

INCH-POUND

MIL-DTL-23351B  
w/AMENDMENT 1  
2 November 2007  
SUPERSEDING  
MIL-DTL-23351B  
3 October 2003

## DETAIL SPECIFICATION

### WAVEGUIDES, SINGLE RIDGE AND DOUBLE RIDGE, GENERAL SPECIFICATION FOR

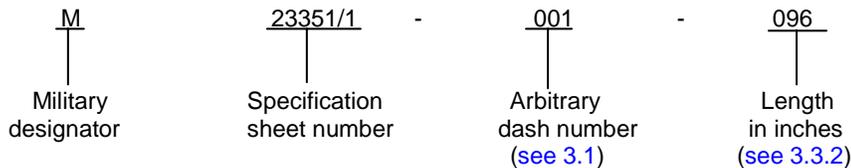
This specification is approved for use by all Departments and Agencies of the Department of Defense.

This specification is inactive for new design after 8 May 1998.

#### 1. SCOPE

1.1 Scope. This specification covers the general requirements for rigid waveguides with single ridge or double ridge inside configurations ([see 6.1](#)).

1.2 Part or identification number (PIN). The (PIN) must be as follows:



#### 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 and 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this specification, whether or not they are listed.

##### 2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract ([see 6.2](#)).

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAT, Post Office Box 3990, Columbus, OH 43218-3990 or emailed to [TubesAmps@dsc.dla.mil](mailto:TubesAmps@dsc.dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://www.assist.daps.dla.mil>.

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DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-202 - Electronic and Electrical Component Parts.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Copies are available online at <http://assist.daps.dla.mil> or <http://assist.daps.dla.mil/quicksearch/> or at Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract ([see 6.2](#)).

ASTM INTERNATIONAL

- ASTM-B210 - Aluminum and Aluminum-Alloy Drawn Seamless Tubes (DoD adopted).
- ASTM-B372 - Seamless Copper and Copper-Alloy Rectangular Waveguide Tube (DoD adopted).

(Copies are available online at <http://www.astm.org> or at ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

ASME INTERNATIONAL

- ASME-B46.1 - Surface Texture (Surface Roughness, Waviness and Lay).
- ASME-Y14.5.1M - Principles, Dimensioning and Tolerancing, Mathematical Definition of (DoD adopted).

(Copies are available online at <http://www.asme.org> or at ASME INTERNATIONAL, P.O. Box 2300, Fairfield, NJ 07007-2300.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the reference cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Material. The material shall be as specified ([see 3.1](#)). Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.2.1 Aluminum alloy. Aluminum alloys 6061 and 6063 shall conform to the chemical composition limits of ASTM-B210. Aluminum alloy 6061 and 6063 waveguides shall be furnished in the F temper.

3.2.2 Copper alloy. Copper alloy shall conform to commercial bronze, 90 percent of ASTM-B372.

3.2.3 Copper. Copper shall conform to type OF or DLP of ASTM-B372.

3.2.4 Silver alloy. Silver alloy shall conform to the chemical composition requirements for grade C (coin silver). In addition, silver alloy waveguides shall be furnished in the drawn temper with a Rockwell hardness of 45.0 to 80.0 on the "B" scale.

3.2.5 Pure tin. The use of pure tin as an underplate or final finish is prohibited both internally and externally. Tin content of the waveguide components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass ([see 6.6](#)).

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3.3 Design and construction. Waveguides shall be of the design, construction, and physical dimensions specified (see 3.1). Eccentricity (see 6.4) shall not exceed 10 percent. Dimensioning and tolerancing shall be interpreted in accordance with ASME-Y14.5.1.

3.3.1 Finish. The interior and exterior surfaces of the waveguide shall be bright, smooth, dry, and free of scales or oxide.

3.3.2 Length. The finished waveguide shall be furnished in nominal straight lengths with ends, or in specific straight lengths without ends (see 6.2). For waveguides ordered with ends, the nominal length shall be as specified (see 3.1), and the shortest permissible length of the ends shall be 60 percent of the nominal length. The maximum permissible weight of ends shall not exceed 25 percent of the lot weight. For waveguides ordered in specific lengths, the length shall be as specified (see 3.1). Waveguides ordered with or without ends shall conform to the tolerances in table I.

TABLE I. Waveguide tolerances.

