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IEEE P1785: A New Standard for Waveguide Above 110GHz

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Анотація

Товариство мікрохвильової теорії і методів (MTT-S) в IEEE недавно почало діяльність з розробки міжнародного стандарту для визначення хвилеводів, використовуваних на частотах 110 ГГц і вище, зокрема металевих хвилеводів. Робоча група стандартів (P1785) вже зустрічалася кілька разів і прагне визначити як розміри хвилеводів (і пов'язаних з ними смуг частот), так і їх інтерфейсів (тобто фланці).

Ключові слова: частота,смуга,розмір,хвилевід,фланець.

Abstract

The Microwave Theory and Techniques Society (MTT-S) of the IEEE has recently launched an activity to develop an international standard to define waveguides used at frequencies of 110 GHz and above—specifically, rectangular metallic waveguides. The standard's Working Group (P1785) has already met several times and is looking to define both the dimensions of the waveguides (and associated frequency bands) and their interfaces (that is flanges).

Keywords: *frequency, band, dimension, waveguides,* flange.

There are many applications that are Hpresently being researched in the Ihigh millimeter-wave/low terahertz frequency range. These applications are supporting many areas, including astronomy, remote sensing, communications, radar systems and homeland security. This standard is being developed to make sure that all of these applications have a commonality and can interface easily with other technologies that are being developed.

FREQUENCY BANOS AND WAVEGUIDE DIMENSIONS

To date, much of the work of the Working Group has concentrated on establishing the frequency bands and waveguide dimensions. It was agreed early on that, for the waveguide aperture, the ratio of the width to height of the waveguide would be 2.T. The waveguide sizes and frequency bands that have been chosen to be included in the standard are shown in Ta**ble** *I.*[1] *The waveguides in the shaded region of Table 1 correspond closely to waveguides given in existing standards (References 2 and 3, for example). The main difference is that the IEEE waveguide sizes are being specified using metric units (that is micrometers, rather than mils that were used, for example in Reference 2). The waveguides will also be named according to their metric size: the letters WM indicate that the size refers to waveguide using metric dimensions, followed by a number indicating the size (in micrometers) of the broad wall dimension of the waveguide. For example, WM-570 refers to a waveguide with a broad wall dimension of 570 pm. Another difference with the IEEE standard is that it will use tighter tolerances for specifying the critical dimensions of the waveguide (that is those dimensions that directly affect electrical performance).*

TABLE I

PROPOSED FREQUENCY BANDS AND WAVEGUIDE DIMENSIONS FOR THE IEEE STANDARD

Waveguide Name	Aperture Width (μm)	Aperture Height (μm)	Cut-off Frequency (GHz)	Minimum Frequency (GHz)	Maximum Frequency (GHz)
WM-2540	2540	1270	59.014	75	110
WM-2032	2032	1016	73.767	90	140
WM-1651	1651	825.5	90.790	110	170
WM-1295	1295	647.5	115.75	140	220
WM-1092	1092	546	137.27	170	260
WM-864	864	432	173.49	220	330
WM-710	710	355	211.12	260	400
WM-570	570	285	262.97	330	500
WM-470	470	235	318.93	400	600
WM-380	380	190	394.46	500	750
WM-310	310	155	483.53	600	900
WM-250	250	125	599.58	750	1100
WM-200	200	100	749.48	900	1400
WM-164	164	82	913.99	1100	1700
WM-130	130	65	1153.0	1400	2200
WM-106	106	53	1414.1	1700	2600
WM-86	86	43	1743.0	2200	3300

For information, ***Table 2*** gives a comparison between the new IEEE waveguide names[1] and the names of related waveguides in the existing MIL standard,[2] and the nearest waveguides that have been proposed previously to extend the MIL series of waveguides.[4]

The series of waveguides shown in Table 1 have been chosen so that they can be easily extended, when necessary, to cover higher frequencies. The following procedure should be followed to extend the waveguide series:

- Select a waveguide size from the unshaded region of Table 1;
- Divide the mechanical dimensions by 10;
- Multiply the frequency values by**10**;
- Rename the waveguide accord- ingly.

For example, the next two sizes in this series (derived from WM-7I0 and WM-570) are shown in ***Table 3.***

The part of the standard covering frequency bands and waveguide dimensions has now been drafted and is likely to be circulated for public comment in the coming few months.

