INTERNATIONAL STANDARD

IEC 60489-8

1984

AMENDMENT 1
2000-10

Amendment 1

Methods of measurement for radio equipment used in the mobile services

Part 8: Methods of measurement for antennas and ancillary equipment

Amendement 1

Méthodes de mesure applicables au matériel de radiocommunication utilisé dans les service mobiles –

Partie 8:
Méthodes de mesure applicables aux antennes et matériels accessoires

International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE U

For price, see current catalogue

FOREWORD

This amendment has been prepared by IEC technical committee 102: Equipment used in radio communications for mobile services and for satellite communication systems.

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

FDIS	Report on voting
102/62/FDIS	102/63/RVD

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

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

_____

Amend the title of this standard on the cover page, the title page and on pages 5 and 9 as follows:

Part 8: Methods of measurement for antennas and ancillary equipment

Page 3

CONTENTS

Add the title of the following new clause 9 in Section two:

Add the following new section and annexes.

Page 9

Replace the text of clauses 1 and 2 as follows:

1 Scope

This International Standard refers specifically to the antennas and ancillary equipment used in the mobile services.

This standard is intended to be used in conjunction with IEC 60489-1.

The supplementary terms and definitions and the conditions of measurement set forth in this standard are intended for type tests and may also be used for acceptance tests.

2 Object

The object of this standard is to standardize the definitions, the conditions and the methods of measurement used to ascertain the performance of antennas and ancillary equipment (for example, duplexer) within the scope of this standard and to make possible a meaningful comparison of the results of measurements made by different observers on different equipment.

Page 19

Add the following new clause 9 and new figures after subclause 8.4:

9 Measurement of duplexers

9.1 General

9.1.1 Supplementary terms and definitions

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

9.1.1.1
duplexer
device allowing the same antenna to be used for simultaneous transmission and reception [IEV 712-06-16]

NOTE There are three terminals which are connected to the transmitter, the receiver and the antenna respectively in a duplexer. The branch from the transmitting terminal to the terminal of the antenna is referred to as the transmitting branch. The branch from the terminal of the antenna to the receiving terminal is referred to as the receiving branch.

9.1.1.2
frequency stability (temperature)
drift characteristic of the extreme frequency at which the specified duplexer performance is satisfied, with temperature. It is expressed as parts per million per centigrade (10^{-6}/°C). The duplexer performance (for example, transmitter noise suppression-ability, transmitter-to-receiver isolation-ability, insertion loss and SWR) should be measured under the condition of specified temperature range and more than specified frequency range

9.1.2
standard test condition
unless otherwise specified, all measurements should be performed under the general test conditions as stated in IEC 60489-1 and the supplementary test conditions given below

9.1.3 Supplementary test conditions

9.1.3.1
test load
non-radiating load with an impedance and power rating specified by the duplexer manufacturer

9.1.3.2
connections to the measuring equipment
care must be taken to ensure that measuring equipment does not adversely affect the duplexer loading conditions

9.2 Transmitter noise suppression-ability

9.2.1 Definition

The ability of the duplexer to suppress the transmitter noise on the frequency band of the receiver, so as to prevent the desired performance of the receiver from degrading.

It is expressed by the minimum coupling attenuation value from the transmitting terminal to the receiving terminal of the duplexer in the above frequency band.

9.2.2 Method of measurement

a) Connect the equipment as illustrated in figure 1.

b) Connect point P1 to P2. Adjust the frequency of the generator (1) to any one within the specified operating frequencies of the receiving branch.

   Adjust the output of the generator (1) and attenuation of the attenuator (2) to provide a signal level within the linear range of the selective measuring device (4). Record the level and value of attenuation.

c) If required, repeat step b) at another specified operating frequency.

d) Connect point P1 to the transmitting terminal (Tx) of the duplexer, and point P2 to the receiving terminal (Rx) of the duplexer.

While maintaining the output of the generator (1) established in step b), vary the frequency over the specified operating range of the receiving branch and adjust the attenuator (2) to provide a signal level within the linear range of the selective measuring device (4). Record the level and the value of the attenuation at each frequency.

9.2.3 Presentation of results

a) Calculate the ratio, in dB, of the recorded level in step b) of 9.2.2 to recorded level in step d) of 9.2.2 and the difference, in dB, between the recorded attenuation in step b) of 9.2.2 and the recorded attenuation in step d) of 9.2.2. Add the value of both the ratio and the difference. Record this coupling attenuation value, in dB.

b) Plot the coupling attenuation value recorded in step a) on the linear ordinate of a graph versus the corresponding frequency on the linear abscissa.

c) The minimum coupling attenuation value in the graph is referred to as transmitter noise suppression ability of the duplexer.

