IEC 60154-2

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Flanges for waveguides –
Part 2: Relevant specifications for flanges for ordinary rectangular waveguides

Brides pour guides d'ondes –
Partie 2: Spécifications applicables relatives aux brides pour guides d'ondes rectangulaires normaux

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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International Standard IEC 60154-2 has been prepared by subcommittee 46F: RF and microwave passive components, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories

This third edition cancels and replaces the second edition published in 1980. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) revise the estimation for return loss at connection interface of waveguides;
b) add two type of waveguide flange for high frequency application, i.e. over 50 GHz;
c) expand the operation frequency range up to 3,3 THz;
d) rename the frequency band over R 1200, i.e. R1,2k.

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

CDV	Report on voting
46F/305/CDV	46F/319/RVC

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 2.

A list of all parts in the IEC 60154 series, published under the general title *Flanges for waveguides*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This International Standard relates to straight hollow metallic tubing for use as waveguides in electronic equipment. In recent years, the operation frequency of waveguide components and systems has been extended to 1 THz and above. However, the IEC 60154 series, series of standards for flanges for waveguides, currently specifies the interface designs up to 40 GHz for rectangular waveguide. In addition to this, the current issues of the IEC 60154 series of standards were issued in the 1970's and do not meet the needs of current applications. This new edition of IEC 60154-2 addresses these two issues by extending the frequency coverage to 3 300 GHz and by addressing current applications for this type of waveguide.

FLANGES FOR WAVEGUIDES –

Part 2: Relevant specifications for flanges for ordinary rectangular waveguides

1 Scope

This part of IEC 60154 specifies the dimensions of flanges for ordinary rectangular waveguide for use in electronic equipment.

It covers requirements for flanges drilled before or after mounting on waveguides. It should be noted that for optimum electrical performance, post-drilling of the alignment holes after mounting is recommended.

The aim of this standard is to specify for waveguide flanges the mechanical requirements necessary to ensure compatibility and, as far as practicable, interchangeability as well as to ensure adequate electrical performance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org/)

IEC 60153-2:2016, *Hollow metallic waveguides – Part 2: Relevant specifications for ordinary rectangular waveguides*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-726 apply.

4 General

4.1 Standardized types

The series of flanges for ordinary rectangular waveguides covered by this standard are shown in Tables 5 to 9 and Figures 1 to 29.

Flat flanges can be used with metal plate air seal gaskets or shims (an example is shown in Figure 13).

4.2 Flange designation

Waveguide flanges covered by the standard shall be indicated by a reference number comprising the following information:

a) the number of the present IEC Publication (60154);

b) the letters "IEC";

c) a dash;

d) a letter relating to the basic construction of the flange, flange style, viz:

P = a flange having a gasket groove but no choke groove (formerly called pressurizable).

C = a choke flange with a gasket groove (formerly called choke, pressurizable).

U = a flange having neither a gasket groove nor a choke groove (formerly called unpressurizable[1];

e) a letter for the flange type according to the drawing. Flanges with the same letter and of the same waveguide size can be mated;

f) the letter and number of the waveguide for which the flange is designed.

Example:

"60154 IEC – UDR 120" denotes a flange without a gasket groove of Type D, for use with rectangular waveguide 60153 IEC – R 120.

5 Mechanical requirements

5.1 Dimensions

5.1.1 Alignment holes

Holes which are intended as alignment holes are clearly indicated in the drawings and shall be precision drilled. These alignment holes shall be those which are the nearest to the narrow side of the waveguide.

Holes which are not intended as alignment holes may be less accurately located than are the alignment holes, but shall be of correspondingly larger diameter to ensure mating of the flanges.

5.1.2 Shank diameter of fixing bolts used for alignment

The basic values and deviations thereon are specified in Tables 1 to 5 and Figures 15 to 21.

5.1.3 Relation between shank and alignment hole diameters

For each individual flange, the proper mating of two flanges is ensured by specifying:

a) the location and basic diameters of the holes and the deviations thereon;

b) the basic diameters of the shanks of coupling bolts with the appropriate fit.

For practical reasons, the ISO fits given in Table 1 are recommended:

[1] All flat flanges shall have this designation, including those that can be made pressure tight by using gaskets as indicated in 4.1.

