INTERNATIONAL STANDARD

IEC 60489-6

Third edition
1999-07

Radio equipment used in mobile services – Methods of measurement –

Part 6: Data equipment

Matériel de radiocommunication utilisé dans les services mobiles – Méthodes de mesure –

Partie 6: Matériel numérique

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RADIO EQUIPMENT USED IN MOBILE SERVICES – METHODS OF MEASUREMENT –

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organization.
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International Standard IEC 60489-6 has been prepared by IEC technical committee 102: Equipment used in radio communications for mobile services and for satellite communication systems.

This third edition of IEC 60489-6 cancels and replaces the second edition, published in 1987, amendment 1 (1989) and amendment 2 (1991). This third edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
102/44/FDIS	102/54/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

IEC 60489-6 forms one of a series of publications under the general title*: Radio equipment used in mobile services – Methods of measurement.* Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next revision.

Annexes A, B, C, E, F and G form an integral part of this standard.

Annexes D, H and I are for information only.

A bilingual version of this standard may be issued at a later date.

RADIO EQUIPMENT USED IN MOBILE SERVICES – METHODS OF MEASUREMENT –

Part 6: Data equipment

1 General

1.1 Scope and object

This part of IEC 60489 refers specifically to mobile radio transmitters and receivers for the transmission of data (telegraphy) signals having the emission characteristics given in 1.1.

This standard is intended to be used in conjunction with IEC 60489-1. The terms and definitions and the conditions of measurement set forth in this standard are intended for type and acceptance tests.

The object of this standard is to standardize the definitions, the conditions and the methods of measurement used to ascertain the radio-frequency performance of data and selective call equipment, thus making possible meaningful comparisons of the results of measurements made by different observers and on different equipment.

This standard will cover the following types of data signals:

– bit streams;
– character strings;
– messages;
– selective calling.

Selective calling differs from messages in their intended functions; it may be considered as data signals, analogous to messages transmitting only the information required to activate an alarm on one receiver or a group of receivers.

The methods of measurements for the radio-frequency parameters are appropriate for the four types of data signals.

To differentiate between the radio-frequency parameters (e.g. adjacent channel power, frequency error) measured in this standard from those in associated standards, the name of each parameter is followed by either “(bit stream)” or “(character string)” or “(message)” or “(selective calling)”. After each radio-frequency parameter the general term “(data)” is used. When each equipment is measured, the proper data type “(bit stream)” “(character string)” “(message)” or “(selective calling)” will be substituted for “(data)”.

1.2 Emission characteristics

This standard is applicable to the following emission characteristics expressed according to the ITU Radio Regulations Emission Designation.

Emission characteristics are expressed by four symbols:

a) – b) – c) – d)

where

a) is the type of modulation of the main carrier;

b) is the nature of signals modulating the main carrier;
c) is the type of information to be transmitted;
d) is the detail of signal(s) (optional).

a) Type of modulation of the main carrier (first symbol):
   - (A) double-sideband;
   - (H) single-sideband, full carrier;
   - (R) single-sideband, reduced or variable level carrier;
   - (J) single-sideband, suppressed carrier;
   - (F) frequency modulation;
   - (G) phase modulation.

b) Nature of signal(s) modulating the main carrier (second symbol):
   - (1) a single channel containing quantized or digital information without the use of a modulating sub-carrier;
   - (2) a single channel containing quantized or digital information with the use of a modulating sub-carrier;
   - (3) two or more channels containing quantized or digital information.

c) Type of information to be transmitted (third symbol):
   - (A) telegraphy – for aural reception;
   - (B) telegraphy – for automatic reception;
   - (C) facsimile;
   - (D) data transmission, telemetry or telecommand.

d) Details of signal(s) (fourth symbol, optional):
   - (A) two-condition code with elements of differing numbers and/or durations;
   - (B) two-condition code with elements of the same number and duration without error-correction;
   - (C) two-condition code with elements of the same number and duration with error-correction;
   - (D) four-condition code in which each condition represents a signal element (of one or more bits);
   - (E) multi-condition code in which each condition represents a signal element (of one or more bits);
   - (F) multi-condition code in which each condition or combination of conditions represents a character.

NOTE – See ITU Radio Regulations (edition 1982), Article 4 and Appendix 6 (AP6, part A) for details and definition of the emission characteristics.

1.3 System characteristics

1.3.1 Transmitter

The transmitters that are measured using the methods in this standard may be capable of simultaneously transmitting two or more data signals or voice and a data signal. The operational characteristics of the system in which the transmitter will be used will establish if the transmitter will be required to simultaneously transmit several types of signals.

