6) and the audio-frequency signal generator (5) in order to produce the standard unwanted signal.

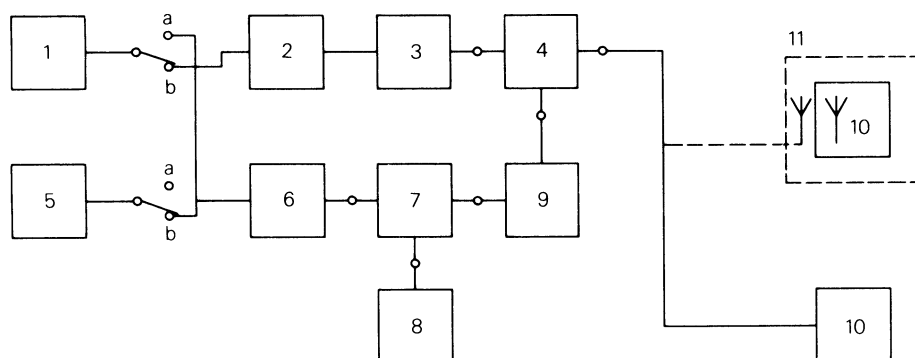
NOTE If 400 Hz is present in the encoded signal, and if the unwanted signal is modulated with 400 Hz, use some other frequency between 300 Hz and 500 Hz to modulate the unwanted signal (see Sub-clause 3.11).

e) Adjust the level of radio-frequency signal generator (6) to a high value [e.g. 80 dB (μ V)] and set its frequency to produce a spurious response. Record this frequency in megahertz and this level in dB (μ V).

NOTE The method of measurement of spurious response immunity (selective calling) requires that the operator search for the frequencies of the unwanted signals which may degrade the output of the receiver (e.g., signal-to-noise ratio, calling probability, error rate, or message acceptance rate). When the receiver has an audio output, this is normally done by applying only the unwanted signal to the receiver at a high level. Then the frequency of the unwanted signal is slowly moved across the frequency band of interest, and the frequencies that produce a change in signal-to-noise ratio are noted. These frequencies are then used in the spurious response immunity (selective calling) method of measurement.

If the receiver-decoder does not have an audio output, other methods for making the search shall be used. One method of making the search is to use a sensitive detector (e.g., a communications receiver tuned to the intermediate frequency of the receiver-decoder) and a probe (antenna) which may also be tuned to the i.f. By placing the probe near the later stages of the i.f. amplifier, the activity of the i.f. amplifier can be monitored. When the above procedure is used, changes in the signal in the i.f. amplifier can be detected and the frequency of the unwanted signal noted.

f) Decrease the step attenuator (9) to a value which will produce a low calling probability (e.g., less than 10 %).



1 = encoder

2 = radio-frequency signal generator

3 = 60 dB step attenuator (1 dB steps)

4 = matching and combining network

5 = audio-frequency signal generator

6 = radio-frequency signal generator

7 = matching and combining network (if required)

8 = radio-frequency signal generator (if required)

9 = 60 dB step attenuator (1 dB steps)

10 = receiver-decoder

11 = radio-frequency coupling device (if required)

NOTE 1 The connections represented by the switches in position a are only for the test described in Sub-clause 15.2.

NOTE 2 The output signals of all generators should be reduced to zero unless otherwise indicated in the method of measurement.

Figure 3 — General test arrangement for receiver-decoder characteristics

g) Transmit the SCTS repeatedly and adjust the step attenuator (9) according to the following rules:

h)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9), according to Step h) 2) or h) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second or third SCTS, increase the attenuation of (9) by 2 dB, and repeat the Step h) 1).

3) If the receiver-decoder recognizes the three SCTSs, record the attenuation value in decibels, decrease the attenuation value by 1 dB, and proceed to Step i) 1).

i)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9), according to Step i) 2) or i) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second, or third SCTS, increase the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and repeat Step i) 1).

3) If the receiver-decoder recognizes the three SCTSs, decrease the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and continue the SCTS transmission procedure in Step i) 1) until the total number of Step i) 1) transmissions is 40.

NOTE 1 If the rules do not require an attenuator change after a transmission of the SCTS, do not record an attenuation value.

