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An American National Standard

Standard Specification for Solid State Bargraph Meters for Shipboard Use [Metric][1]

This standard is issued under the fixed designation F1755M; 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.

ε[1] NOTE—Reapproved with editorial changes in October 2012.

1. Scope

1.1 This specification provides the requirements for design, construction, performance, and testing of solid state bargraph-type indicating meters.

1.2 The solid state bargraph meters covered by this specification are intended for use in shipboard applications of electrical measurement. This specification covers the requirements and quality assurance provisions for solid state, panel-type (edgewise), and rectangular switchboard-type instruments, which use light-emitting diodes (LEDs) for bargraph indication and optional digital displays.

1.3 This specification's requirements may be invoked for specialized measurement applications where another quantity, for example, position, weight, concentration of a trace element in an atmosphere sample, and so forth, is converted to electrical energy for display and measurement. Special dial markings shall be specified for such cases.

1.4 The values stated in metric units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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]

B117 Practice for Operating Salt Spray (Fog) Apparatus

D3951 Practice for Commercial Packaging

F1166 Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

2.2 *Federal Specifications:*[3]

TT–E–529 Enamel, Alkyd, Semigloss, Low VOC Content

2.3 *Federal Standards:*[3]

H28 Screw Thread Standards for Federal Services

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *accuracy, n*—the accuracy is a number that defines the limit of errors expressed as a percentage of full-scale value.

3.1.2 *center-zero meter, n*—meter with display mode characterized by a sequentially illuminated string of LEDs starting at the center scale zero position and extending in either direction from zero, proportional to the polarity and magnitude of the input signal.

3.1.3 *dual bargraph display, n*—two completely independent bargraph displays included in a single enclosure.

3.1.4 *end-scale value, n*—the value of the actuating electrical quantity that corresponds to end scale indication. When zero is not at the end or at the electrical center of the scale, the higher value is used. See Table 1.

3.1.5 *end-zero meter, n*—meter with display mode characterized by a sequentially illuminated string of LEDs starting from a zero point, normally at the left for switchboard-style meters or horizontally installed edgewise meters, or the bottom of vertically installed edgewise meters, that extends in the direction of full-scale value.

3.1.6 *full-scale value, n*—full-scale value is the largest value of the actuating electrical quantity that can be indicated on the scale. For instruments with zero between the ends of the scale, the full-scale value is the arithmetic sum of the values of the actuating electrical quantity corresponding to the two ends of the scale.

3.1.7 *response time, n*—the response time is the time required for the indicating means to display a new value after a step change has occurred in the measured quantity to a new constant value.

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.10 on Electrical.

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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 DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil..

TABLE 1 End-Scale Values

Range	End-Scale Values (for Ratings)	End-Scale Values
0-150	0, 150	150
50-0-150	50, 150	150
150-0-150	150, 150	150
90-140	90, 140	140

3.1.8 *scale division, n*—a scale division is the increment between the centers of two consecutive scale marks. The number of scale marks is one more than the number of scale divisions. For example, 10 scale divisions require 11 scale marks.

3.1.8.1 *linear scale divisions, n*—linear scale divisions are scale divisions that are spaced an equal distance apart and of the same value, for example, scale divisions spaced 5 A apart on a 100–A meter.

3.1.8.2 *nonlinear scale divisions, n*—nonlinear scale divisions are scale divisions of the same value spaced an unequal distance apart.

3.1.9 *scale length, n*—the scale length is the length of the path described by the pattern of the LEDs in moving from one end of the scale to the other. For multiple scale meters, the longest scale shall be used to determine the scale length.

3.1.10 *scale visibility, n*—scale visibility is the maximum horizontal or vertical viewing angle measured from a line normal to the scale from which all scale marks and arcs, but not necessarily all markings, may be seen.

4. Classification

4.1 *Classification*—Bargraph meters covered in this specification shall be classified by type and style as specified in 4.2 – 4.3.

4.2 *Type*—The type designation defines the physical configuration of the meter and the scale.

4.2.1 Rectangular/switchboard-type meters present angular displays from 90 to 270° scale for the measured parameter(s). Fig. 1 provides typical dimensional and mounting data for rectangular/switchboard-type meters.