Length	Tolerance (all plus)
Stock lengths (with ends) Specific lengths	1
Up to 14 feet, inclusive	1/4
Over 14 feet	1/2

3.4 Bow. When measured as specified in 4.6.2, the bow between any two points 2 feet apart on the concave external surface of the waveguide shall not be more than .010 inch on the narrow surface (E-plane) and .020 inch on the wide surface (H-plane), unless otherwise specified (see 3.1). If the waveguide is less than 2 feet long, the allowable bow shall be proportionate to the above requirements.

3.5 Twist. When waveguides are measured as specified in 4.6.3, the maximum twist along the longitudinal axis shall not exceed 1 degree per foot of length on the face of the interior or exterior surfaces.

3.6 Squareness of cut. When measured as specified in 4.6.4, the departure from square of the end of any waveguide shall not exceed .010 inch for waveguides up to .625 inch maximum inside waveguide dimension, inclusive, and .016 inch-per-inch (one degree) for waveguides over .625 inch maximum inside waveguide dimension.

3.7 Surface roughness. When measured as specified in 4.6.5, the interior surface roughness of the waveguide shall not exceed the values shown in table II.

TABLE II. Surface roughness tolerances of waveguides.

Specified major inner dimension (inches)	Allowable surface roughness, maximum arithmetic average (AA)	
	Aluminum and aluminum alloy	Copper, copper alloy, and silver alloy
Up to 4, exclusive	63	32
4 and over	125	63

3.8 Scratches. When measured as specified in 4.6.6, scratches shall not be more than .001 inch deep in the longitudinal direction for waveguides with internal width dimensions of .625 inch or larger. For waveguides with internal width dimensions of less than .625 inch, the depth of scratches shall not exceed .12 percent of the width.

3.9 Marking. Each length of waveguide shall be marked in accordance with method I of MIL-STD-1285, with the PIN (see 3.1) and the manufacturer's source code. The manufacturer's name or trademark may also be marked on the waveguide, provided such letters are not expressly forbidden in the contract, and their height does not exceed 50 percent of the outside dimension of the waveguide. The markings shall be applied with a permanent ink or paint. Not more than 6-inch intervals shall be permitted from the end of one marking to the beginning of the next marking.

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3.10 Workmanship. The waveguide shall be free from defects of a nature that may interfere with normal military applications. The waveguide shall be uniform in composition and wall thickness, straight and smooth from end to end, and shall be free from internal and external mechanical imperfections, and shall have a clean, bright appearance in accordance with good commercial practice. In addition, the interior surface of the waveguide shall be free from burrs, die marks, chatter marks, dirt, grease, scales, and splinters.

4. VERIFICATION

4.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor.

4.2 Classification of inspections. The inspections specified herein are classified as follows.

- a. Materials inspection (see 4.3).
- b. Conformance inspection (see 4.5).

4.3 Material inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table III, used in fabricating the waveguides, are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

TABLE III. Materials inspection.

Material	Requirement paragraph	Applicable specification or publication
Aluminum alloy	3.2.1	ASTM-B210
Copper alloy	3.2.2	ASTM-B372
Copper	3.2.3	ASTM-B372
Silver alloy	3.2.4	

4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "General Requirements" of MIL-STD-202.

4.5 Conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspection.

4.5.1.1 Inspection lot. An inspection lot shall consist of all waveguides of the same PIN produced under essentially the same conditions, and offered for inspection at one time.

4.5.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table IV.

TABLE IV. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph
Visual and Mechanical inspection	3.3 through 3.3.2, 3.9 and 3.10	4.6.1 and 4.6.1.1

4.5.1.2.1 Sampling plan. Statistical sampling and inspection shall be performed on an inspection lot basis with a random sample of waveguides selected in accordance with table V. Acceptance shall be based upon zero defect sampling plan. No failures shall be permitted.

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TABLE V. Group A and B sampling plan.

Lot size	Sample size
1-13	100 percent
14-150	13
151-280	20
281-500	29
501-1200	34
1201-3200	42
3201-10,000	50
10,001-35,000	60

4.5.1.2.2 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for re-inspection. Such lots shall be separate from new lots, and shall be clearly identified as re-inspected lots.

4.5.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table VI, in the order shown, and the sample shall be selected from inspection lots that have passed group A inspection.