NOTE 2 In these measurements the SCTS is transmitted 40 times.

NOTE 3 A careful study of the example in Figure F.4, page 49, of Appendix F, is recommended to avoid the possibility of misunderstanding Steps h) and i).

j) Steps e) to i) may be repeated for other unwanted signal frequencies.

12.3 Presentation of results

a) Calculate the average of the attenuation values recorded in Steps h) and i) of Sub-clause 12.2.

b) The spurious response immunity (selective calling) in decibels is:

$$A - B - C - D - E$$

where:

A is the output level of the radio-frequency signal generator (6) recorded in Step e) of Sub-clause 9.2 in dB (μV)

B is the loss of the combining network (7) in decibels

C is the loss of the combining network (4) in decibels

D is the average attenuation value calculated in Step a) of this sub-clause in decibels

E is the reference sensitivity (selective calling) in dB (μV) determined in Sub-clause 8.3

c) Record in a table the unwanted signal frequency and the spurious response immunity (selective calling) calculated in Step b) of this sub-clause.

d) Record the reference sensitivity (selective calling) in dB (μV), the standard input-signal frequency and the characteristics of the standard unwanted signal used. If 400 Hz is not used to modulate the Unwanted signal, record the frequency used.

13 Intermodulation immunity (selective calling)

13.1 Definition

The ability of the receiver-decoder to prevent two unwanted signals which have a specific frequency relationship to the wanted signal frequency (see Appendix D) from degrading the desired response at the output of the receiver-decoder.

It is the ratio, expressed in decibels, of:

a) the level of one of two equal-level unwanted input signals that cause a wanted input signal, which is 3 dB in excess of the reference sensitivity (selective calling), to produce a calling probability equal to the standard calling probability, to

b) the reference sensitivity (selective calling).

13.2 Method of measurement

NOTE 1 The value of the reference sensitivity (selective calling) determined in Sub-clause 8.3 is required for this measurement.

NOTE 2 A measuring error may result from intermodulation between generators, generator noise, or receiver desensitization. See Appendix A and Appendix B for precautions regarding the signal generators.

a) Connect the equipment as illustrated in Figure 3, page 10, with the switches in position b.

b) Modulate the radio-frequency signal generator (2) by the SCTS.

c) In the absence of the unwanted signals, apply a signal from the radio-frequency signal generator (2) at the standard input-signal frequency so that the level at the input of the receiver-decoder is 3 dB in excess of the reference sensitivity (selective calling) determined in Sub-clause 8.3. Record this value.

d) Choose a pair of frequencies f_n and f_r that may produce an intermodulation response (see Appendix D).

e) Adjust the unmodulated radio-frequency signal generator (8) to frequency f_n and adjust the signal level to a high value, for example, 80 dB (μ V). Record this level.

f) Apply the standard unwanted signal at the frequency f_r from the radio-frequency signal generator (6) at the same level as in Step e).

NOTE If 400 Hz is present in the encoded signal, and if the unwanted signal is modulated with 400 Hz, use some other frequency between 300 Hz and 500 Hz to modulate the unwanted signal (see Sub-clause 3.11).

g) Decrease the step attenuator (9) to a value which will produce a low calling probability (e.g., less than 10 %).

h) Transmit the SCTS repeatedly and adjust the step attenuator (9) according to the following rules:

i)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9), according to Step i) 2) or i) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second or third SCTS, increase the attenuation of (9) by 2 dB, and repeat Step i) 1).

3) If the receiver-decoder recognizes the three SCTSs, record the attenuation value in decibels, decrease the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and proceed to Step j) 1).

j)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9) according to Step j) 2) or j) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second, or third SCTS, stop the SCTS, increase the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and repeat Step j) 1).

3) If the receiver-decoder recognizes the three SCTSs, decrease the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and continue the SCTS transmission procedure in Step j) 1) until the total number of Step j) 1) transmissions is 40.

NOTE 1 If the rules do not require an attenuator change after a transmission of SCTS, do not record an attenuation value.

NOTE 2 In this step the SCTS is transmitted 40 times.