9.3 Transmitter-to-receiver isolation ability

9.3.1 Definition

The ability of the duplexer to isolate the transmitter output power level so as to prevent the desired performance of the receiver from degrading.

It is expressed by the minimum coupling attenuation value from the transmitting terminal to the receiving terminal of the duplexer in the transmitting frequency band.

9.3.2 Method of measurement

a) Connect the equipment as illustrated in figure 1.

b) Connect point P1 to P2. Adjust the frequency of the generator (1) to any one within the specified operating frequencies of the transmitting branch.

Adjust the output of the generator (1) and attenuation of the attenuator (2) to provide a signal level within the linear range of the selective measuring device (4). Record the level and value of attenuation.

c) If required, repeat step b) at another specified operating frequency.

d) Connect point P1 to the transmitting terminal (Tx) of the duplexer, and point P2 to the receiving terminal (Rx) of the duplexer.

While maintaining the output of generator (1) established in step b), vary the frequency over the specified operating range of the transmitting branch and adjust the attenuation of attenuator (2) to provide a signal level within the linear range of the selective measuring device (4). Record the level and the value of attenuation at each frequency.

9.3.3 Presentation of results

a) Calculate the ratio, in dB, of the recorded level in step b) of 9.3.2 to the recorded level in step d) of 9.3.2, and the difference, in dB, between the recorded attenuation in step b) of 9.3.2 and the recorded attenuation in step d) of 9.3.2. Add the values of both the ratio and difference. Record this coupling attenuation value, in dB.

b) Plot the coupling attenuation value recorded in step a) on the linear ordinate of a graph versus the corresponding frequency on the linear abscissa.

c) The minimum coupling attenuation value in the graph is referred to as transmitter-to-receiver isolation ability of the duplexer.

9.4 Insertion loss

9.4.1 Definition

Transmission loss of the transmitter output power level and the receiver input signal level through the duplexer.

9.4.2 Method of measurement

a) Connect the equipment as shown in figure 2a to the attenuator (4) in the circuit, if the input SWR of the selective measuring device (5) exceeds 1,2:1.

b) Connect point P1 to point P2. Adjust the frequency of the generator (1) to any one within the specified operating frequencies of the transmitting branch. Adjust the output of the generator (1) and the attenuation of the attenuator (2) to provide a signal level within the linear range of the selective measuring device (4). Record the level.

c) If required, repeat step b) at another specified operating frequency.

d) Connect point P1 to the transmitting terminal (Tx) and point P2 to the antenna terminal (Ant).

   While maintaining the output of the generator (1) established in step b), vary the frequency over the specified operating range of the transmitting branch. Record the level indicated by the selective measuring device (5) at each frequency.

e) Connect the equipment as illustrated in figure 2b; connect point P1 to point P2. Adjust the frequency of the generator (1) to any one within the specified operating frequencies of the receiving branch. Adjust the output of the generator (1) and the attenuation of the attenuator (2) to provide a signal level within the linear range of the selective measuring device (4). Record the level.

f) If required, repeat step e) at another specified operating frequency.

g) Connect point P1 to the antenna terminal (Ant) and point P2 to the receiving terminal (Rx).

   While maintaining the output of the generator (1) established in step e), vary the frequency over the specified operating range of the receiving branch. Record the level indicated by the selective measuring device (5) at each frequency.

9.4.3 Presentation of results

a) Calculate the ratio, in dB, of the recorded level in step b) of 9.4.2 to the recorded level in step d) of 9.4.2 and the ratio, in dB, of the recorded level in step e) of 9.4.2 to the recorded level in step g) of 9.4.2. Record this value, in dB.

b) Plot the ratio recorded in step a) on the linear ordinate of a graph versus the corresponding frequency on the linear abscissa.

c) The maximum ratio in the specified operating frequency range of both branches is referred to respectively as the insertion loss of the transmitting branch and the receiving branch.

9.5 Standing-wave ratio (SWR)

9.5.1 Definition

The ratio of the maximum to the minimum values of the voltage in the standing-wave pattern along a lossless transmission line with the transmitting or antenna terminal as a load, while the receiving and antenna terminal or the receiving and transmitting terminal are connected to the test load.

9.5.2 Method of measurement

a) Connect the equipment as illustrated in figure 3.