TABLE II

COMPARING THE IEEE[1], MIL[2] AND 'EXTENDED' MIL[4] WAVEGUIDE NAMES

MIL name	New IEEE Name	fmin (GHz)	fmax (GHz)
WR-10	WM-2540	75	110
WR-08	WM-2032	90	140
WR-06	WM-1651	110	170
WR-05	WM-1295	140	220
WR-04	WM-1092	170	260
WR-03	WM-864	220	330
'Extended MIL' name	**New IEEE Name**	**fmin (GHz)**	**fmax (GHz)**
WR-2.8	WM-710	260	400
WR-2.2	WM-570	330	500
WR-1.9	WM-470	400	600
WR-1.5	WM-380	500	750
WR-1.2	WM-310	600	900
WR-1.0	WM-250	750	1100

WAVEGUIDE INTERFACES

The attention of the standards Working Group is now turning to the waveguide interfaces, often called “flanges”. The Working Group is keen to ensure that it considered all flange designs that are used regularly at these frequencies (that is at 110 GHz and above). Therefore, a subgroup is being set up to investigate this matter further. Advice is also being sought from the entire millimeter- and submillimeter-wave communities to help identify any such candidate flange designs. *If you are aware of any flange design that you consider should he included in this standard, please contact the authors of this article.* The plan is that the standard, when published, will contain all appropriate flanges that will be used routinely in this frequency region.

TABLE III

EXTENDED FREQUENCY BANDS AND WAVEGUIDE DIMENSIONS FOR THE IEEE STANDARD

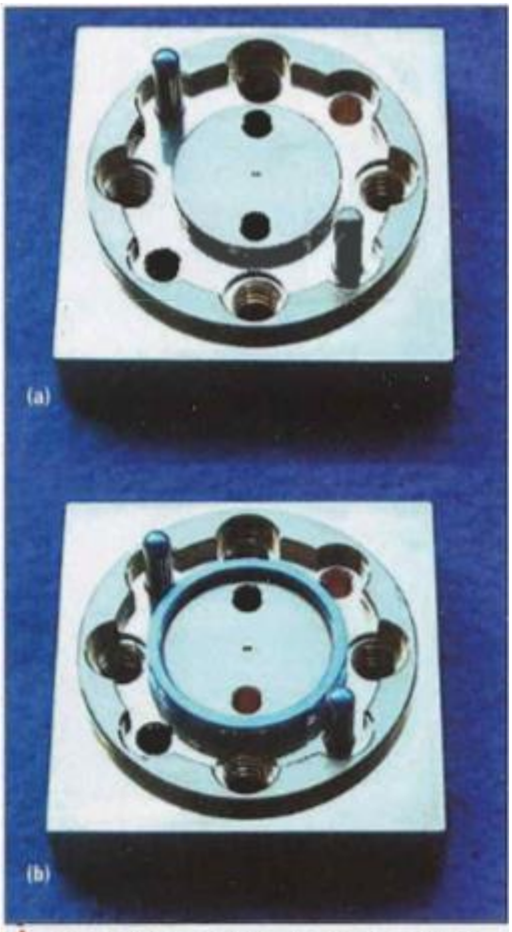
Waveguide Name	Aperture Width (μm)	Aperture Height (μm)	Cut-off Frequency (GHz)	Minimum Frequency (GHz)	Maximum Frequency (GHz)
WM-71	71	35.5	2111.2	2600	4000
WM-57	57	28.5	2629.7	3300	5000

For example, one such flange that is likely to be considered for inclusion in the standard is a precision version of the MIL-F- 3922-67D flange (often called UG-387) that has been described[*,1,2,3,4,5] and is shown in ***Figure 1.*** Compared to the conventional UG-387 flange,[6] this precision version contains two additional alignment dowel holes immediately above and below the waveguide aperture. These additional holes (and the associated dowel pins) are specified to a tighter dimensional tolerance than the dowel holes and pins found on the conventional UG-387 flange. This leads to better mechanical alignment of the waveguide interfaces and hence lower electrical reflection from a mated pair of flanges.

▲ *Fig. 1 A precision version of the so-called "UG-387" flange, showing the two additional dowel holes, immediately above and below the rectangular waveguide aperture.*

Another type of flange that is likely to be considered for inclusion in the standard is a newer design— a ring-centered flange,[7] as shown in ***Figure 2.*** This design is compatible with both the UG-387 and precision UG-387 flange designs, but also uses a coupling ring to significantly improve the alignment of the flange interfaces.

It is expected that the IEEE standard, when published, will contain several flange designs, allowing end- users (such as customers, suppliers, etc.) to chose a design that best meets their given requirements. The role of the standard, in this context, is to provide the information needed for this choice to be made reliably.



▲ *Fig. 2 Ring-centered waveguide flange: (a) with dowel holes and pins and (b) with the coupling ring in place.*

Conclusions

The IEEE is well on its way to publishing a standard for defining rectangular metallic waveguides for use at frequencies above 110 GHz. Already, there are many applications emerging for the use of this part of the electromagnetic spectrum—millimetre-wave, submiUimeter-wave, terahertz, etc.[8] Therefore, the publication of this standard is timely, and should serve our industry well for many years to come.

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