Designation: D2658 – 18

Standard Test Method for Determining Dimensions of Fiberboard Boxes[1]

This standard is issued under the fixed designation D2658; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the interior and exterior dimensions of regular slotted or special slotted styles of single-wall corrugated, double-wall corrugated and solid fiberboard boxes.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D685 Practice for Conditioning Paper and Paper Products for Testing

D996 Terminology of Packaging and Distribution Environments

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

D4727/D4727M Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes

D5118/D5118M Practice for Fabrication of Fiberboard Shipping Boxes

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ANSI Standard:*[3]

B46.1 Surface Texture Surface Roughness, Waviness and Lay

2.3 *TAPPI Standards:*[4]

T400 Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product

T827 Box Blank Dimensioning, Test Method

2.4 *FBA/PMMI:*[5]

Tolerances for Corrugated Regular Slotted Containers (RSCs) Voluntary Industry Standard (See also ANSI Technical Report PMMI B155 TR2.1[3])

2.5 *FBA/FEFCO:*[6]

Common Footprint Specifications

2.6 *GMA/ISO:*[7]

Standard Pallet Size (most common)

3. Terminology

3.1 *Definitions*—General terms in this test method are defined in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *blank*—flat sheet of containerboard or combined board that has been cut, scored and slotted as preliminary operations to making a box.

3.2.2 *caliper*—containerboard or combined board thickness.

3.2.3 *depth*—the distance between the innermost surfaces of the box measured perpendicular to the length and width.

3.2.4 *exterior dimensions*—the measurement of the outer most surfaces of the length, width and depth of a box.

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.27 on Fiberboard Shipping Containers, Containerboard and Related Structures and Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from Technological Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Suite 115, Peachtree Corners, GA 30092, http://www.tappi.org.

[5] Available from the Fibre Box Association Suite 985, 500 Park Blvd, Itasca, IL 60143, or PPMI 11911 Freedom Dr #600, Reston, VA 20190.

[6] Available from the FBA and FEFCO (European Federation of Corrugated Manufacturers) Avenue Louise 250, B-1050 Brussels, Belgium.

[7] Available from ISO Central Secretariat, Chemin de Blandonnet 8, CP 401-1214 Vernier, Geneva, Switzerland (historic document from Grocery Manufacturer's Association).

3.2.5 *fishtail (or skew)*—variation in the width of the manufacturer's joint, the difference between the width of top and bottom gaps measured at the score line.

3.2.6 *interior dimensions*—the shortest distances between opposite walls of a box.

3.2.7 *KD box – knock down (flat)*—a box blank that has been folded and the manufacturer's joint has been sealed but which has not been erected.

3.2.8 *length*—the larger of the two dimensions of the open face of a box.

3.2.9 *panel*—a face or side of a box

3.2.10 *regular slotted*—one-piece box with all flaps the same length and outer flaps meeting. Inner flaps may or may not meet, but do not overlap.

3.2.11 *slot*—a cut made to remove a narrow strip of material in a fiberboard sheet in order to form flaps and facilitate folding without bulging while making a box.

3.2.12 *special slotted*—one-piece box with all flaps meeting or not meeting but not overlapping.

3.2.13 *width*—the lesser of the two dimensions of the open face of a box.

4. Significance and Use

4.1 Dimensions are important properties in the general construction of a box, and accurate methods of measurement are required for research work, routine control, and acceptance testing for conformance to specifications. For packages to carry and protect their contents effectively and efficiently, boxes and interior components must be properly and consistently sized. Correctly dimensioned and well-made boxes can be more easily set up by hand or be erected using automatic equipment. "Square" boxes (rectangular parallelepipeds) will stack better to accept load and improve stability during storage and shipment.

4.1.1 Interior dimensions of boxes are critical when the contents of the box are intended to fill or nearly fill the box with little unused side and head space. The inside dimension by tape method are the size values most often cited in box design (see 9.1, and TAPPI T827). The interior size of a box can be estimated from the score to score measurements when the scoring allowance is taken into account (see Appendix X2). The actual inside dimensions can be measured directly using the box gauge method (see 9.2). Either method can be used to measure interior box dimensions.

4.1.2 Exterior dimensions may be the critical design criteria when attempting to optimize use of the shipping platform area and overall stack height based on transportation and storage limitations. Exterior dimensions are also key design elements when making common footprint boxes.[5] The exterior dimensions of a box can be measured directly using the exterior dimensions by tape method (see Appendix X1).

