SLOVENSKI STANDARD
SIST IEC 60615:1995

01-avgust-1995

Terminologija za mikrovalovne naprave

Terminology for microwave apparatus

Terminologie pour appareils à micro-ondes

Ta slovenski standard je istoveten z: **IEC 60615**

ICS:

01.040.29	Elektrotehnika (Slovarji)	Electrical engineering (Vocabularies)
29.020	Elektrotehnika na splošno	Electrical engineering in general

SIST IEC 60615:1995 **en**

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
615

Première édition
First edition
1978-01

Terminologie pour appareils à micro-ondes

Terminology for microwave apparatus

Bureau central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE S

Pour prix, voir catalogue en vigueur
For price, see current catalogue

CONTENTS

Page

FOREWORD 5

PREFACE 5

Clause

1. General 7
2. General terms 7
3. Frequency 13
4. Immittance 15
5. Noise figure 31
6. Power, attenuation and gain 33
7. Signals 41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

TERMINOLOGY FOR MICROWAVE APPARATUS

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by IEC Technical Committee No. 66, Electronic Measuring Equipment.

A first draft was discussed at the meeting held in Baden-Baden in 1972. The draft, Document 66(Central Office)20, was submitted to the National Committees for approval under the Six Months' Rule in September 1975.

The following countries voted explicitly in favour of publication:

Australia	Netherlands
Belgium	Poland
Denmark	Spain
Finland	Sweden
France	Turkey
Germany	Union of Soviet Socialist Republics
Hungary	United Kingdom
Italy	United States of America
Japan	

This standard complements the definitions appearing in Chapter 62 of the International Electrotechnical Vocabulary: Waveguides, published in 1961. This chapter, incidentally, is under revision at the time of publication of the present standard.

TERMINOLOGY FOR MICROWAVE APPARATUS

1. General

1.1 *Scope*

This standard applies to microwave measuring apparatus and microwave measuring techniques.

Note. — The term microwaves is used to signify radio waves in the frequency range from about 1 GHz upwards. (The low-frequency boundary of the microwave range is usually considered to be where lower-frequency techniques and lumped circuit elements cannot generally be used efficiently. It is then necessary to apply distributed line techniques and transmission line theory.)

1.2 *Object*

To establish the essential definitions related to microwave measuring techniques and apparatus.

2. General terms

2.1 *Anechoic chamber*

A space bounded by absorbing wall coating, such that the walls can be considered as being non-reflective for electromagnetic waves in a stated frequency range.

2.2 *Cavity resonator*

A space bounded by conductive coating to obtain resonance of a specific mode at a stated frequency.

2.2.1 *Echo box*

A tunable cavity resonator used for the purpose of supplying a signal at a particular frequency to adjust a radar receiver. This signal is available during the "ringing" time of the resonator, after the transmitter pulse is turned off.

2.3 *Circulator*

A multiport device in which power to any port is transmitted to the next port according to a given order of sequence.

Note. — By reversing the biasing field the order of sequence is reversed. This property may be used to switch electromagnetic energy.

2.4 *Isolator*

A passive two-port device having much greater attenuation in one direction of propagation than in the other.

Note. — The ratio (usually expressed in decibels) of the power entering the output port and the power delivered to the input port is called *isolation*.

2.5 *Corner reflector*

A reflecting object consisting of two or three mutually intersecting flat conducting surfaces and functioning by multiple reflection.

Note. — Corner reflectors may be dihedral or trihedral. A 90° trihedral reflector may be used as a radar target, since regardless of exact orientation the incident wave retraces its path.

2.6 *Cut-off frequency of a waveguide mode*

That frequency below which the propagation constant of a waveguide becomes real for a specific mode, so that no significant propagation in that mode is possible.

2.7 *Cut-off frequency of a waveguide*

That frequency below which a travelling wave in the dominant mode cannot be satisfactorily propagated.