NOTE 3 A careful study of the example in Figure F.4, page 49, of Appendix F is recommended to avoid the possibility of misunderstanding Steps i) and j).

k) Steps d) to j) may be repeated for other unwanted signal frequencies.

13.3 Presentation of results

a) Calculate the average of the attenuation values recorded in Steps i) and j) of

Sub-clause 13.2.

b) The intermodulation immunity (selective calling), in decibels, is:

$$A - B - C - D - E$$

where:

A is the output level of the radio-frequency signal generator (8) [the output level of the radio-frequency signal generator (6) is at the same level] recorded in Step e) of Sub-clause 13.2 in dB (μ V)

B is the loss of the combining network (7) in decibels

C is the loss of the combining network (4) in decibels

D is the average of the attenuation values calculated in Step a) of this sub-clause, in decibels

E is the reference sensitivity (selective calling) in dB (μ V) determined in Sub-clause 8.3

c) Record in a table the values of the departure from the standard input signal frequency of the unwanted signal frequencies and the intermodulation immunity (selective calling) calculated in Step b).

d) Record the reference sensitivity (selective calling) in dB (μ V), the standard input-signal frequency and the characteristics of the standard unwanted signal used. If 400 Hz is not used to modulate the unwanted signal, record the frequency used.

14 Sensitivity reduction under multipath propagation conditions (selective calling)

Variations of amplitude and phase of a radio-frequency signal are created by multipath reflections in the propagation medium whenever the transmitting or receiving antennas are in motion. These signal variations are a function of both the antenna velocity and the frequency of the desired radio-frequency signal.

Variations of signal amplitude, due to motion, follow a Rayleigh distribution in limited areas where the direct signal is missing. They may, therefore, be simulated by modulating the desired radio-frequency signal.

14.1 Definition

The ratio, expressed in decibels, of:

- a) the r.m.s. value of a Rayleigh faded input signal level that is required to maintain the standard calling probability, to
- b) the reference sensitivity (selective calling).

14.2 Method of measurement

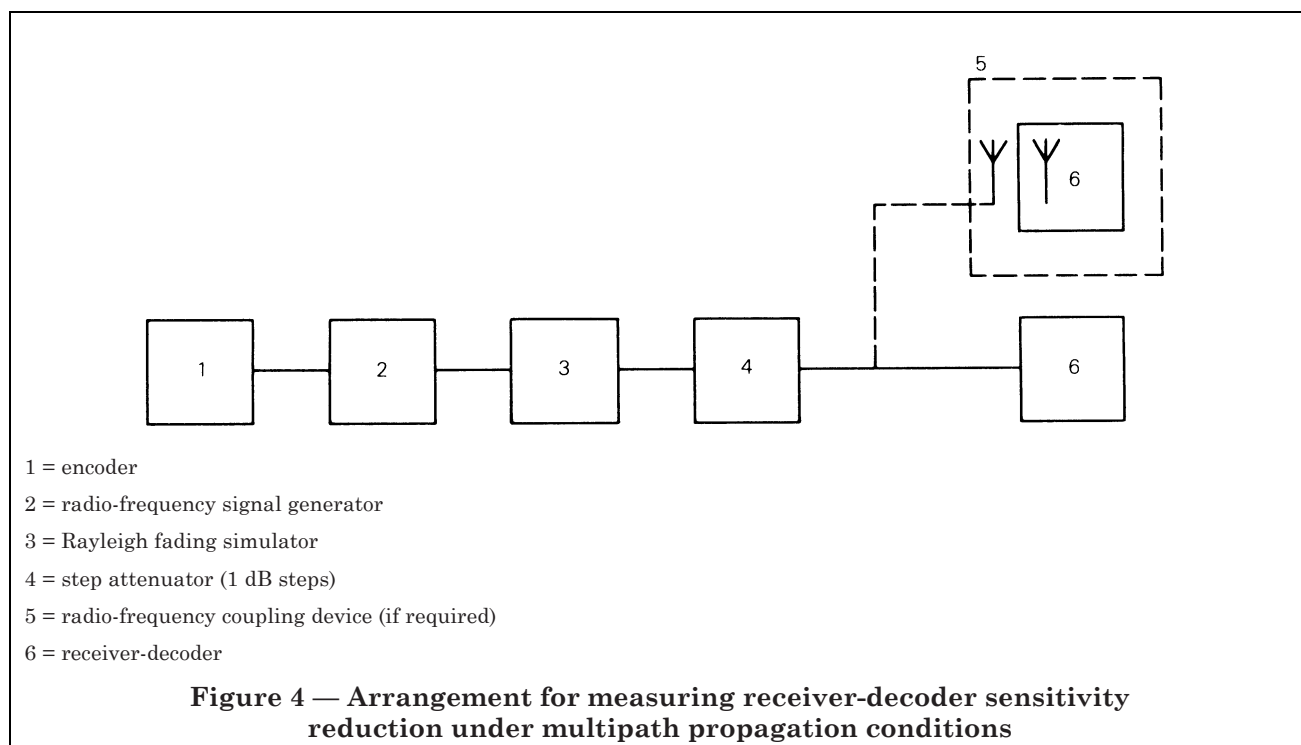
- a) Connect the equipment as illustrated in Figure 4 (see Appendix C for details of the Rayleigh fading simulator).
- b) Modulate the radio-frequency signal generator (2) with the SCTS.
- c) Apply the output of the radio-frequency signal generator (2) to the Rayleigh fading simulator (3) at the level specified by the manufacturer of the fading simulator.
- d) Adjust the Rayleigh fading simulator to the non-fading setting and adjust the level so that it is equal to the r.m.s. output value that the simulator would have at other velocities. Proceed to Step f).