4.2 *Measuring a Lot Quantity of Boxes*—This method determines if a lot (that is, production run) is within specified tolerance for each dimension (length, width, and depth as are shown in Practice D5118/D5118M). A minimum of five specimens are measured. The test result for each dimension is the individual measurements of that dimension on all specimens (see 9.3).

4.3 *Measuring Single Boxes*—Determines if one particular box is within specified tolerance for each dimension. The test result for each dimension is the average of all measurements of that dimension (see 9.4).

5. Apparatus

5.1 *Types of Apparatus:*

5.1.1 *For Box Dimensions by Tape Method* (see 9.1)—Use a standard metal or similar measuring tape with resolution to at least 1/16 in. (1.6 mm) and a straight edge that exceeds than the nominal width or depth dimension of the box (whichever is longer).

5.1.2 *Estimating Interior Box Dimensions by Tape Method* (see Appendix X2)—Use a standard metal or similar measuring tape with resolution to at least 1/16 in. (1.6 mm).

5.1.3 *Interior Box Dimensions by Method (see 9.2)*—Use a gauge specific to this standard. The gauge involves a degree of human judgment and assumes careful and accurate placement and reading of specified apparatus.

5.1.3.1 *Measuring Equipment,* consisting of two flat metal plates mounted on each end and at right angles to a telescoping spacing bar (Fig. 1).

(1) Metal Plates—The metal plates shall be not less than 3/16 in. (4.8 mm) thick and shall have length and width dimensions of 4 by 3 in. (102 by 76 mm) with a maximum surface roughness height of 64 µ in. (1.63 µm), in accordance with ANSI B46.1. All sharp edges shall be relieved and corners shall be rounded with approximately 1/4-in. (6.35-mm) radius. The plates shall be mounted firmly at each end of the telescoping bar and must be parallel to each other within 0.02 in. (0.5 mm).

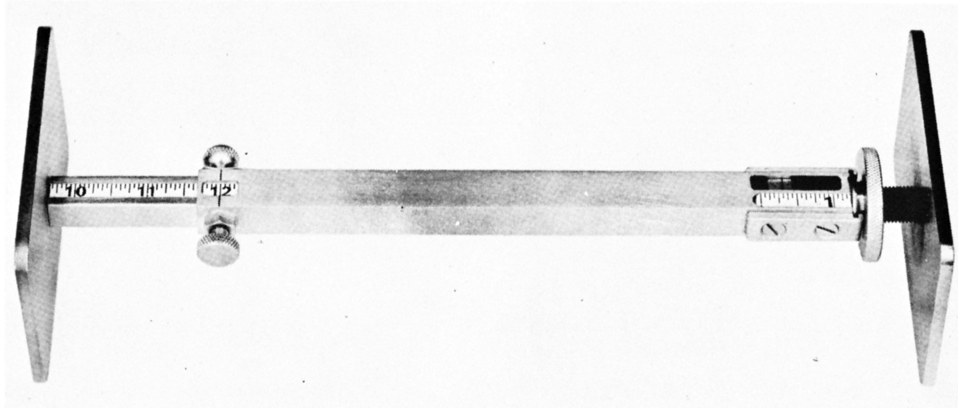
(2) Spacing Bar—Provision shall be made for adjusting and locking the spacing bar at the linear distance between the two plane surfaces. If the spacing bar incorporates a built-in scale for convenience in reading measurements, it shall be accurate to one half of the minimum measurement unit; that is, if the minimum measurement unit is 1/16 in. (1.6 mm), the instrument must be accurate to 1/16 in. (1.6 mm), etc.

(3) Size and Weight Ranges—Correct weight of the measuring instrument is important. Weights of instruments for three basic size ranges shall conform to the specifications given in Table 1.

6. Sampling

6.1 Select specimens at random in accordance with good practice or sampling procedures.

6.2 Boxes used for measurement should first be inspected to see if they meet quality requirements for "squareness" (see Voluntary Standards – Tolerances). If "square" boxes are not available to be measured this outcome should be clearly shown in the test report. If the boxes to be measured cannot be set up so that the opposing panels and the tops and bottoms are parallel planes, then meaningful measurement is impossible for the box gauge method (see 9.3). Exterior box measurements for out of square boxes also have limited utility and should not be



NOTE 1—This device has limited commercial availability; however, sufficient detail has been provided to have one constructed by a typical metal or equipment fabrication shop.

NOTE 2—The unit shown covers the middle range from 10 to 18 in. (254 to 457 mm). Rounded knurled knob at upper left is lifted to set gauge to the nearest full unit measurement below box dimension. Knurled knob at lower left is used to lock extension rod in place. Adjusting nut at right end moves right end plate to proper tension against side of box. Fractions of unit measurement over initial adjustment are read at right end scale. Reading shown is $12\frac{5}{16}$ in.