2.8 *Electrical length* (in units of angle)

For an arbitrary device, the electrical length l (in degrees) is defined as:

$$l = \frac{d\theta_1}{df} \times \left(\frac{d\theta_0}{df}\right)^{-1} \times 360$$

where:

$\frac{d\theta_1}{df}$ = rate of change of the phase difference (with frequency) between input and output of the device

$\frac{d\theta_0}{df}$ = rate of change of the phase difference (with frequency) between two points in free space separated by one wavelength

Note. — For devices having an electrical length less than 90°, a simpler definition may be used: the phase difference (in degrees) between input and output signal of a two-port device at a specific frequency.

2.9 *Guided wave*

An electromagnetic wave which propagates along or between physical boundaries or structures.

2.10 *Group-delay*

The slope of the phase/angular frequency transmission characteristic of a microwave device.

2.11 *Gyrator*

Non-reciprocal phase-shifter having a differential phase shift of π radians.

Note. — The use of the word gyrator to denote gyromagnetic devices in general is deprecated.

2.12 *Waveguide transmission modes*

2.12.1 *Dominant mode*

The mode with the lowest cut-off frequency.

2.12.2 *Transverse electric* (T.E. or H) *mode*

A mode in which the longitudinal component of the electric field is zero at all points and the longitudinal component of the magnetic field is not zero.

2.12.3 *Transverse magnetic* (T.M. or E) *mode*

A mode in which the longitudinal component of the magnetic field is zero at all points and the longitudinal component of the electric field is not zero.

2.12.4 *Transverse electromagnetic* (T.E.M. or E.H.) *mode*

A mode in which the longitudinal components of both the electric and magnetic fields are zero at all points.

2.12.5 *Hybrid mode*

A mode in which both the electric and magnetic fields have longitudinal components.

2.13 *Balanced modulator*

A modulator in which certain modulation components are suppressed by a balanced arrangement of elements.

2.14 *Linear modulator*

A modulator in which, for a given magnitude of carrier, the modulated characteristic of the output wave bears a substantially linear relation to that of the modulating wave.

2.15 *Propagation constant*

In a rectilinear uniform transmission line, at any given frequency, the propagation constant of a unidirectional transmission mode of an electromagnetic field, which is a sinusoidal function of time at that given frequency, is the logarithmic rate of change with respect to distance of the complex amplitude of any arbitrary field component at any arbitrary point of any arbitrary section of the line. The propagation constant is a complex quantity.

2.15.1 *Attenuation constant*

The real part of the propagation constant (usually expressed in nepers per unit length).

2.15.2 *Phase constant*

The imaginary part of the propagation constant (usually expressed in radians per unit length).

2.16 *Velocity concepts*

2.16.1 *Phase velocity of a transmission mode*

The ratio between the angular frequency and the phase constant of a given transmission mode.

2.16.2 *Group velocity of a transmission mode*

The reciprocal of the rate of change with respect to angular frequency of the phase constant of a given transmission mode.

Note. — The group velocity coincides with the phase velocity if the phase constant is a linear function of the angular frequency.

2.17 *Transmission line*

A material structure forming a continuous path from one place to another, for directing the transmission of electromagnetic energy along this path.

2.18 *Waveguide*

A transmission line comprising a conductive tube which may contain a material dielectric.

2.19 *Dielectric waveguide*

A transmission line in which the waves are guided by dielectric material without conductive boundaries.

2.20 *Cut-off wavelength*

The cut-off wavelength of a waveguide mode is the free space wavelength which corresponds to the cut-off frequency.

2.21 *Waveguide wavelength*

The wavelength of a propagation mode of a waveguide is the distance between two transverse planes at which the phases of the same field components differ by 2 π. It is equal therefore to the ratio between the phase velocity and the frequency.

For a waveguide filled with uniform dielectric, the waveguide wavelength is given by the formula:

$$\lambda_g = \frac{\lambda}{\sqrt{\varepsilon_r - \frac{\lambda^2}{\lambda_c^2}}}$$

where:

ε_r = relative dielectric constant
λ = free space wavelength and
λ_c = cut-off wavelength of the given mode in the same air-filled guide

For a waveguide with air dielectric, the wavelength is given by the formula:

$$\lambda_g = \frac{\lambda}{\sqrt{1 - \frac{\lambda^2}{\lambda_c^2}}}$$

where:

λ = free space wavelength and
λ_c = cut-off wavelength of the given mode in the same air-filled guide

3. Frequency

3.1 *Frequency meter*

3.1.1 *Digital frequency meter*

An instrument in which the measured frequency is indicated in the form of a number digitally displayed.