Many of the systems that require the transmitter to transmit both analogue voice and data arrange it so that either voice or data are transmitted, but not simultaneously. In this instance this standard would be used to measure the transmitter radio-frequency parameters with the transmitter in the data mode only. IEC 60489-2 should be used to measure the radio-frequency parameters with the transmitter in the analogue voice mode.

When the system requires that the transmitter transmit simultaneously more than one signal, the radio-frequency parameters will be measured with the transmitter transmitting only the maximum number of simultaneous signals required by the system. For example, a transmitter may be capable of transmitting three types of signals, but the system may require under some circumstances that two signals be transmitted simultaneously and, at all other times, only one signal will be transmitted. In this case, the measurements should be made while the transmitter is transmitting the two simultaneous signals.

When the system requires that input signals, other than the data signal to be used in the measurement, be applied simultaneously with the data signal to the transmitter under test, they should be applied to the proper port and at the signal levels specified by the manufacturer. The measurements in this standard will then be made using simultaneously the data signal and the other required signals (see figure 1).

1.3.2 Receiver

In this standard, the subclauses entitled “Method of measurement” are designed to measure the value of a radio-frequency parameter. In some cases, it is only necessary to determine if the receiver-decoder is compliant with the radio-frequency parameter specification. This can usually be done more simply and with less effort than measuring the radio-frequency parameter. For the more frequently measured radio-frequency parameters, a compliance test method is included in the appropriate clauses. The specified value for the radio-frequency parameter will be the appropriate value specified by a regulation, contract or equipment specification.

The degradation measurements for receivers (4.3 to 5.1) requires the knowledge of the sensitivity. This sensitivity is used to derive a value for the wanted signal level. In one case, the sensitivity to use is the measured usable sensitivity – MUS – (determined according to 4.2 for every equipment under test). Alternatively, it is possible to use the specified usable sensitivity – SUS – applicable for a set of equipment.

According to the type of measurement performed, it is necessary to add, immediately after the name of each measured parameter, either “(referred to MUS)” or “(referred to SUS)”.

1.4 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60489. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60489 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(721), *International Electrotechnical Vocabulary – Chapter 721: Telegraphy, facsimile and data communication*

IEC 60489-1, *Methods of measurement for radio equipment used in the mobile services – Part 1: General definitions and standard conditions of measurement*

IEC 60489-2, *Methods of measurement for radio equipment used in the mobile services – Part 2: Transmitters employing A3E, F3E or G3E emissions*

2 Terms and definitions

For the purpose of this part of IEC 60489, the definitions given in IEC 60489-1, as well as the following supplementary definitions, apply.

2.1
average frequency
number of positive (or negative) going zero crossings of the signal divided by the total time duration of the measurement

2.2
binary digit bit
member of a set of two elements commonly used to represent information [IEV 721-02-08]

2.3
bit rate
number of bits transmitted per unit of time, expressed in bit/s, kbit/s or Mbit/s

2.4
bit stream
continuous series of bits

2.5
character
member of a set of elements agreed upon to be used for organization, representation or control of information

NOTE – Characters may be letters, digits, punctuation marks or other symbols and, by extension, function controls such as space shift, carriage return or line feed contained in a message.

[IEV 721-03-09]

2.6
character string
character or sequence of characters

2.7
comparator (data)

2.7.1
comparator (bit stream or character string)
device capable of

– storing a reference sequence of bits or characters,
– counting the number of bits or characters that are transmitted,
– comparing the bits or characters received with the reference sequence of bits or characters,
– counting the number of correctly received bits or characters

2.7.2
comparator (message or selective calling)
device or person capable of

– storing a reference message or call,
– counting the number of times a message or a call is transmitted,
– comparing the message or the call received with the reference message or call,
– counting the number of correctly received message or calls

2.8
data
information represented in a manner suitable for automatic processing

[IEV 721-01-02]

2.9
data source
device that generates the standard baseband test signals in the form of an electrical signal. For character and messages, this is normally specified by the equipment manufacturer

2.10
decoder
device, which may be in the receiver, that translates the demodulated signal into the intended output signal.

For selective calling, the output signal is only an alarm, indicating 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.

2.11
encoder
device which translates a group of input signals into a unique group of output signals suitable for transmission (see figure 1)

NOTE – Examples of functions that may be involved are

– addition of synchronization bits,

– addition of error correction bits,

– parallel/serial conversion,

– amplitude and phase shaping.

2.12
erroneous bit, character or message
any decoded bit, character or message that is not the same as the transmitted bit, character or message

2.13
error
failure to decode correctly the intended transmitted bit, character, message or selective calling

NOTE – Another type of error is the reception of data in the absence of any intended transmission (false reception). The mean time between two successive false receptions is generally so high that a measurement would be impractical; this parameter is estimated by calculation.