e) Adjust the velocity of the simulator to a specified velocity.

f) Increase the step attenuator (4) to a value which will produce a low calling probability (e.g., less than 10 %).

g) Transmit the SCTS repeatedly and adjust the step attenuator (4) according to the following rules:

- h)
 - 1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (4), according to Step h) 2) or h) 3), whichever is appropriate.
 - 2) If the receiver-decoder fails to recognize either the first, second or third SCTS, decrease the attenuation of (4) by 2 dB, and repeat Step h) 1).
 - 3) If the receiver-decoder recognizes the three SCTSs, record the attenuation value in decibels, increase the attenuation of (4) by 1 dB, record the new attenuation value in decibels, and proceed to Step i) 1).



i)

- 1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (4) according to Step i) 2) or i) 3), whichever is appropriate.
- 2) If the receiver-decoder fails to recognize either the first, second, or third SCTS, decrease the attenuation of (4) by 1 dB, record the new attenuation value in decibels, and repeat Step i) 1).
- 3) If the receiver-decoder recognizes the three SCTSs, increase the attenuation of (4) by 1 dB, record the new attenuation value in decibels, and continue the SCTS transmission procedure in Step i) 1) until the total number of Step i) 1) transmissions is 40.

NOTE 1 If the rules do not require an attenuator change after a transmission of the SCTS, do not record an attenuation value.

NOTE 2 In this step the SCTS is transmitted 40 times.

NOTE 3 A careful study of the example in Figure F.4, page 49, of Appendix F is recommended to avoid the possibility of misunderstanding Steps h) and i).

- j) Repeat Steps e) to i) with the Rayleigh fading simulator (3) adjusted for 100, 50, 20, 10, 5, 2 and 1 km/h (see Appendix C).

14.3 Presentation of results

- a) Calculate the average of the attenuation values recorded in Steps h) and i) of Sub-clause 14.2, with the Rayleigh fading simulator set to the non-fading position as in Step d) of Sub-clause 14.2.
- b) Calculate the average of the attenuation values recorded in Steps h) and i) of Sub-clause 14.2, with the Rayleigh fading simulator adjusted for a velocity specified in Step e) of Sub-clause 14.2.
- c) The sensitivity reduction under multipath propagation conditions (selective calling) in decibels is:

$$A - B$$

where:

A is the average of the attenuation values calculated in Step a) in decibels

B is the average of the attenuation values calculated in Step b) in decibels

- d) Record in a table the velocities and the sensitivity reduction under multipath propagation conditions (selective calling).
- e) Record the standard input-signal frequency.

