IEEE Standards

IEEE Std 521™-2002
(Revision of IEEE Std 521-1984)

521™

IEEE Standard Letter Designations for Radar-Frequency Bands

IEEE Aerospace & Electronic Systems Society

Sponsored by the
Radar Systems Panel

Published by
The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

8 January 2003

Print: SH95016
PDF: SS95016

IEEE Std 521™-2002
(Revision of
IEEE Std 521-1984)

IEEE Standard for Letter Designations for Radar-Frequency Bands

Sponsor

Radar Systems Panel
of the
IEEE Aerospace & Electronic Systems Society

Approved 12 September 2002

IEEE-SA Standards Board

Abstract: The Standard Letter Designations for Radar-Frequency Bands was first issued in 1976 and was written to remove the confusion that developed from the misapplication to radar of letter band designations of other microwave frequency users. This standard relates the letter terms in common usage to the frequency ranges that they represent. The 1984 revision defined the application V and W to a portion of the millimeter wave region while retaining the previous letter designators for frequencies. The current (2002) revision keeps the same letter band designations, includes a change in the definition of millimeter wave frequencies to conform to the ITU designation, and revises the notes to Table 1. Table 1 has been modified for international applications by including Regions 1 and 3 in addition to Region 2.
Keywords: frequency, letter band, radar

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Print: ISBN 0-7381-3355-8 SH95016
PDF: ISBN 0-7381-3356-6 SS95016

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied "**AS IS**."

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

Note: Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Introduction

(This introduction is not part of IEEE Std 521-2002, IEEE Standard for Letter Designations for Radar-Frequency Bands.)

The Standard Letter Designations for Radar-Frequency Bands was first issued in 1976 and was written to remove the confusion which developed from the misapplication to radar of letter band designations of other microwave frequency users. This standard relates the letter terms in common usage to the frequency ranges that they represent. The 1984 revision defined the application V and W to a portion of the millimeter wave region while retaining the previous letter designators for frequencies below the millimeter region. This revision keeps the same letter band designations, includes a change in the definition of millimeter wave frequencies to conform to the ITU designation, and revises the notes to Table 1.

The Standard Letter Designations for Radar-Frequency Bands issued in 1976 and revised in 1984 listed the specific frequency ranges for radar only for Region 2 in Table 1. Table 1 has been modified for international application by including Regions 1 and 3 in addition to Region 2.

Participants

At this time this standard was completed, the IEEE Aerospace & Electronic Systems Society (AESS) Radar Systems Panel had the following members:

J. A. Bruder, *Chair*

D. A. Ausherman
S. Ayasli
D. K. Barton
W. G. Bath
W. D. Blair
E. Brookner
L. J. Cantafio
J. Crain
G. R. Curry
M. E. Davis
J. K. Day
E. Evans
A. Farina
E. Ferraro
J. R. Fritsch
C. H. Gager
J. S. Goldstein
M. Greenspan
H. Griffiths
J. R. Guerci
D. N. Held
R. T. Hill
P. Hughes
P. Hull
S. L. Johnston
A. Kozma
F. LeChevalier
R. J. Lefevre
R. H. Logan
J. M. Loomis
R. W. McMillan
J. M. Milan
T. Miller
R. K. Moore
R. L. Nevin
J. T. Nessmith
R. M. O'Donnell
W. P. Posey
J. A. Scheer
W. A. Skillman
M. I. Skolnik
J. K. Smith
R. N. Trebits
G. V. Trunk
H. Ward
M. C. Wicks
D. Zasada

The following members of the balloting group voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

David K. Barton
Joseph A. Bruder
Gerald Crain
Alfonso Farina
Ellen Ferraro
J. Scott Goldstein
Porter Hull
Stephen L. Johnston
Russell J. Lefevre
Robert W. McMillan
Merrill I. Skolnik
Robert N. Trebits
David Zasada

When the IEEE-SA Standards Board approved this standard on 12 September 2002, it had the following membership:

James T. Carlo, *Chair*
James H. Gurney, *Vice Chair*
Judith Gorman, *Secretary*

Sid Bennett
H. Stephen Berger
Clyde R. Camp
Richard DeBlasio
Harold E. Epstein
Julian Forster*
Howard M. Frazier
Toshio Fukuda
Arnold M. Greenspan
Raymond Hapeman
Donald M. Heirman
Richard H. Hulett
Lowell G. Johnson
Joseph L. Koepfinger*
Peter H. Lips
Nader Mehravari
Daleep C. Mohla
William J. Moylan
Malcolm V. Thaden
Geoffrey O. Thompson
Howard L. Wolfman
Don Wright

*Member Emeritus

Also included is the following nonvoting IEEE-SA Standards Board liaison:

Alan Cookson, *NIST Representative*
Satish K. Aggarwal, *NRC Representative*

Savoula Amanatidis
IEEE Standards Managing Editor

Contents

IEEE Standard for Letter Designations for Radar-Frequency Bands

1. Scope

Since World War II, radar systems engineers have used letter designations as a short notation for describing the frequency band of operation. This usage has continued throughout the years and is now an accepted practice of radar engineers. Radar-frequency letter designations are used for the following reasons:

1) They provide a convenient method for describing the band in which the radar operates without the need for awkwardly stating the limits of the frequency in numerical terms. For example, it is more convenient to say an L-band radar than a 1215–1400 MHz radar. This is especially important in titles of published papers on radar, in advertising of radar systems and components, or in any other situation where a short notation is desired.

2) In military radar systems, the exact frequency of operation cannot usually be disclosed, but it is permissible in many cases to describe the band in which it operates. The letter designations permit this.

3) Each radar-frequency band has its own particular characteristics. Thus an X-band radar will be different from an S-band radar. The letter designations are often used in this manner to indicate the particular nature of the radar as it is influenced by its frequency. There are vast differences in characteristics, applications, and environmental constraints that distinguish radars in the different bands. It is the need to communicate concisely the whole set of characteristics which are shared by S-band radar, as distinguished from L-band radar, C-band radar, and the others, which requires the established usage of letter designations.

2. Usage

The nomenclature of Table 1 shall be followed when letter designations are used to describe the frequency of radar operation. When appropriate, it is suggested that the specific International Telecommunications Union (ITU) radiolocation numerical band limits be inserted parenthetically; for example, VHF (216–225 MHz) or L-band (1.215–1.4 GHz).

3. Relation to other nomenclature

The radar letter designations are consistent with the recommended nomenclature of the ITU, as shown in Table 2. Note that the high frequency (HF) and the very high frequency (VHF) definitions are identical in the

two systems. The essence of the radar nomenclature is to subdivide the existing ITU bands, in accordance with radar practice, without conflict or ambiguity.

The letter band designations should not be construed as being a substitute for the specific frequency limits of the frequency bands. The specific frequency limits should be used when appropriate, but when a letter designation of a radar-frequency band is called for, those of Table 1 shall be used.

The letter designations described in this standard are designed for radar usage and are used in current practice. They are not meant to be used for other radio or telecommunication purposes, unless they pertain to radar.

The letter designations for electronic countermeasure operations, as described in Air Force Regulation No. 55-44, Army Regulation No. 105-86, and Navy OPNAV Instruction 3430.9B, are not consistent with radar practice and shall not be used to describe radar-frequency bands.