TABLE VI. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
Bow	3.4	4.6.2
Twist	3.5	4.6.3
Squareness of cut	3.6	4.6.4

4.5.1.3.1 Sampling plan. (See 4.5.1.2.1).

4.5.1.3.2 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for re-inspection. Such lots shall be separate from new lots, and shall be clearly identified as re-inspected lots.

4.5.1.3.3 Disposition of sample units. Sample units that have passed all the group B inspection may be delivered on the contract.

4.5.2 Periodic inspection. Periodic inspection shall consist of group C. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.5.2.1.4), delivery of products which have passed groups A and B shall not be delayed pending the results of these periodic inspections.

4.5.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in table VII, in the order shown. Group C inspection shall be made on sample units selected from inspection lots that have passed the group A and B inspections.

TABLE VII. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph
Surface roughness	3.7	4.6.5
Scratches	3.8	4.6.6

4.5.2.1.1 Sampling plan. The first two lengths of the production lot shall be tested. Thereafter one out of each 25 lengths shall be tested.

4.5.2.1.2 Failures. If one or more sample units fail to pass group C inspection, the lot shall be considered to have failed.

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4.5.2.1.3 Disposition of sample units. Sample units that have been subjected to group C inspection shall not be delivered on the contract.

4.5.2.1.4 Non-compliance. If a sample fails to pass group C inspection, the contractor shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstated; however final acceptance and shipment shall be withheld until the group C re-inspection has shown that the corrective action was successful. In the event of failure after re-inspection, information concerning the failure shall be furnished to the cognizant inspection activity.

4.6 Methods of inspection.

4.6.1 Visual and mechanical examination. Waveguides shall be examined to verify that the materials, design, construction, physical dimensions, finish, length, marking, and workmanship are in accordance with the applicable requirements (see 3.2 through 3.3.2, 3.9 and 3.10).

4.6.1.1 Dimensions. Waveguides with 1-inch major outside dimension and over shall be measured at a point at least 1 inch from the end; waveguides with less than 1-inch major outside dimension shall be measured at least .5 inch from the end to ascertain that all dimensions are as specified (see 3.1) and that the waveguide is of the specified length (see 3.1). Eccentricity may be measured at any point around the periphery. For the purpose of determining conformance with the dimensional requirements prescribed herein, any measured value outside the specified limiting values for any dimension shall be construed as failing to meet specification requirements.

4.6.2 Bow (see 3.4). Bow is the departure from a straight longitudinal line connecting any two points 2 feet apart on the external surface of the waveguide without the effect of gravity or any other forces. The waveguide shall be so positioned during measurement that gravity will not tend to increase or decrease the amount of bow. Measurements shall be made along any 2-foot portion of the total length.

4.6.3 Twist (see 3.5). The angle of twist of waveguides shall be measured as shown on figure 1 and as follows:

- a. The waveguide shall be placed on a flat, horizontal, reference plane. Waveguides with noticeable, flatwise, bow shall be positioned with the waveguide surface on the side of the convex curvature in contact with the reference plane.
- b. One end of the waveguide surface shall be held in intimate contact with the reference plane by suitable means while the other end of the waveguide remains free.
- c. Using an engraved, transparent, protractor segment, determine the angle line on the protractor which coincides to the nearest degree with the surface of the waveguide, while one edge of the protractor segment contacts, or is kept parallel to the reference plane by means of parallel face blocks.

4.6.4 Squareness of cut (see 3.6). The squareness of the cut of the waveguide shall be measured using an adjustable protractor.

4.6.5 Surface roughness (see 3.7). The average interior surface roughness of the waveguide shall be measured in accordance with ASME-B46.1, except flaws shall be included in the surface roughness measurement and the corner radius shall not be included in the measurement. Surface roughness shall be measured across the grain over the full width of the waveguide interior surface, at the center of the waveguide length and 6 inches from the end of the length, unless otherwise specified (see 3.1 and 6.2).