15 Protection from radio-frequency intermodulation false operation (selective calling)

15.1 Definition

The ability of the receiver-decoder to prevent two unwanted signals (one of which is modulated by the SCTS) having a specific frequency relationship to the wanted signal frequency, from causing unwanted responses at the output of the receiver-decoder due to intermodulation (see Appendix D).

It is the ratio, expressed in decibels, of:

- a) the level of the modulated unwanted signal that produces the standard calling probability, to
- b) reference sensitivity (selective calling).

NOTE This method of measurement provides the two-signal intermodulation characteristic. For specific modulation processes, the modulating signal may have to be inverted.

15.2 Method of measurement

NOTE 1 The value of the reference sensitivity (selective calling) determined in Sub-clause 8.3 is required for this measurement.

NOTE 2 A measuring error may result from intermodulation between generators, generator noise, or receiver desensitization. See Appendix A and Appendix B for precautions regarding the signal generators.

- a) Connect the equipment as illustrated in Figure 3, page 10, with the switches in position a.
- b) Choose a pair of frequencies f_n and f_r that may produce an intermodulation response (see Appendix D). Record these frequencies.
- c) Adjust the unmodulated radio-frequency signal generator (6) to frequency f_n , modulated with the SCTS and adjust the signal level to a high value, for example 80 dB (μ V). Record this level.
- d) Apply the unwanted unmodulated input signal of frequency f_r from the output of the radio-frequency signal generator (8) to the combining network (7) at the same level as in Step c).
- e) Increase the step attenuator (9) to a value which will produce a low calling probability (e.g., less than 10 %).
- f) Transmit the SCTS repeatedly and adjust the step attenuator (9) according to the following rules:
- g)
 - 1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9), according to Step g) 2) or g) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second, or third SCTS, decrease the attenuation of (9) by 2 dB, and repeat Step g) 1).

3) If the receiver-decoder recognizes the three SCTSs, record the attenuation value in decibels, increase the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and proceed to Step h) 1).

h)

1) Transmit the SCTS a maximum of three times, terminating the transmission sequence, however, if the receiver-decoder fails to recognize the signal any one of those times. Adjust the step attenuator (9), according to Step h) 2) or h) 3), whichever is appropriate.

2) If the receiver-decoder fails to recognize either the first, second, or third SCTS, decrease the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and repeat Step h) 1).

3) If the receiver-decoder recognizes the three SCTSs, increase the attenuation of (9) by 1 dB, record the new attenuation value in decibels, and continue the SCTS transmission procedure in Step h) 1) until the total number of Step h) 1) transmissions is 40.

NOTE 1 If the rules do not require an attenuator change after a transmission of the SCTS, do not record an attenuation value.

NOTE 2 In this step the SCTS is transmitted 40 times.

NOTE 3 A careful study of the example in Figure F.3, page 48, of Appendix F is recommended to avoid the possibility of misunderstanding Steps g) and h).

i) Steps b) to h) may be repeated for other unwanted signal frequencies.

15.3 Presentation of results

a) Calculate the average of the attenuation values recorded in Steps g) and h) of Sub-clause 15.2.

b) The protection from radio-frequency intermodulation false operation (selective calling) in decibels is:

$$A - B - C - D - E$$

where:

A is the output level of the radio-frequency signal generator (6) [the output of the radio-frequency signal generator (8) is set at the same level] recorded in Step c) of Sub-clause 15.2 in dB (μV)

B is the loss of the combining network (7) in decibels

C is the loss of the combining network (4) in decibels

D is the average of the attenuation values calculated in Step a) of this Sub-clause, in decibels

E is the reference sensitivity (selective calling) in dB (μV) determined in Sub-clause 8.3

c) Record in a table the values of the departure from the standard input-signal frequency of the unwanted signals and the protection from radio-frequency intermodulation false operation (selective calling) in Step b).

d) Record the reference sensitivity (selective calling) in dB (μV) and the standard input-signal frequency.

16 False responses due to noise (selective calling)

Receiver noise can cause the decoder to produce false calling responses in the absence of selective calling signals.

16.1 Definition

The mean time between false calling responses (*M*) is defined as the average time between consecutive false calling responses.

For the purpose of this measurement, this time is estimated by observing the time required to produce eight false calling responses and dividing it by eight.