4.2.2 Edgewise/panel-type meters present linear displays for measured parameters. Fig. 2 provides typical dimensional and mounting data for edgewise type meters.

4.2.2.1 *Orientation of Meter*—For edgewise/panel-type meters, the scale marking shall be specified either for a vertical or horizontal mounting condition.

4.3 *Style*—The style designation defines the meters display attributes as follows:

4.3.1 *Bargraph Display*—The bargraph display shall consist of light-emitting diode (LED) elements that illuminate to produce a bar image proportional to the input signal. The display designation defines whether the meter has single or dual bargraph displays.

4.3.2 *Digital Display*—The digital display designation defines the number of digits in the digital display as follows:

4.3.2.1 3-digit display.

4.3.2.2 3½-digit display.

4.3.2.3 4-digit display.

4.3.2.4 4½-digit display

4.3.2.5 No digital display.

5. Ordering Information

5.1 Purchase orders or inquiries for bargraph meters of this specification shall specify the following:

5.1.1 Title, date, and year of this specification.

5.1.2 Quantity.

5.1.3 Type, and for edgewise meter, orientation (see 4.2).

5.1.4 Style of display (single or dual, digital display) (see 4.3).

5.1.5 Window type (plastic or shatterproof glass) (see 7.5).

5.1.6 Dial colors (see 7.9.1.1).

5.1.7 Range(s) (see 7.9.2).

5.1.8 Power supply voltage (see 8.1.1).

5.1.9 Signal input (analog or digital) (see 8.1.2).

5.1.10 Color(s) of bargraph display (see 8.2.2).

5.1.11 Optional features available:

5.1.11.1 Anti-glare windows (see 7.5.1).

5.1.11.2 Splashproof or spraytight window (see 7.5.2).

5.1.11.3 Internal illumination (see 7.6).

5.1.11.4 External accessories (see 7.8).

5.1.11.5 Alarm set points (see 8.1.4).

5.1.11.6 Digital display (see 8.2.4)

5.1.11.7 Nonstandard range values (see 8.2.4).

5.1.11.8 Dot matrix display types (see 8.2.4).

5.1.11.9 Intensity control (see 8.2.5).

5.1.12 Certification requirements (see 10).

5.1.13 Packaging requirements.

5.1.14 Testing requirements (include only if tests other than the production tests required by this specification are to be performed).

6. Materials and Manufacture

6.1 *Materials*—All materials used in the construction of these bargraph meters shall be of a quality suitable for the purpose intended and shall conform to the requirements of this specification.

6.1.1 *Metals*—Metals and the treatment of metals shall be corrosion-resistant.

6.1.2 *Plastics*—Plastic, when used, shall be suitable thermoplastic or thermosetting material so molded as to produce a dense solid structure, uniform in texture, finish, and mechanical properties.