NOTE The SWR measuring device has a nominal impedance equal to that of the transmitting line and a residual SWR of not more than 1,05 below or equal to 500 MHz and not more than 1,10 above 500 MHz. This residual SWR should be measured with all connectors to be used – measurement included.

b) Connect point P1 to the transmitting terminal (Tx) and point P2 to the antenna terminal (Ant). Vary the frequency of the generator (1) over the specified operating frequency range of the transmitting branch. Record the SWR at each frequency, as read on the SWR measuring device (3).

c) Connect point P1 to the antenna terminal (Ant) and point P2 to the transmitting terminal (Tx). Vary the frequency of the generator (1) over the specified operating frequency range of the receiving branch. Record the SWR at each frequency, as read on the SWR measuring device (3).

9.5.3 Presentation of results

The maximum value recorded in step b) and c) of 9.5.2 is respectively referred to as SWR of the transmitting branch and the receiving branch.

9.6 Rating power

9.6.1 Definition

The permissible input power at the transmitting terminal of the duplexer under specified operating conditions.

9.6.2 Method of measurement

a) Connect the equipment as illustrated in figure 4. Connect point P1 to point P2.

b) Adjust the output of the generator (1) at the specified frequency to achieve the specified power as indicated by the power meter (5). Record the settings of the generator.

c) Switch off the output of the generator and connect point P1 to the transmitting terminal (Tx) and point P2 to the antenna terminal (Ant.).

d) Switch the generator (1) output on and restore the settings recorded in b). Record the SWR measuring device (3) reading.

e) Apply the power for a period of 4 h under specified temperature and humidity conditions. No damage or deformation shall be observed and the change in SWR from the value recorded in d) shall be less than 10 %.

9.6.3 Presentation of results

The result shall state the rating power, the test frequency and the environmental temperature and humidity.

9.7 Duplexer performance under conditions deviating from standard test conditions

If required, the performance of the duplexer should be evaluated under conditions deviating from standard test conditions.

The performance characteristics and the environmental conditions at which the measurements are to be made shall be those explicitly specified in the equipment specification.

The results obtained may be compared with those obtained under standard test conditions.

9.7.1 Initial measurements under standard test conditions

Before beginning the test described in the following subclause, the relevant performance characteristics must first be measured under standard test conditions in accordance with the methods specified in this section.

9.7.2 Variation of ambient temperature

9.7.2.1 Cold

The required characteristics shall be measured under the environment conditions specified in clause 28 of IEC 60489-1.

9.7.2.2 Dry heat

The required characteristics shall be measured under the environment conditions specified in clause 28 of IEC 60489-1.

9.7.2.3 Evaluation of frequency stability (temperature)

Measure the duplexer performance, for example, transmitter noise suppressionability, transmitter-to-receiver isolationability, insertion loss and SWR, versus frequency under standard test conditions, specified cold and dry heat, and more than specified frequency range.

Estimate the drift of the extreme frequencies corresponding to the satisfied requirement of performance, for example transmitter noise suppressionability, transmitter-to-receiver isolationability, insertion loss and SWR. It is expressed in 10^{-6}/°C. The maximum value is referred to as the frequency stability (temperature).

9.7.3 Variation of humidity

The required characteristics shall be measured under the environment conditions specified in clause 28 of IEC 60489-1.

9.7.4 Vibration

For equipment intended to have immunity to vibration, the required characteristics shall be measured after the vibration test has been performed in conformity with 30.1 of IEC 60489-1.

NOTE Duplexers intended to be used for transceivers operating under vibration conditions should be tested additionally under real conditions, i.e. forming a part of transceivers, when the quality of transmitted (received) information or signal-to-noise ratio on the transmission (reception) channel is estimated.

9.7.5 Shock

For equipment intended to have immunity to shock, the required characteristics shall be measured after the shock test has been performed in conformity with 30.2 of IEC 60489-1.

9.7.6 Dust and sand

For equipment intended to have immunity to dust and sand, the required characteristics shall be measured after the dust and sand test has been performed in conformity with 30.4 of IEC 60489-1.

9.7.7 Driving rain

For equipment intended to have immunity to driving rain, the required characteristics shall be measured after the driving rain test has been performed in conformity with 30.5 of IEC 60489-1.

9.7.8 Corrosion (salt fog)

For equipment intended to have immunity to corrosion (salt fog), the required characteristics shall be measured after the corrosion test has been performed in conformity with 30.6 of IEC 60489-1.

Add the following new section after Section two:

Section three – Vehicular antennas and conditions

10 Supplementary definitions and conditions

Definitions used in this standard generally conform with those given in IEC 60050(138).

In this section, as stated in Section one, clause 3, the term "antenna" will be used. This term is synonymous with "aerial" (see IEV 712-01-01).

10.1 Impedance of test equipment

The characteristic impedance of any transmission line connecting test equipment to the antenna shall be equal to the declared nominal impedance of the antenna.

10.2 Bandwidth

The extent of a continuous range of frequencies over which an antenna characteristic or performance parameter conforms to a specified value.