16.2 Method of measurement

NOTE 1 Five per cent of the measurements will require more than 13 times the mean time (*M*) of the equipment (see Appendix G). If the required measurement time is too long to be practical, this measurement should not be specified.

NOTE 2 This test is applicable only to receivers in which the squelch can be disabled, thus allowing receiver noise to reach the decoder.

a) Terminate the input terminals of the receiver as specified by the manufacturer and, with no input signal applied to the receiver, deactivate the receiver squelch.

b) Adjust receiver gain and volume control, if fitted for normal decoder operation, in accordance with the manufacturer's instructions.

c) Monitor the operation of the decoder until eight false operations have occurred. Record the total time interval (*H*) in hours.

16.3 Presentation of results

Calculate *M*, using:

$$M = \frac{H}{8} \text{ (hours)}$$

17 Signalling attack time (selective calling)

17.1 Definition

The elapsed time from the instant when the radio-frequency input-signal modulated by the standard coded test signal is applied at the receiver until the receiver-decoder successfully responds. If the response is an audio output, then the signalling attack time (selective calling) is measured when the audio output reaches 50 % of the steady-state value.

17.2 Method of measurement

- a) Connect the equipment as illustrated in Figure 5.
- b) Modulate the radio-frequency signal generator (5) with the SCTS.
- c) Adjust the radio-frequency signal generator (5) to the standard input-signal frequency and to produce a level 30 dB above reference sensitivity (selective calling) at the receiver input terminals.
- d) Display the encoder voltage on one trace of a double-beam oscilloscope and display the decoder alarm indicating signals on the other beam.
- e) Measure the time interval from the instant when the coded signal voltage applied to the radio-frequency signal generator exceeds 50 % of its maximum level until the alarm circuit output has reached 50 % of its maximum amplitude.

NOTE If the receiver has no alarm device, the activation of the squelch circuit shall be used as an indication of response.