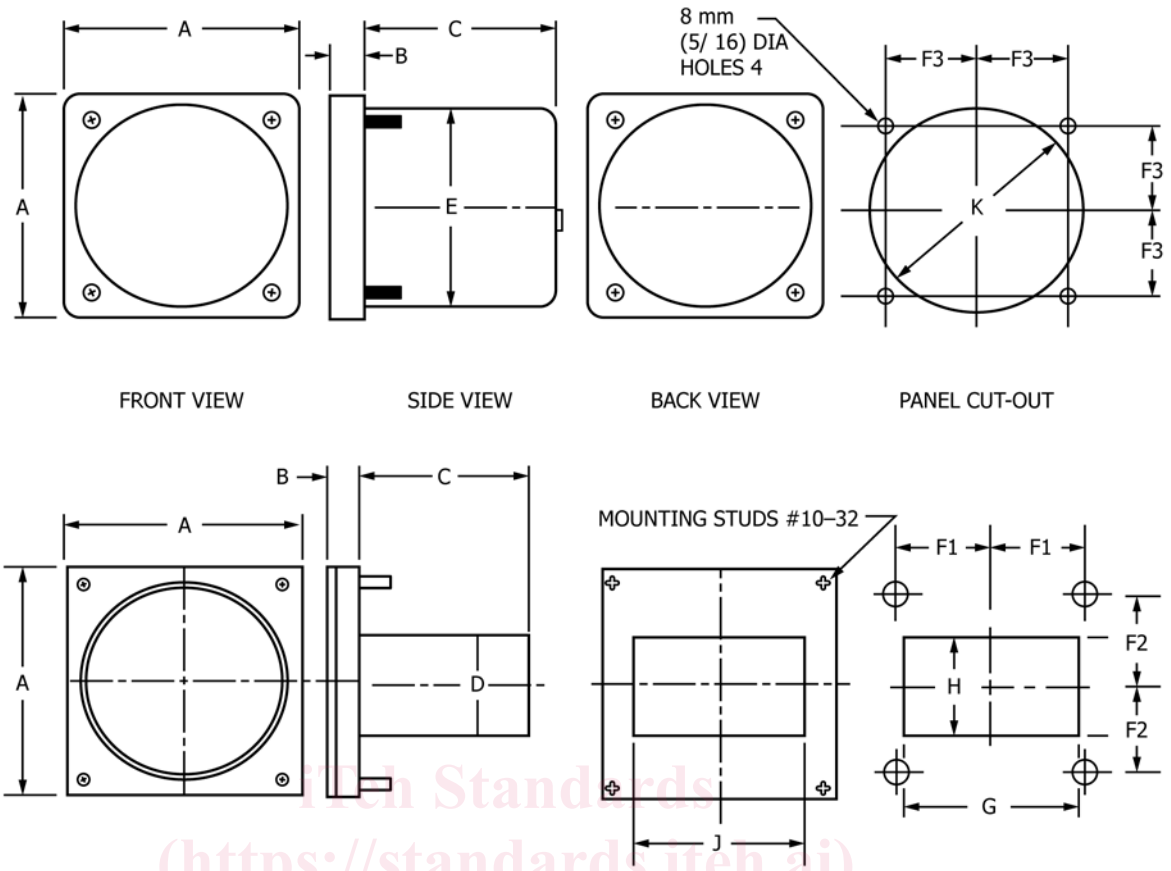
6.1.3 *Glass*—Glass used for the meter window shall be the shatterproof type.

6.1.4 *Gaskets*—Material used in gaskets shall not cause corrosion of metal parts with which they come in contact.

6.2 *Manufacture:*

6.2.1 *Finishes:*

6.2.1.1 *External Finishes*—The portion of the meter case exposed to view from the front of the panel or switchboard shall have a black semigloss finish. No nickel or bright trimmings shall be used. The external finish may be epoxy-coated, electro-coated, or painted in accordance with TT–E–529. Metal cases shall be rendered resistant to corrosion prior to the application of the final finish.