4.6.6 Scratches (see 3.8). Inspection for scratches shall be 6 inches from each end and at the center of the waveguide.

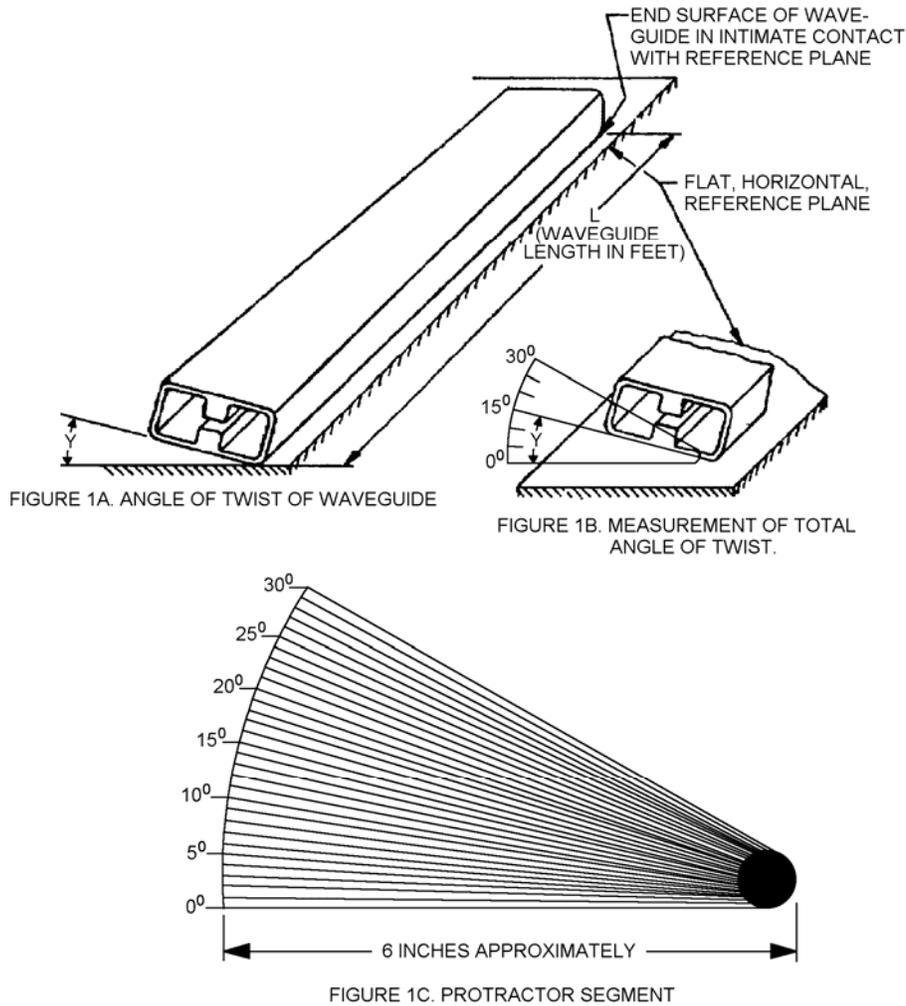


FIGURE 1. Method of determining twist.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Waveguides covered by this specification are intended for use as transmission lines in military services radio and electronic equipment.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. The complete part number (see 3.1 and 6.4).
- c. Stock lengths or specific lengths of waveguide required (see 3.3.2).
- d. Special methods or increased frequency of checking surface roughness (see 4.6.5).
- e. Packaging (see 5.1).

6.3 Definitions. For the purpose of this specification, the following definitions apply:

6.3.1 Eccentricity. Eccentricity is the maximum deviation of the wall thickness at any cross section from the mean wall thickness at that cross section.

6.3.2 Specific length. A waveguide furnished to a specified exact dimension, intended for end use in an application that requires a certain length.

6.3.3 Stock length. A waveguide furnished to a nominal length, intended for and used in an application that may require the waveguide to be cut into smaller pieces.

6.3.4 Ends. A section of waveguide resulting from cutting a manufactured piece of waveguide into stock lengths.

6.4 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals is available on their website at <http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm>. Further information is available at the following EPA site: <http://www.epa.gov/epaoswer/hazwaste/minimize/>. Included in the EPA list of 31 priority chemicals are cadmium, lead, and mercury. Use of the materials on the list should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

6.5 Subject term (keyword) listing.

bow	radio
finish	transmission lines
lengths	twist

6.6 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of 3 percent lead, by mass, have shown to inhibit the growth of tin whiskers (see 3.2.5). For additional information on this matter, refer to ASTM-B545 (Standard Specification for Electrodeposited Coatings of Tin).

6.7 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

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Custodians:  
Army - CR  
Navy - EC  
Air Force - 11  
DLA - CC

Preparing activity:  
DLA - CC  
  
(Project 5985-2007-022)

Review activities:  
Army - AR  
Navy - AS, MC, OS, SH  
Air Force - 19, 99

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