Table 1—Standard radar-frequency letter band nomenclature

<table>
<tr><th colspan="5">International table</th></tr>
<tr><th rowspan="2">Band designation</th><th rowspan="2">Nominal frequency range</th><th colspan="3">Specific frequency ranges for radar based on ITU assignments (see Notes 1, 2)</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>HF</td><td>3–30 MHz</td><td colspan="3">(Note 3)</td></tr>
<tr><td>VHF</td><td>30–300MHz</td><td>None</td><td>138 –144 MHz
216– 225 MHz
(See Note 4)</td><td>223-230 MHz</td></tr>
<tr><td>UHF</td><td>300–1000 MHz
(Note 5)</td><td colspan="3">420–450 MHz (Note 4)
890–942 MHz (Note 6)</td></tr>
<tr><td>L</td><td>1–2 GHz</td><td colspan="3">1215–1400 MHz</td></tr>
<tr><td rowspan="2">S</td><td rowspan="2">2–4 GHz</td><td colspan="3">2300–2500 MHz</td></tr>
<tr><td>2700–3600 MHz</td><td colspan="2">2700–3700 MHz</td></tr>
<tr><td rowspan="2">C</td><td rowspan="2">4–8 GHz</td><td colspan="3">4200– 4400 MHz (Note 7)</td></tr>
<tr><td>5250–5850 MHz</td><td colspan="2">5250–5925 MHz</td></tr>
<tr><td>X</td><td>8–12 GHz</td><td colspan="3">8.5–10.68 GHz</td></tr>
<tr><td rowspan="2">Ku</td><td rowspan="2">12–18 GHz</td><td colspan="3">13.4–14 GHz</td></tr>
<tr><td colspan="3">15.7–17.7 GHz</td></tr>
<tr><td>K</td><td>18–27 GHz</td><td>24.05–24.25 GHz</td><td>24.05–24.25 GHz
24.65–24.75 GHz
(Note 8)</td><td>24.05–24.25 GHz</td></tr>
<tr><td>Ka</td><td>27–40 GHz</td><td colspan="3">33.4–36 GHz</td></tr>
<tr><td>V</td><td>40–75 GHz</td><td colspan="3">59–64 GHz</td></tr>
<tr><td rowspan="2">W</td><td rowspan="2">75–110 GHz</td><td colspan="3">76–81 GHz</td></tr>
<tr><td colspan="3">92–100 GHz</td></tr>
<tr><td rowspan="3">mm
(Note 9)</td><td rowspan="3">110–300 GHz</td><td colspan="3">126–142 GHz</td></tr>
<tr><td colspan="3">144–149 GHz</td></tr>
<tr><td colspan="3">231–235 GHz
238–248 GHz
(Note 10)</td></tr>
</table>

NOTES
1—These international ITU frequency allocations are from the table contained in Article S5 of the *ITU Radio Regulations*, 1998 Edition. The ITU defines no specific service for radar, and the frequency assignments listed are derived from those radio services that use radiolocation. The frequency allocations listed include those for both *primary* and *secondary* service. The listings of frequency assignments are included for reference only and are subject to change.
2—The specific frequency ranges for radiolocation are listed in the *NTIA Manual of Regulations & Procedures for Federal Radio Frequency Management*, Chapter 4. The NTIA manual (known as the *Redbook*) can be downloaded from the website: http://www.ntia.doc.gov/osmhome/redbook/redbook.html.
3—There are no official ITU radiolocation bands at HF. So-called HF radars might operate anywhere from just above the broadcast band (1.605 MHz) to 40 MHz or higher.
4—Frequencies from 216–450 MHz were sometimes called *P-band*.
5—The official ITU designation for the ultra high frequency band extends to 3000 MHz. In radar practice, however, the upper limit is usually taken as 1000 MHz, L- and S-bands being used to describe the higher UHF region.
6—Sometimes included in L-band.
7—Designated for aeronautical navigation, this band is reserved (with few exceptions) exclusively for airborne radar altimeters.
8—The frequency range of 24.65–24.75 GHz includes satellite radiolocation (earth to space only).
9—The designation mm is derived from *millimeter* wave radar, and is also used to refer to V- and W-bands, and part of Ka-band, when general information relating to the region above 30 GHz is to be conveyed.
10—No ITU allocations are listed for frequencies above 275 GHz.

Table 2—Comparison of radar-frequency letter band nomenclature with ITU nomenclature

Radar nomenclature		ITU nomenclature			
Radar letter designation	**Frequency range**	**Frequency range**	**Band No.**	**Adjectival band designation**	**Corresponding metric designation**
HF	3–30 MHz	3–30 MHz	7	High frequency (HF)	Dekametric waves
VHF	30–300 MHz	30–300 MHz	8	Very high frequency (VHF)	Metric waves
UHF	300–1000 MHz	0.3–3 GHz	9	Ultra high frequency (UHF)	Decimetric waves
L	1–2 GHz				
S	2–4 GHz	3–30 GHz	10	Super high frequency (SHF)	Centimetric waves
C	4–8 GHz				
X	8–12 GHz				
Ku	12–18 GHz				
K	18–27 GHz				
Ka	27–40 GHz	30–300 GHz	11	Extremely high frequency (EHF)	Millimetric waves
V	40–75 GHz				
W	75–110 GHz				
mm	110 –300 GHz				