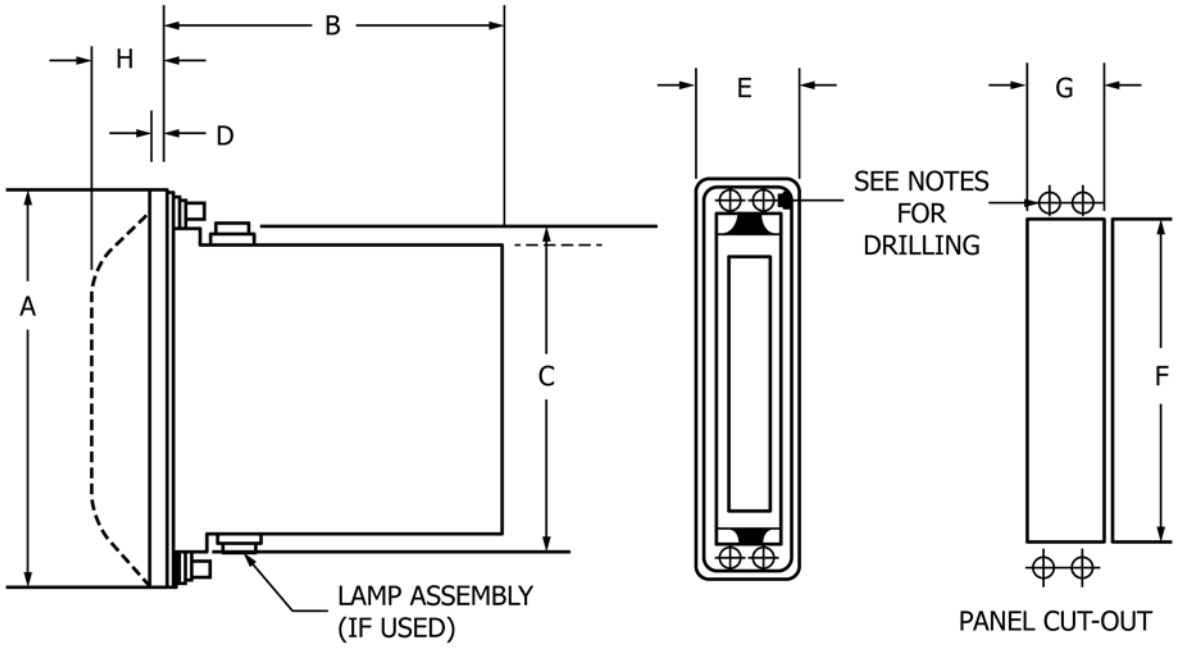
DIMENSIONAL CHARACTERISTICS FOR RECTANGULAR/SWITCHBOARD-TYPE METERS

A	B	C	D	E	F_1	F_2	F_3	G	H	J	K
112 mm (4.43 in)	17.4 mm (0.69 in)	135 mm (5.31 in)	—	101 mm (3.98 in)	—	—	43 mm (1.69 in)	—	—	—	101.6 mm (4.0 in)
216 mm (8.75 in)	26.2 mm (1.03 in)	135 mm (5.31 in)	—	101 mm (3.98 in)	—	—	43 mm (1.69 in)	—	—	—	101.6 mm (4.0 in)

123 mm (4.84 in)	19 mm (0.75 in)	142 mm (5.6 in)	50.8 mm (2.0 in)	—	43 mm (1.69 in)	43 mm (1.69 in)	—	114 mm (4.49 in)	54 mm (2.13 in)	109 mm (4.3 in)	—
118 mm (4.63 in)	22.3 mm (0.88 in)	142 mm (5.6 in)	50.8 mm (2.0 in)	—	43 mm (1.69 in)	43 mm (1.69 in)	—	95 mm (3.75 in)	57 mm (2.25 in)	86 mm (3.38 in)	—
118 mm (4.63 in)	22.3 mm (0.88 in)	142 mm (5.6 in)	50.8 mm (2.0 in)	—	43 mm (1.69 in)	43 mm (1.69 in)	—	114 mm (4.49 in)	54 mm (2.13 in)	108 mm (4.26 in)	—
181 mm (7.13 in)	22.3 mm (0.88 in)	217 mm (8.55 in)	40.6 mm (1.6 in)	—	63.5 mm (2.5 in)	83 mm (3.26 in)	—	172 mm (6.78 in)	47 mm (1.84 in)	137 mm (5.38 in)	—

NOTES: All dimensions are in millimeters (inches are in parenthesis and are nominal unless otherwise specified).