2.14
error ratio
number of erroneous bits, character messages or selective callings received, divided by the total number of bits, characters, messages or selective callings transmitted, respectively.

For selective calling (1 – error ratio) is also called “calling probability”

2.15
message
group of characters and function control sequences which is transferred as an entity from a transmitter to a receiver, where the arrangement of the characters is determined at the transmitter

[IEV 721-09-01]

2.16
message format
description of the elements and their arrangement in a message

NOTE – The arrangements may include among other items, synchronization bits, address bits, text, flag bits and additional bits for error correction and/or detection:

a) synchronization bits: additional bits which are provided only for the purpose of synchronization;

b) address: information that identifies the address or identifies the sending unit;

c) function: information that identifies which of a plurality of responses is to be executed;

d) text: information (e.g. character string);

e) error control bits: bits which are provided solely for the purpose of error correction and/or detection.

2.17
modulation

NOTE – The detailed description of the modulation should be given in specifications of equipment under test.

2.17.1
analogue modulation

2.17.1.1
amplitude modulation:
– peak envelope amplitude: the amplitude of one radio-frequency oscillation at the crest of the envelope of the modulated wave;

– modulation depth: for double-sideband amplitude modulation, the modulation depth, in per cent, 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

2.17.1.2
frequency or phase modulation
– maximum permissible deviation: the value to which the peak frequency or phase deviation is limited by an agreed convention for a particular class of service;

– deviation: the variation of the carrier wave in frequency or phase, expressed in per cent of the maximum permissible deviation

2.17.2
digital modulation

2.17.2.1
keying method
for example,

– frequency-shift keying (FSK)

– phase-shift keying (PSK)

– minimum-shift keying (MSK)

2.17.2.2
roll-off factor and its transmitter percentage
– roll-off factor is expressed by the product of the pulse-shaping function baseband filter cut-off frequency and the modulation symbol time

– transmitter percentage is the ratio percentage of the roll-off factor, which is performed by transmitters, the residual percentage being performed by receivers

2.18
port
place of access to a device or network where energy, representing data, may be supplied or withdrawn, or where the device or network variable may be observed or measured

2.19
radio pager
small radio receiver-decoder which produces an alarm following reception of a selective call; intended to be worn on a person and usually has an integral antenna

2.20
reference error ratio
the following reference error ratios apply for an equipment measured with the standard test signal code (data):

– reference error ratio (bit stream or character string) 0,01 or 1 %;

– reference error ratio (message or selective calling) 0,2 or 20 %.

For selective calling (1 – reference error ratio) = 0,8 or 80 % is also called “standard calling probability”

2.21
selective-calling system
system whereby the transmission of a signal code from a station enables another predetermined station or group of stations to be called exclusively; it may be used as “selective calling” or “selective call”

2.22
standard baseband test signals
for the purpose of the measurements described in this standard the following definitions apply:

a) reference sequence of bits

binary sequence pattern of 511 bits which are generated in a pseudo-random order

NOTE – For details concerning the generation of the pseudo-random binary sequence (PRBS) pattern, see CCITT Fascicle VIII.1, Recommendation O.153.

b) reference sequence of characters

character sequence pattern comprising all elements of a specified character set arranged in a specified pseudo-random order

c) reference message or selective call

message or selective call whose content is defined in the equipment specification

NOTE – This unique message is repeated three or four times in the “up and down” method.

2.23
standard coded test signal (data): SCTS (data)
radio-frequency signal applied to a data receiver-decoder that simulates the output of a transmitter which is modulated by one of the following standard baseband test signals:

– the reference sequence of bits; or

– the reference sequence of characters, or

– the reference message or the selective call

– at the bit rate defined in the data equipment specification

All parameter tolerances (e.g. rise time, tone frequencies, phase-shift angles) should be small enough to ensure that the results are not significantly influenced. In addition to any other parameters, the equipment specification should define the appropriate values for

– the modulation depth of double-sideband modulation, or

– the frequency/phase deviation of angle modulation, or

– the amplitude relationship to the carrier of single-sideband, full, reduced or variable carrier modulation,

– the frequency relationship to the carrier of single-sideband, full, reduced or variable carrier modulation

2.24
standard train of standard coded test signal (bit stream or character string)

NOTE 1 – The length of the standard trains has been chosen in order to achieve a dispersion of ±1 dB for the measurement of reference sensitivity and of ±2 dB for all other measurements.