Table 1 – ISO specifications

Type of flange	Range of size	Fit
Rectangular flanges for type R waveguide	R12 and larger	All
	R 14 – R 32	A9
	R 40 – R 70	B9
	R 84 and smaller	C9
Circular flange for type R waveguide	All	B9

When electrical requirements make it necessary, the hole position tolerance should be reduced and the hole diameter fit to the shank should be improved accordingly.

Actual values are shown in the respective drawings and tables.

5.1.4 Overall dimensions and thickness of flanges

The values quoted are taken from established designs and it should be noted that these values are based in general on the use of brass, but for other materials other values might be more appropriate.

5.1.5 Surface roughness of contact area of flanges

For subsequent study.

5.1.6 Flatness of contact area

The flatness of contact area shall be better than the values given in Table 2:

Table 2 – Requirements of root mean square of roughness on the contact area

Range of sizes	Requirement of root mean square of roughness mm
R 12 and larger dimensions	For subsequent study
R 14 – R 26	≤ 0,05
R 32 – R 180	≤ 0,02
R 220 and smaller dimensions	≤ 0,01

5.1.7 Perpendicularity of the axis of the holes

The perpendicularity of the axis of the holes to the contact area of the flange shall be 90° ± 1/4°.

5.1.8 General requirements for assemblies

Positioning of the holes shall be based on the theoretical symmetry lines of the inside cross-section of the waveguide unless otherwise indicated.

5.1.9 Perpendicularity of the contact area

The perpendicularity of the contact area of the flange to the axis of the waveguide shall be 90° ± 1/4°.

5.2 Additional requirements for unmounted flanges

5.2.1 General

The drawings shown are for mounted flanges. In the individual drawings, one or more methods are shown by way of example for the mounting of flanges to the waveguide. This, however, does not exclude socket or through-type methods of mounting if the actual dimensions allow this. For flanges having a choke groove, the socket type method should be used.

In the case of flange sizes PDR 3 to PDR 12 inclusive and UDR 3 to UDR 12 inclusive, the particular cross-section of the flanges to be used is left to the discretion of the individual user.

For the grooved flanges, a rectangular gasket is employed. An example is shown in Figure 14. The dimensions of the grooves and gaskets for flange sizes PDR 3 to PDR 12 inclusive have been left for subsequent study.

The flanges are designed for copper alloys, aluminium alloys and magnesium alloys. The particular type of alloy and finish is to be specified by the user. Unless otherwise specified, means shall be provided to reduce to a minimum galvanic or other corrosive action. The particular type of gasket and gasket material is to be specified by the user.

For pre-drilled flanges, the positioning of the holes should be based on the theoretic symmetry lines of the flange aperture.

5.2.2 Shape of aperture

The requirements for the dimensions of the aperture in the flange only apply to that part which effects mating between the flange and the waveguide.

The basic dimensions of the flange aperture shown in Table 1 are equal to the basic outside dimensions of the tubes according to IEC 60153-2.

The deviations for the dimensions of the aperture will depend on the materials and assembly methods and shall, therefore, be determined by agreement between purchaser and manufacturer.

For socket types, the front aperture should have dimensions within the deviations specified for the inside cross-section of the appropriate size of waveguide.

5.2.3 Ordering information

When ordering unmounted flanges, an allowance should be made on certain of the specified dimensions to cover the effects of possible machining after mounting.

5.3 Information on reflection

The reflections at the flange joint are of three kinds:

a) those caused by the allowed deviations on the internal dimensions of the waveguides;

b) those caused by lateral displacements of the two flange assemblies;

c) those caused by the chokes (in the following, these reflections are not taken into account).

When the deviations on the dimensions of the waveguides (according to IEC 60153-2) and of the assemblies (according to this standard) sum up to cause maximum lateral displacement and maximum changes of the waveguide internal dimensions, the theoretical maximum reflection may be calculated by the ISO/IEC Guide 98-3: 2008 and equation (1):

$$\text{Return loss} = -10\log\left[\left(\frac{\lambda_g{}^2\Delta a}{4a^3}\right)^2 + \left(\frac{\Delta b}{b}\right)^2 + \left(\frac{4{,}934\lambda_g\Delta a'^2}{a^3}\right)^2 + \left(\frac{7{,}8957\Delta b'^2}{\lambda_g b}\right)^2\right] \quad \text{dB} \qquad (1)$$

where

a is the basic inside width of the waveguide;

b is the basic inside height of the waveguide;

λ_g is the waveguide wavelength;

Δa and Δb are the waveguide internal deviations;

$\Delta a'$ and $\Delta b'$ are displacements of the waveguide axes.