FIG. 1 Rectangular/Switchboard/Type Meters



A	B	C	D	E	F	G	H
133.35 mm (5.25 in)	131.95 mm (5.20 in)	–	14.61 mm (0.58 in)	36.53 mm (1.44 in)	110.74 mm (4.36 in)	36.58 mm (1.44 in)	22.99 mm (0.91 in)
146.55 mm (5.77 in)	140.0 mm (5.5 in)	116.8 mm (4.6 in)	15.5 mm (0.61 in)	31.0 mm (1.22 in)	118.1 mm (4.65 in)	26.9 mm (1.06 in)	---
152.4 mm (6.0 in)	171.0 mm (6.73 in)	144.1 mm (5.675 in)	13.7 mm (0.54 in)	54.86 mm (2.16 in)	144.78 mm (5.7 in)	45.0 mm (1.77in)	---
152.4 mm (6.0 in)	217.2 mm (8.55)	136.5 mm (5.375 in)	20.3 mm (.80 in)	44.2 mm (1.75 in)	172.2 mm (6.78 in)	46.7 mm (1.84 in)	---
170.2 mm (6.7 in)	154.0 mm (6.06 in)	116.8 mm (4.6 in)	15.5 mm (0.610 in)	38.86 mm (1.53 in)	139.1 mm (5.475 in)	31.5 mm (1.24 in)	---
177.8 mm (7.0 in)	184.2 mm (7.25 in)	138.9 mm (5.47 in)	12.7 mm (0.5 in)	63.5 mm (2.50 in)	139.7 mm (5.5 in)	47.6 mm (1.875 in)	41.3 mm (1.625 in)
241.3 mm (9.5 in)	114.3 mm (4.5 in)	182.9 mm (7.2 in)	20.3 mm (0.8 in)	45.72 mm (1.8 in)	184.2 mm (7.25 in)	38.1 mm (1.5 in)	---
254.0 mm (10.0 in)	269.2 mm (10.6 in)	215.1 mm (8.47 in)	12.7 mm (0.5 in)	91.95 mm (3.62 in)	215.9 mm (8.5 in)	76.2 mm (3.0 in)	63.5 mm (2.5 in)
285.7 mm (11.25 in)	217.2 mm (8.55 in)	136.5 mm (5.375 in)	20.8 mm (.820 in)	91.7 mm (3.6 in)	172.2 mm (6.78 in)	46.7 mm (1.84 in)	----

NOTES: All dimensions are in millimeters (inches are in parentheses and are nominal unless otherwise specified). For specific drilling information, contact the manufacturer.

FIG. 2 Dimensional Characteristics of Edgewise Meters

6.2.1.2 *Internal Finishes*—Internal finishes shall be of a material that shall not melt, crack, chip, blister, or scale as a result of the tests specified herein.

6.3 *Threaded Parts*—Threaded parts shall be in accordance with FED-STD-H28. Where practical, threads shall be in conformity with the coarse-thread series. The fine-thread series shall be used only for applications that might show a definite advantage through their use. Where a special diameter pitch combination is required, the thread shall be of American National Form and of any pitch between 16 and 36 which is used in the fine-thread series.

6.3.1 *Locking of Screw-Thread Assemblies* —Screw-thread assemblies shall not loosen as a result of the tests specified herein. When practicable, split-type lockwashers or equivalent means shall be provided under all nuts.

6.4 *Sealing*—The meter case shall be sealed by means of gaskets, by fusing or soldering metal-to-metal or metal-to-glass, or other means which will enable the meter to withstand the tests specified herein.

7. Design and Construction

7.1 *Dimensional Data*—Typical physical dimensions for switchboard and edgewise meters are shown in Fig. 1 and Fig. 2.

7.2 *Mounting*—Bargraph meter shall be front panel mounted to simplify mechanical installation or removal for service, or both. Electrical connections locations shall be designed to facilitate meter removal. Typical mounting dimensions are indicated in Fig. 1 and Fig. 2.

7.2.1 *Mounting Hardware*—The necessary mounting hardware, such as mounting clips, nuts, washers, bolts, shall be supplied with each meter. The machine screws shall have the same finish as the external finish (see 6.2.1.1).

7.3 *Maintainability*—The meter shall be constructed so that no special tools are required for insertion or removal of the meter.

7.4 *Cases*—Cases shall be corrosion resistant. Cases shall be designed and constructed with close-fitting joints to minimize the entrance of dust and moisture (see 6.4).

7.5 *Windows*—The meter display shall be provided with a window of methyl methacrylate (MMA), polycarbonate (PC), or shatterproof glass. If the window is made MMA or PC, the external surface shall be treated to resist scratching. The window shall be free from detrimental defects that would prevent the display from being easily read or from meeting the luminous distribution and color requirement. Such defects include electrostatic effects, scratches, chips, cracks, or craze.