3.1.2 *Absorption frequency meter* (wavemeter)

A cavity, calibrated in frequency and coupled to a transmission line, which, when tuned to the frequency of the propagating wave, absorbs electromagnetic power from that transmission line.

3.1.3 *Transmission frequency meter* (wavemeter)

A cavity, calibrated in frequency and inserted in a transmission line, which, when tuned to the frequency of the propagating wave, allows power to pass from the transmission line into a detector.

3.2 *Frequency multiplier*

A device for delivering an output wave whose frequency is a multiple of the input frequency.

3.3 *Frequency divider*

A device which divides the frequency of a continuous wave signal by an integral number.

3.4 *Spectrum analyser*

An instrument indicating the spectral amplitude distribution of the input signal over a desired frequency range, generally by providing a visual display of the amplitude of each frequency component in relation to its frequency in cartesian form.

3.5 *Transfer oscillator*

A stable tunable oscillator whose frequency, either fundamental or harmonic can be made precisely coherent with the fundamental of the unknown signal.

Note. — Using heterodyne techniques, time-variant frequency or phase deviations can be readily observed and measured.

4. **Immittance**

Term used to cover impedance and/or admittance.

4.1 *Immittance charts*

4.1.1 *Smith chart*

A coordinate system consisting of two families of orthogonal intersecting circles bounded by an outer circle. The chart coordinates display the complete range of possible values of normalized real and imaginary components of a passive immittance encountered along any mismatched (electrically) uniform transmission line or waveguide under steady-state conditions:

$$(R + jX)/Z_0 \quad \text{or}$$

$$(G + jB)/Y_0$$

where:
Z_0 = characteristic impedance
Y_0 = characteristic admittance

The coordinates are arranged so that normalized immittances are graphically related to the phase displacement along the transmission line or waveguide. Angular rotation of 2π radians (360°) is linearly related to the travel of $\lambda/2$ along a transmission line or waveguide.

The radial scale gives reflection coefficient magnitude increasing linearly from zero at the centre of the chart to unity at the rim.

Note. — In this definition only passive immitances are taken into account. It can, however, be extended for the representation of immittances having a real part of a restricted negative value. In that case, the outer circle gives a reflection-coefficient magnitude higher than unity.

4.1.2 *Z-theta chart*

This chart is similar to the Smith chart except that impedances are represented in polar form:

$$|Z| = |R + jX|$$

$$\Theta = \arctan \frac{X}{R}$$

4.2 *Microwave multiport junction*

A volume generally confined between conductive boundaries, where transmission lines are coupled electrically and/or magnetically.

4.2.1 *Directional coupler*

A four-port reciprocal junction, ideally lossless and matched at each port, in which the power fed into any one port is divided between only two of the other ports.

Note. — Ideally no power will be transmitted to the fourth port and none will be transmitted back to the first.

4.2.2 *Coupling factor (of a directional coupler)*

The ratio (generally expressed in decibels) between the power fed into one port and the power available at another.

Note. — In devices where the input power is very unequally divided between two other ports, the coupling factor is conventionally referred only to the less coupled port.

4.2.3 *Directivity (of a directional coupler)*

The ratio (generally expressed in decibels) of

- the output power at one of the ports, when only a travelling wave propagates between two other ports in one direction,
- to the output power at the same port, when the direction of the wave propagation between the same two other ports is reversed.

4.2.4 *Hybrid junction*

A directional coupler in which the power fed into any one port is, in the ideal case, equally divided between only two of the other ports.

Note. — If these two ports are properly terminated, no power will be transmitted to the fourth port. Furthermore, if power is fed into the fourth port none of it will be transmitted to the first port.