FIG. 1 Detail of Gauge Equipment

TABLE 1 Instrument Weight for Three Basic Size Ranges

Size Range of Boxes, in. (mm)	Instrument Weight, oz (g)
Up to 10[A] (254)	2 lb 0 ± 2 (907 ± 57)
10 to 18 (254 to 457)	2 lb 8 ± 2 (1134 ± 57)
18 to 34 (457 to 864)	3 lb 6 ± 3 (1530 ± 85)

[A] A purchased instrument may have a minimum usable size of 6 in. (152 mm).

reported without notation that the test box(es) were not "square." While the interior tape measure method (see 9.2) can return valid dimensions when erect boxes are not "square," the issue of poor squareness is an over-riding concern. Only "square" boxes should be measured for dimensions. If many or most boxes are not "square," this is a separate quality issue from box dimensions (see Practice D5118/D5118M, Section 6.6 on Workmanship).

6.2.1 *Slots*—Should be centered on the aligning scores (to within $\frac{1}{16}$ in. of score center) and slots should end on the score, or not go beyond the perpendicular score by more than $\frac{1}{8}$ in. If the boxes have short slots (that do not abut the score line), the box cannot be properly set up and a new box should be selected.

6.2.2 *Score Lines at the Manufacturer's Joint*—When a KD (Knock Down) box is folded into a flat plane, the panels on each side of the manufactures joint should be collinear when compared to one another. If the panel edges do not form a continuous line, the box is out of square. The dimensions will then be different, depending on where they are measured.

6.2.3 *Skew/Fish Tail at the Manufacturer's Joint*—The minimum allowable gap at either end of the manufacturer's joint is $\frac{1}{16}$ of an inch. If the gap is less, the blank is likely to bind during erection into a box. The difference between the width of the top and bottom gaps (at the score line) should not exceed $\frac{1}{8}$, or the box will not be square and dimensions will vary with point of measurement.

7. Test Specimens

7.1 *Measuring a Lot Quantity of Boxes:*

7.1.1 In no instance shall fewer than five specimens be measured and taken as representative of the lot.

7.1.2 For large lots, a formal sampling plan is advised. Application of TAPPI T400 is suggested.

NOTE 1—Acceptance or rejection of a production lot should be based on a sampling plan mutually agreeable to both the supplier and user of the boxes as indicated in a specification, contract, or other agreement.

7.2 *Measuring a Single Box*—Select an individual specimen (see Section 6).

8. Conditioning

8.1 Condition the boxes for measuring in accordance with Practice D685 or Practice D4332 at standard conditions.

9. Procedure

9.1 *Interior Box Dimensions by Tape Method (see Fig. 2):*

9.1.1 When ordering or designing a box the interior score to score dimension are the most critical measurements. It is these dimensions that are most commonly quoted and used in specifications, computer aided design (CAD) or other structural drawings. The interior dimensions of a box can be determined from an unformed blank, from a KD box, or from a fully formed box. Interior score to score dimensions of boxes as measured by the tape method require use of blanks or disassembled boxes that are laid open. If measuring from a blank no added steps are required. If measuring from a KD box, the manufacturer's joint must first be carefully separated so the box can be laid out as a sheet. When starting with a sealed box, the flaps must be carefully loosened and the manufacturer's joint, if any, needs to be carefully separated so the box can be laid open as a flat sheet.

9.1.2 Lay the blank on a flat surface with the inside of the blank facing upward and with the glue tab on the right side, see Fig. 2.