18 Recovery time (selective calling)

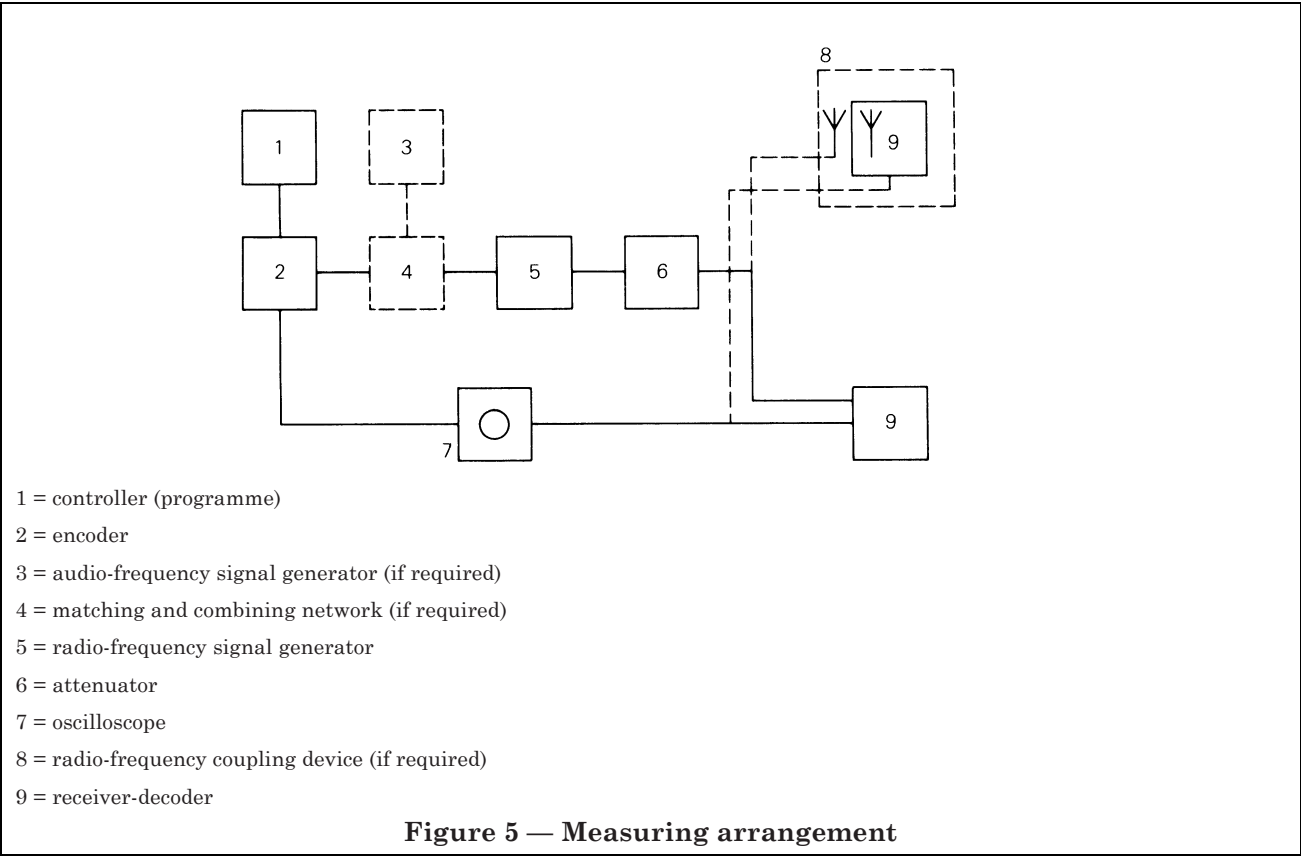
18.1 Definition

The minimum time interval that is needed between two successive encoded calling sequences to ensure that the decoder will respond correctly to the second sequence.

This characteristic can be observed only when the decoder automatically resets.

18.2 Method of measurement

- a) Connect the equipment specified by the manufacturer as illustrated in Figure 5, page 16.
- b) Modulate the radio-frequency signal generator (5) with the SCTS.
- c) Adjust the radio-frequency signal generator (5) to the standard input-signal frequency and to produce a level 30 dB above reference sensitivity (selective calling).
- d) Arrange for the interval between two successive SCTSs to be variable from zero to at least twice the recovery time stated by the manufacturer.
- e) With the time interval set for zero, transmit the two SCTSs repeatedly and observe whether the second SCTS is successfully decoded. After each transmission series, adjust the interval according to the following rules:
 - if the receiver-decoder fails to decode the signal, increase the interval by 20 % of the value of the recovery time stated by the manufacturer;



— if the receiver-decoder successfully decodes the signal, do not change the interval until there have been four consecutive successes. Then record this value of the interval. This is the recovery time (selective calling).

19 Required protection time (selective calling)

19.1 Definition

The maximum time during which a partially operated decoder requires protection from other coded signals containing the complementary part of the necessary code (see Figure 6).

19.2 Method of measurement

a) Connect the equipment as illustrated in Figure 3, page 10.

The encoder used to make the measurement shall incorporate a means to vary the time interval between transmission of the two parts of the SCTS.

b) Modulate the radio-frequency signal generator (2) with the SCTS.

c) Adjust the radio-frequency signal generator (2) to the standard input-signal frequency and to produce a level 30 dB above reference sensitivity (selective calling) at the receiver input terminals.

d) Arrange the encoder to initially send the first part of an SCTS and after an interval, adjustable up to recovery time, send the remaining part of the SCTS.

e) Increase the interval to a value which will produce a low calling probability (e.g. less than 10 %).

f) Transmit the SCTS repeatedly and observe whether the signal is successfully decoded. After each transmission, adjust the interval according to the following rules:

— if the receiver-decoder (10) fails to decode the signal, decrease the interval by 20 % of the value of protection time stated by the manufacturer;

— if the receiver-decoder (10) successfully decodes the signal, do not change the interval until there have been four consecutive successes. Record this value of time interval. This is the protection time (selective calling).

NOTE In individual-tone sequential systems having more than two tones, it may be necessary to repeat this measurement with the time interval in different positions of the SCTS.

20 Signal-to-residual output-power ratio (selective calling)

This characteristic is only applicable to receivers and decoders employing continuous individual-tone selective calling signalling and having accessible audio-terminals.