For all measurements and compliance tests, except sensitivity reduction under multipath propagation conditions (bit stream or character string), the standard trains are

– for bit stream : 2 556 bits of SCTS;

– for character string : 2 556 characters of SCTS

NOTE 2 – For the measurements in this standard, the required reliability is obtained if the transmission is stopped after 26 bit or character errors are detected.

2.25
standard unwanted signal (data)
the standard unwanted signal for measuring spurious response immunity and intermodulation immunity is not modulated.

The standard unwanted signal for measuring adjacent radio-frequency signal selectivity or co-channel interference rejection is continuously modulated with a binary sequence pattern of 32 767 bits which is generated in a pseudo-random order. The modulation is identical with the modulation characteristics of the system transmitter

2.26
telegraphy

form of telecommunication in which the transmitted information is intended to be recorded on arrival as a graphic document; the transmitted information may sometimes be presented in an alternative form or may be stored for subsequent use

NOTE 1 – A graphic document records information in a permanent form and is capable of being filed and consulted; for example, it may take the form of written or printed matter or of a fixed image.

NOTE 2 – This is the definition given in the International Telecommunication Convention (Nairobi, 1982).

NOTE 3 – Telegraphy does not include television or videography.

[IEV 721-01-06, modified]

3 Test conditions

3.1 Standard test conditions

3.1.1 Unless otherwise stated, measurements shall be performed under the general test conditions as stated in IEC 60489-1 and the supplementary test conditions given in 3.2.

3.1.2 In this standard, the methods of measurement have been developed under the assumption that automatic test equipment is available.

3.1.3 If the data source and encoder are external to the transmitter but are dedicated to its application, the manufacturer shall supply to the organization making the measurements either detailed information so that the items can be fabricated, or the device itself.

3.2 Supplementary test conditions

3.2.1 Receivers

3.2.1.1 Receiver-decoder having an integral antenna

In this standard, the methods of measurement and compliance tests have been written for receivers having antenna terminals. For receivers with integral antennas, the following test conditions apply:

– for average radiation sensitivity (data) (see 11.1.6), measurements and compliance tests are made on a test site;

– measurements and compliance tests in 4.1 through 4.9 (data) for receiver-decoders having an integral antenna are made with the receiver in a suitable radio-frequency coupling device (RFCD).

The RFCD may be

– a test fixture device for coupling a given equipment with an integral antenna to an input socket. It is generally designed and provided by the manufacturer. It allows relative measurements to be performed at the same frequency or around the same frequency. Therefore the measurements and compliance tests in 4.5 (spurious response immunity) and in 6.1 (radiated spurious components) are excluded;

– a stripline arrangement as described in IEC 60489-1, annex A, clause A.3. This is a measuring instrument for coupling any equipment with integrated antenna to an input socket. It allows relative measurement of signals to be performed situated at different frequencies.

The same procedures are used as for receivers having antenna terminals, except that the input-signal level recorded is that introduced at the input terminals of the RFCD instead of at the antenna terminals of the receiver.

NOTE 1 – For message or selective calling, the measurements and compliance tests (4.1 through 4.9) have been designed for non-automatic use: the number of trials in these measurements and compliance tests have been reduced to the minimum required to obtain the necessary accuracy and variation. Various automatic measurement procedures may be used, but it is not proposed that they be standardized at this time. On the other hand, for bit stream and character string, the measurements and compliance tests (4.1 through 4.9) have been designed to use automatic error counting equipment.

NOTE 2 – The measurements in 4.1 through 4.9 (message or selective calling) 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).

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

Depending on the type of modulation and the measuring equipment available, one of the three measuring arrangements described below shall be employed.

a) Arrangement A

The arrangement comprises the following pieces of equipment:

– a test data source and an encoder as required, or a test encoder combining these two functions;

– a radio-frequency signal generator or an alternate signal source (see 3.3.9) capable of being modulated in accordance with the type of modulation used by the receiver;

– an impedance matching network (or pad; see (3) of figure 2) placed as close as possible to the receiver under test.

NOTE – Examples of impedance matching networks and combining networks are given in annex A.

b) Arrangement B

For some types of single-sideband modulation, with corresponding characteristics as given in 1.2 b) (1), it may be possible to simulate the modulated signal by using two radio-frequency generators. In this case, an arrangement similar to arrangement A may be used, but with the signal generator or alternate signal source replaced by two radio-frequency signal generators, the outputs of which are connected to a combining network terminated in an adjustable attenuator.

c) Arrangement C

The arrangement is similar to arrangement A, except that it also requires a means to convert the output frequency of the alternate signal source to the nominal frequency specified for the receiver. This is accomplished by using a radio-frequency signal generator