7.5.1 *Anti-Glare Coatings*—When anti-glare is specified, windows shall be coated with an anti-glare coating. The coating shall be uniform in quality and condition, clean, smooth, and free from foreign materials. The coating shall show no evidence of flaking, peeling, or blistering. The coating shall not contain blemishes such as discolorations, stains, smears, and streaks. The coating shall show no evidence of a cloudy or hazy appearance.

7.5.1.1 *Specular Reflectance*—The coating reflectance shall be not greater than 0.6 % for energy incident on the surface at an angle of 0 to 15° inclusive. The reflectance shall be not greater than 1.0 % at an angle of 30°.

7.5.1.2 *Light Loss*—The coating light loss shall be not greater than 2.0 %.

7.5.2 *Splashproof/Spraytight Windows* —When specified, splashproof or spraytight windows shall be furnished.

7.6 *Internal Illumination*—When specified, meters shall be equipped with internal illumination provided by a minimum of two lamps, so placed to illuminate the dial evenly.

7.7 *Auxiliary Components*—All connections from the shunts and resistors to the input terminals of the meters shall be insulated to prevent shock hazard.

7.8 *External Accessories*—External shunt, shunt leads, transformers, resistors, and other external accessories shall be furnished when required.

7.9 *Meter Scales:*

7.9.1 *Dial*—The dial shall be made of stiff material and shall be supported and secured firmly to the meter.

7.9.1.1 *Dial Colors*—The meter dial shall have white markings on a black background as standard.

7.9.1.2 *Dial Markings*—Dial legend markings shall be sharply defined and visible from the front of the case but not distract attention from the scale markings. Unless otherwise specified, the following information shall be marked on the dial or on an attached nameplate.

(a) Manufacturer's name.

(b) Units of measurement.

(c) The quantity producing end-scale deflection. For end-zero meters, the dial markings shall be FS, indicating full scale, followed by the full-scale value and units of measurement (for example, FS-50 mV). For meters that are not end-zero meters, the dial markings shall be marked ES indicating end scale followed by the end-scale value and units of measurement (for example, ES-50 mV).

7.9.2 *Ranges*—For end-zero meters, the full-scale ranges shall be as specified. For meters that are not end-zero meters, the center and end-scale ranges shall be specified appropriately.

7.9.3 *Scale Divisions*—Unless otherwise specified, the value of each scale division shall be one, two, or five of the units measured or any decimal multiple or submultiple of these numbers.

7.9.3.1 *Linear Scales*—The total number of scale divisions shall be determined by dividing the total range by the smallest increment. For example; a 150-V scale with the smallest increment of 5 V is listed as having 30 scale divisions.

7.9.3.2 *Nonlinear Scales*—The total number of scale divisions shall be determined by dividing the total range by the smallest increment, although to avoid crowding scale marks, a portion of the scale shall not be marked. For example, a 100-A scale with the smallest increment of 2 A, but with no marks between 0 and 10 A, is listed as having 50 scale divisions.

7.9.4 *Scale Visibility*—The scale and characters shall be uniform visually in character brightness, legibility, and cleanliness of display with all elements of the meter illuminated. The entire meter scale shall be clearly visible from a distance of 1

m (3 ft) and from a viewing angle of 45° from normal; both vertically and horizontally. The scale visibility shall not deteriorate during the tests specified herein.

7.9.5 *Scale Markings*—Numerals, letters, and symbols shall be in accordance with Practice F1166. Scale markings shall be as specified herein.

7.9.5.1 The orientation of numerals shall be tangential or erect for 90° scales, erect for 180 and 270° scaleplates, and erect for edgewise scales.

7.9.5.2 The sequence of scale divisions and numerals through the linear portion of the scale plate shall be uniform.

7.9.5.3 The scales shall begin and end with a numbered mark, including 0, when applicable.

7.9.5.4 There shall be not greater than five minor scale divisions between an intermediate or major scale division nor greater than three intermediate scale divisions between a major scale division.

7.9.5.5 The numbered markings shall be spaced uniformly and shall be expressed in the same units of measurement as those of the end-scale marking. One, two, and five or decimal multiples thereof, shall be used when possible.