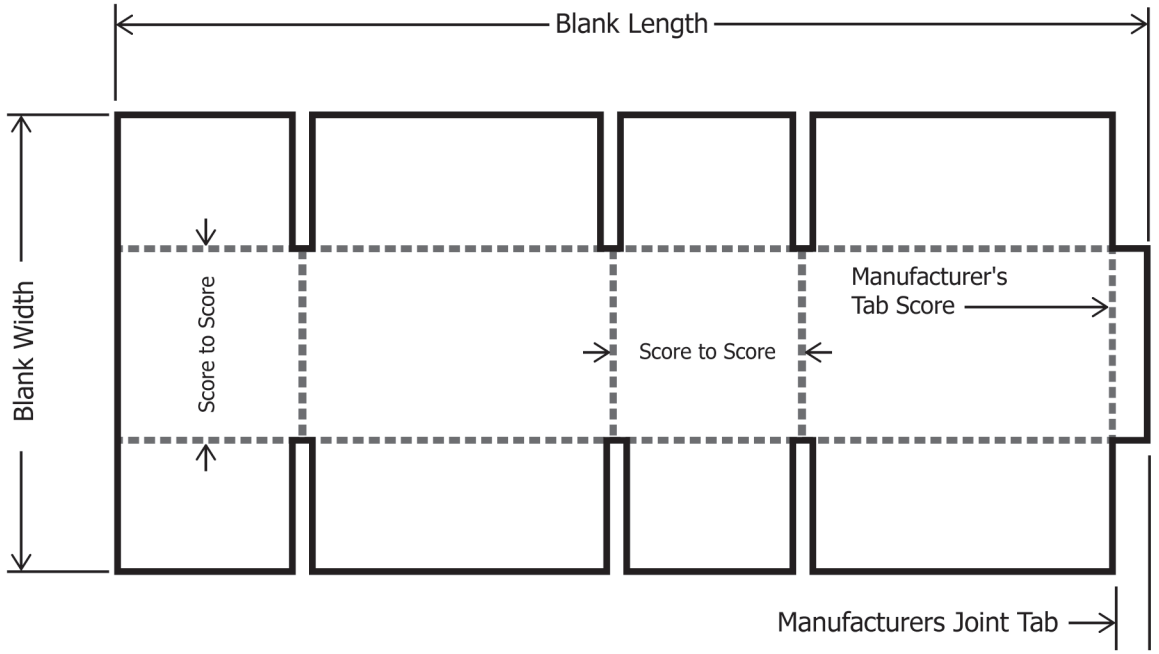


FIG. 2 Blank Dimensions Including Scoring Allowances

9.1.3 Using a pen or pencil mark the exact center of each vertical score near mid box height and each horizontal score on at least one panel, at mid panel width. Use caution to mark the score line, not a wrinkle or a crease. If there is uncertainty about the exact location of a score, this uncertainty needs to be noted in the report.

9.1.4 Starting at the left, place the 1 in. mark of the tape on the edge of the blank and measure to the center of the vertical score on the right side of the panel. Record this and all measurements taken to the nearest 1⁄16 in. (1.5 mm). Make sure to adjust the recorded value for having started the measurement on the 1 in. mark. *Note that the measurement being taken is score to score or score to edge and it is not an interior size of the box.* But, these measurements are reproducible as quality control and design measurements.

9.1.5 Measure from the center of the score at the end point of the first panel to the center of the score line on the adjacent panel to the right. Use the pen and pencil marks (see 9.2.3) to locate measuring points. Continue the measurements until all the panels have been measured.

9.1.6 Measure the distance between the two horizontal scores.

9.1.7 Measure the distance from the center of the upper horizontal score to the edge of the adjacent flap. Measure the distance from the lower horizontal score to the edge of the adjacent flap.

9.1.8 Measure the gross blank length and width. Total all measurements between vertical edges and vertical scores and between the vertical scores. The sum of these measurements should agree with the panel length to within 1⁄8 of an inch (3.2 mm). Similarly the sum of the distance between the horizontal scores and the distances between the horizontal scores and the flap edges should agree with the gross blank width measurement to within 1⁄8 of an inch (3.2 mm). If the two measure of length and width disagree by a larger amount, note the discrepancy and re-measure the inter score distances and gross dimensions.

9.2 *Interior Box Dimensions by Gauge Method:*

9.2.1 *Measuring Length*—Measure the length dimension between the two end panels, holding the instrument as close as possible to the side panel opposite the manufacturer's joint. Place one end of the instrument firmly against one end of the box and adjust the other end until it is just tight enough that, when released with the box inclined so that the side panel closest to the instrument is at an angle of approximately 65° to the horizontal, the instrument will slide slowly down the side of the box and come to rest at the bottom. When the correct extension of the instrument has been obtained, lock it, and if equipped with a self-contained scale, read the distance between the faces directly. If the instrument does not incorporate a scale, remove the instrument from the box and measure the distance between the outer surfaces of the plates by means of a separate scale accurate to 1⁄32 in. (0.8 mm).

9.2.2 *Horizontal Measurements*—Measure the width dimension of the box between the two side panels, holding the instrument as close as possible to the end panel opposite the manufacturer's joint. Correct extension and measurement reading is obtained in the same manner as previously described for length.

9.2.3 *Vertical Measurements*—Measure the depth dimension between the end flaps when these have been folded into position and at the end opposite the manufacturer's joint. Place the instrument, with the spacing bar extended to a point less than the actual depth of the box, in an upright position approximately in the center of the bottom end flap and close the corresponding top end flap over it. Extend the instrument while in this position until the top end flap is brought into a horizontal