NOTE 1 The first term within brackets represents the worst case reflection component at a flange joint caused by changes of the waveguide internal dimensions.

NOTE 2 The second term within brackets represents the reflection component at a flange joint caused by the displacement of the flange assemblies.

At the high end of the waveguide frequency band, the reflection component is maximum when the displacement exists in the short wall direction only.

At the low end of the waveguide frequency band, the reflection component is maximum when the displacement exists in the long wall direction only.

NOTE 3 The maximum reflection at the high end of the waveguide frequency band is smaller than the maximum reflection at the low end of the band for the small magnitude of displacement.

NOTE 4 The "reflection loss" in decibels is given as a positive quantity.

Table 3 – The worst "return loss" in (positive) decibels for waveguides *(1 of 2)*

Flange type	Type designation IEC 60153-1	f_min in GHz	f_max in GHz	Return loss at f_min in dB	Return loss at f_max in dB
Type A	R 32	2,6	3,95	48	53
	R 40	3,22	4,9	45	48
	R 48	3,94	5,99	45	47
	R 58	4,64	7,05	45	48
	R 70	5,38	8,17	45	47
Type B	R 84	6,57	9,99	45	47
	R 100	8,2	12,5	45	47
	R 120	9,84	15	45	48
	R 140	11,9	18	46	48
	R 180	14,5	22	45	48
	R 220	17,6	26,7	44	46
	R 260	21,7	33	45	47
	R 320	26,3	40	44	46
Type C	R 220	17,6	26,7	44	46
	R 260	21,7	33	45	47
	R 320	26,3	40	45	46
	R 400	32,9	50,1	45	45
	R 500	39,2	59,6	44	43
Type D	R 14	1,13	1,73	45	48
	R 18	1,45	2,2	45	48
	R 22	1,72	2,61	45	48
	R 26	2,17	3,3	45	48
	R 32	2,6	3,95	45	47
	R 40	3,22	4,9	45	48
	R 48	3,94	5,99	45	47
	R 58	4,64	7,05	45	48
	R 70	5,38	8,17	45	47
	R 84	6,57	9,99	45	47
	R 100	8,2	12,5	45	47
	R 120	9,84	15	45	48
	R 140	11,9	18	46	48
	R 180	14,5	22	45	47
Type E	R 32	2,6	3,95	45	47
	R 40	3,22	4,9	45	48
	R 48	3,94	5,99	45	47
	R 58	4,64	7,05	45	48
	R 70	5,38	8,17	45	47
	R 84	6,57	9,99	45	47
	R 100	8,2	12,5	45	47

Table 3 *(2 of 2)*

Flange type	Type IEC 60153-1	*f*_min in GHz	*f*_max in GHz	Return loss at *f*_min in dB	Return loss at *f*_max in dB
Type F	R 400	32,9	50,1	46	48
	R 500	39,2	59,6	45	47
	R 620	50	75	37	40
	R 740	60	90	38	40
	R 900	75	110	37	40
	R 1.2k	90	140	37	40
	R 1.4k	110	170	37	40
	R 1.8k	140	220	37	40
	R 2.2k	170	260	38	40
	R 2.6k	220	330	38	40
	R 3.2k	260	400	36	38
	R 4k	330	500	36	38
	R 5k	400	600	37	38
	R 6.2k	500	750	34	35
	R 7.4k	600	900	29	31
	R 9k	750	1100	27	28
	R 12k	900	1400	24	25
	R 14k	1100	1700	21	22
	R 18k	1400	2200	17	18
	R 22k	1700	2600	14	15
	R 36k	2200	3300	11	11
Type G	R 400	32,9	50,1	46	48
	R 500	39,2	59,6	45	47
	R 620	50	75	37	40
	R 740	60	90	38	40
	R 900	75	110	38	40
	R 1.2k	90	140	37	40
	R 1.4k	110	170	37	40
	R 1.8k	140	220	37	40
	R 2.2k	170	260	38	41
	R 2.6k	220	330	38	40
	R 3.2k	260	400	36	39
	R 4k	330	500	37	39
	R 5k	400	600	38	40
	R 6.2k	500	750	36	33
	R 7.4k	600	900	31	33
	R 9k	750	1100	29	31
	R 12k	900	1400	28	30
	R 14k	1100	1700	26	28
	R 18k	1400	2200	21	23
	R 22k	1700	2600	20	21
	R 36k	2200	3300	17	18