7.9.5.6 Scale division markings shall occupy not greater than 20 % of the space between a scale division mark and an adjacent mark.

8. Requirements

8.1 *Electrical Requirements:*

8.1.1 *Power Supply Voltage*—The meters shall operate from a voltage as specified as follows. A means of reverse voltage protection shall be provided:

5 ± 0.25 V direct current (Vdc)
28 ± 1.0 Vdc
115 ± 8.0 V alternating current (Vac)

8.1.2 *Signal Input*—The meters shall accept a digital or analog signal as specified.

8.1.3 *Insulation Resistance*—The insulation resistance shall be not less than 2 MΩ between the external terminals and the meter case.

8.1.4 *Alarm Set Points*—When specified, the meter shall be furnished with adjustable visible set points with form-C relay contact outputs for control of external devices such as remote alarms. The hysteresis of set points shall be not greater than 1.0 % of full scale.

8.1.4.1 *Setting*—Set points shall be programmed from the front of the meter. Set points should be set to a point on the bargraph as standard and use of the digital display for setting exact numerical values is an option.

8.2 *Displays:*

8.2.1 *Color Coding*—The LED color coding shall conform to Practice F1166.

8.2.2 *Bargraph Display*—The bargraph display shall consist of segmented LED displays of the colors specified, which illuminate to produce a bar image equal to the corresponding scale value of the input. LED display color selection includes red, green, amber or use of tricolor LED display as an option.

8.2.3 *Power-On Indication*—The zero LED shall be continuously illuminated to serve as a "power on" and as a "zero reference" even in the absence of a signal input.

8.2.4 *Digital Display*—When specified, the meter shall include a red LED digital display that shall display continuously a specified range of values. The standard digital display shall match the bargraph display. An optional feature of different range values for the digital and bargraph displays shall be available when specified. The standard nominal character height shall be 4.88 mm (0.192 in.) for edgewise types with 2.4 mm (0.095 in.) as an option. The standard nominal character height shall be 10.5 mm (0.41 in.) for switchboard-type meters. The display type shall be seven segment as standard with dot matrix as an option.

8.2.5 *Intensity Control*—When specified, dimming controls shall be provided to maintain appropriate brightness, legibility, and operator dark adaptation level. These controls shall apply to all LED displays and, when used, dial illumination. The display luminance shall vary in direct proportion to ambient lighting, and the dial illumination in inverse proportion.

8.2.6 *Adjustments*—The meter shall contain provisions to adjust the zero-offset and full-scale range. The adjustment devices shall be accessible from the rear of the meter when connected to the input signal and power supply sources.

8.2.7 *Set Point Visual Indication*—Visual indication of the set point locations shall be shown on the bargraph display by illuminating that LED segment corresponding to the set value when the input signal is lower than the set point value. When the input signal is greater than the set point value, the LED segment corresponding with the set point value is off. When the signal level is one LED segment greater or lower than the set point value, the LED corresponding to the set point value will flash once a second (1 Hz). When the signal level and the set point value are the same, the LED corresponding to the location will flash twice a second (2 Hz).

8.3 *Performance Requirements:*

8.3.1 *Zero Adjustment*—The meter shall include provision for zero adjustment by automatic or manual means. Manual means for zero adjustments shall provide for a minimum excursion of ±1 % of full scale about scale zero. The means shall be designed such that scale zero does not change as a result of any of the tests specified herein.

8.3.2 *Span Adjustment*—The meter shall include provision for span adjustment that provides for a full-scale adjustment above and below full scale of not less than 1.0 % of the rated full scale. The span adjuster shall be designed to prevent it from shaking loose and changing adjustment when subject to tests specified herein.

8.3.3 *Accuracy:*

8.3.3.1 *Bargraph Display*—The required accuracy of the meter bargraph display shall be established using the following equation:

$$\text{Bargraph display accuracy} = \frac{100}{[\text{number of LED elements}] - 1}$$

8.3.3.2 *Digital Display Accuracy*—The error of the digital display shall be not greater than 1.0 % for 3- and 3½-digit displays and shall be not greater than 0.1 % for displays with 4- and 4½-digit displays.