10.3 Polarization

The orientation of the electric vector of the wave radiated by the antenna.

10.4 Test environment

10.4.1 Standard test mounting

Two arrangements of standard test mounting (ground-plane test mounting and back-to-back test mounting), not taking into account the effects of mounting on a car, are shown in annex C.

10.4.2 Test vehicle

The test vehicle shall be a four-door passenger automobile of steel construction, not more than four years old, and in operating condition. It shall have the following approximate dimensions:

Overall size	Roof size	Wheel size
m	m	m
Height: 1,5 ± 0,25	Length: 1,5 ± 0,25	0,33 to 0,38
Length: 5 ± 0,75	Width: 1,25 ± 0,25	
Width: 1,5 ± 0,25		

10.5 Standard antenna

One type of standard antenna intended only for mounting on a standard ground plane or on a test vehicle, is shown in annex D.

Back-to-back antennas are under consideration.

10.6 Environmental conditions

Unless otherwise specified, measurement should be made at an environmental temperature of 0 °C to 30 °C, at humidity below the dew point.

10.7 Radiation pattern

For the purpose of this section, the radiation pattern is the graphical representation in dB of the relative strength of the field radiated from the antenna plotted against the angular distance from a given reference direction.

For measurements made on a vehicle, the front shall be designated as 0°.

Measurements will normally be made in the horizontal plane, but measurements at elevated angles may be required.

10.8 Relative antenna gain

In this section, the gain of an antenna cannot be referred to an absolute standard. Relative antenna gain is the gain of the antenna under test compared with that of the standard antenna having the same mounting.

10.9 Percentage coverage gain

The percentage coverage gain of an antenna in a given plane is the percentage of the total angular coverage for which the gain does not fall below that of a stated reference level by more than the specified amounts.

10.10 Shock stability

The ability of the antenna to maintain specified performance after being subjected to the specified shock test.

10.11 Vibration stability

The ability of the antenna to maintain its mechanical integrity while being vibrated, and specified electrical performance after completion of the test.

11 Standing-wave ratio (SWR)

11.1 Test conditions

The antenna under test, complete with its mounting arrangement, is to be attached to the standard test mounting (see 10.4). Adapters may be used to facilitate the mounting of the test antenna, provided that they do not alter the intended height by more than 2 mm. The test site is considered satisfactory if the change in the SWR reading is less than 10 % of the SWR when

the antenna and the standard test mounting are moved in a horizontal direction a minimum of λ/2: on each of the four azimuths, 90° apart, or, if the measurement is made on the test vehicle, back and forth one wavelength, in at least two perpendicular directions.

NOTE Movement over a total distance of half a wavelength in every direction includes all the phase possibilities for the reflected signals.

11.2 SWR measurement procedure

The antenna under test with its mounting system (see annex C) shall be located in a space relatively free from reflections at the desired frequency, through a SWR measuring device, that has a nominal impedance equal to the nominal impedance of the transmission line and a residual SWR of not more than 1,05 below 500 MHz and 1,10 above 500 MHz. This residual SWR should be measured with all connectors to be used in the measurement included and with the line terminated in a matched load with a SWR of not more than 1,01. The measurement shall be made at each frequency of interest.

The SWR, as read on the measuring device, will be the SWR of the antenna under test at the selected frequency. If the r.f. loss in the line connecting the antenna to the measuring device exceeds 0,5 dB, the measured SWR values shall be properly corrected to take account of the line loss.

11.3 Presentation of results

At least the maximum (corrected) SWR for the frequencies of interest shall be provided, along with the nominal impedance of the measuring device.

When the test is mode on the test vehicle, its dimensions and the position of the antenna shall be indicated.

12 Radiation pattern

12.1 Test conditions

The antenna under test together with its mounting system shall be installed on a test range (see annex A)

where

– the antenna shall have the same polarization;

– the separation between the source antenna and the antenna under test shall be at least $2\left(L_1^2 + L_2^2\right) / \lambda$;

– where L_1 and L_2 are the maximum dimensions respectively of the source antenna and the antenna under test plus ground plane, and λ is the wavelength of the test frequency;

– the antenna under test shall be placed in an area where the field is substantially uniform. The field shall previously be probed by a half-wave dipole over the effective antenna volume of the antenna under test. If the field intensity variation exceeds 1,5 dB, the test site shall be considered unusable;

– the 0° reading shall be taken at the start and end of each pattern run. If the two readings differ by more than 0,5 dB, the run is void and must be retaken;

– the type and length of cable connecting the test antenna to the receiver shall be the same as for the standard antenna so that there is no difference in cable attenuation;