20.1 Definition

The ratio, expressed in decibels, of:

a) the receiver output power when a signal modulated with 1 000 Hz plus the continuous selective calling tone is applied to its input, to

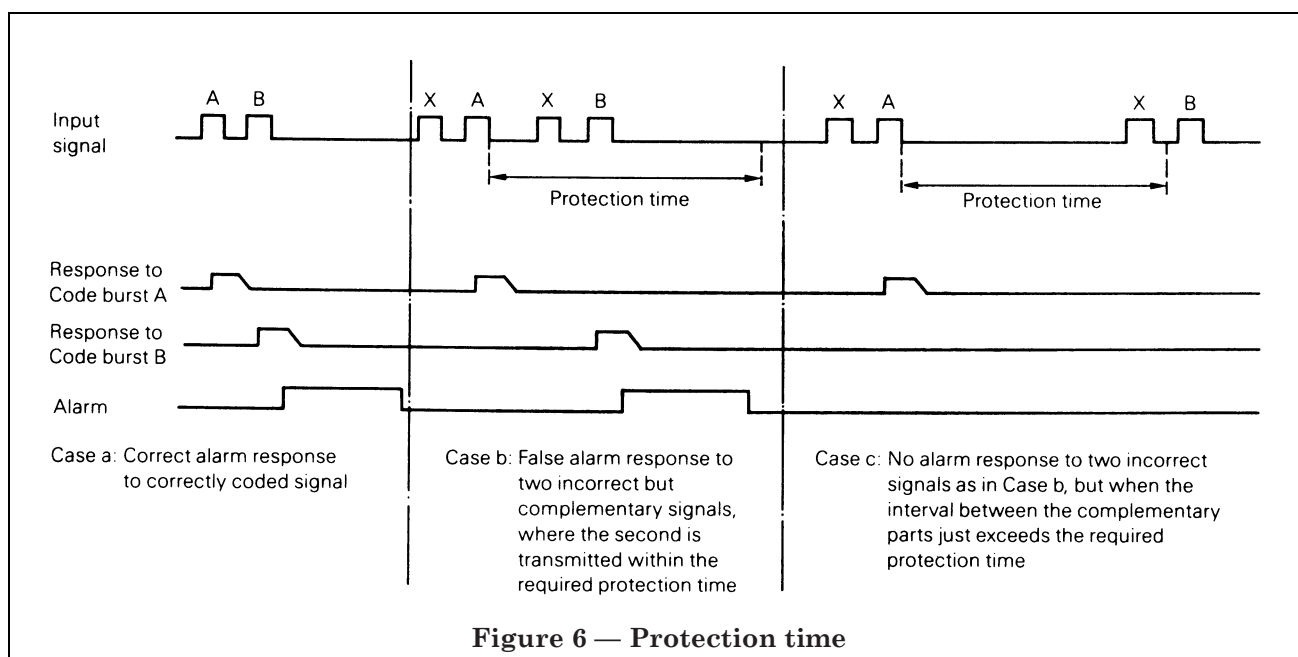


Figure 6 — Protection time

- b) the receiver output power when a signal modulated only by the continuous selective calling tone is applied to its input.

20.2 Method of measurement

- a) Connect the equipment as illustrated in Figure 7, page 18.
- b) Connect the audio-frequency test load and an audio-frequency voltmeter to the output of the receiver.
- c) Apply a standard input signal modulated with 1 000 Hz and the continuous selective calling tone at a level 30 dB above the level which produces 12 dB SINAD to the input of the receiver. The composite modulation should be adjusted in accordance with the manufacturer's instructions.
- d) Adjust the receiver volume control to produce the reference output power at the test load.

- e) Remove the standard 1 kHz modulation but not the continuous individual-tone modulation and record the reduction, in decibels, of the power dissipated in the audio-frequency load.

21 Impulsive-noise tolerance (selective calling)

21.1 Definition

The ability of a receiver to prevent impulsive-noise from degrading the desired response at the output of the receiver.

It is expressed as a ratio of:

- a) The median level of spectrum amplitude of the impulsive-noise that causes a wanted signal, which is 3 dB in excess of the reference sensitivity (selective calling), to produce a calling probability equal to the standard calling probability, to
- b) the reference sensitivity (selective calling).

