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American National Standard

for thermal demand meters

ANSI C12.5-1978

american national standards institute, inc.
1430 broadway, new york, new york 10018

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C12.5-1978

American National Standard for Thermal Demand Meters

Secretariat

Edison Electric Institute
National Bureau of Standards

Approved August 1, 1978

American National Standards Institute, Inc

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Published by

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Foreword

(This Foreword is not a part of American National Standard for Thermal Demand Meters, ANSI C12.5-1978.)

This American National Standard provides recommended minimum requirements for general-service-type thermal watt demand meters and watthour-thermal watt demand meters.

Except that performance requirements are now part of American National Standard Code for Electricity Metering, ANSI C12-1975, this standard is equivalent to and supersedes the requirements of the former AEID-EEI-NEMA standards for Thermal Demand Meters, EEI Pub. No. MSJ-5-1967, NEMA Pub. No. EI-15-1967. For convenience in using this standard, the performance requirements are included as an Appendix.

This standard and other former AEIC-EEI-NEMA standards on meters and meter devices were referred to the American National Standards Committee on Electricity Metering, C12, for approval and publication as an American National Standard.

Suggestions for improvement of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

This standard was processed and approved for submittal to ANSI by American National Standards Committee for Electricity Metering, C12. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C12 Committee had the following members:

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A. M. Salazar, Secretary

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The editorial subcommittee that prepared this standard had the following members:

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American National Standard for Thermal Demand Meters

1. Scope

This standard covers the class designations, voltage and frequency ratings, scale values, demand intervals, multiplying constants, mounting dimensions, terminal arrangements, and other features of general-service-type thermal watt demand meters and watthour-thermal watt demand meters. Although this standard specifically refers to watt demand meters, it is suggested that ampere and volt-ampere demand meters follow the applicable requirements so far as practicable.

2. Definitions

Only definitions not included in American National Standard Code for Electricity Metering, ANSI C12-1975, are provided here. Definitions that pertain to this standard and are part of ANSI C12-1975 are included in Appendix A.

2.1 Bottom-Connected Thermal Watt or Watthour-Thermal Watt Demand Meter. A bottom-connected thermal watt demand meter or watthour-thermal watt demand meter is one having a bottom-connection terminal assembly.

2.2 Detachable (Socket-Mounted) Thermal Watt or Watthour-Thermal Watt Demand Meter. A detachable thermal watt demand meter or watthour-thermal watt demand meter is one having bayonet-type terminals arranged on the back of the demand meter for insertion into matching jaws of a meter socket.

2.3 Self-Contained Thermal Watt or Watthour-Thermal Watt Demand Meter. A self-contained thermal watt demand meter or watthour-thermal watt demand meter is one in which the terminals are arranged for connection to the circuit being measured without the use of external instrument transformers.

2.4 Thermal Watt Demand Meter. A thermal watt demand meter is a lagged-demand meter that transforms electric energy to heat energy and indicates or records the maximum kilowatt demand.

2.5 Transformer-Rated Thermal Watt or Watthour-Thermal Watt Demand Meter. A transformer-rated thermal watt demand meter or watthour-thermal watt demand meter is one in which the terminals are arranged for connection to the secondary windings of external instrument transformers.

2.6 Watthour-Thermal Watt Demand Meter. A watthour-thermal watt demand meter is a thermal watt demand meter and a watthour meter installed in a common case.

3. Requirements Applicable to All Thermal Demand Meters

3.1 General

3.1.1 Thermal demand meters shall be substantially constructed of good material in a workmanlike manner with the objective of attaining stability of performance and sustained accuracy over long periods of time and over wide ranges of operating conditions with a minimum of maintenance.

3.1.2 The watthour meter contained in a watthour-thermal watt demand meter shall be in accordance with applicable standards for watthour meters insofar as practicable. (See ANSI C12-1975 and American National Standard for Watthour Meters, ANSI C12.10-1978.)

3.1.3 The envelope dimensions and terminal arrangements and dimensions shall conform with applicable standards for watthour meters. (See ANSI C12.10-1978.)

3.1.4 Finish. All thermal watt demand meters and watthour-thermal watt demand meters shall meet the Class I general-purpose finish requirements or, if specified, Class II finish, as shown in Section 4.

3.1.5 Raintightness. When mounted in normal operating position in or on a meter mounting intended for outdoor installation, thermal demand meters shall pass the test described in Underwriters Laboratories Research Bulletin No. 23, "Rain Tests of Electrical Equipment – Methods and Apparatus," September 1941.[1]

3.1.6 General. Other performance requirements not specifically covered by this standard shall be consistent with ANSI C12-1975.

[1] Available from Underwriters Laboratories, Inc, 333 Pfingsten Road, Northbrook, Ill. 60062.

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3.2 Mounting. Mounting arrangements shall be (1) detachable (socket or Type "S") or (2) bottom-connected (Type "A").

3.3 Classes. The classes shall be:

(1) Single Range: 5, 10, 50, 100, and 200

(2) Dual Range: 5-10, 50-100, and 100-200

3.4 Voltage and Frequency. The voltage and frequency ratings shall be 120, 240, 277, or 480 volts; 60 hertz.

3.5 Time Characteristics. Thermal watt demand meters shall have a time characteristic of not less than 15 minutes.

3.6 Temperature Rise. The temperature-rise performance specifications given in Appendix B for watthour meters are applicable to thermal watt demand meters, except for their heaters.

3.7 Scales

3.7.1 Full-Scale Values

(1) Full-scale values are based on the following conditions:

(a) Class 5 and Class 10: maximum current, rated voltage, and 83-1/3% power factor.

(b) Class 50, Class 100, and Class 200: maximum current, rated voltage, and 100% power factor.

(2) Full-scale values shall be as listed in Table 1.

3.7.2 Demand Scales. Demand scales with 100 divisions, marked 0-1.0 or 0-100, may be provided.

3.7.3 Scale Length. The scale shall be at least 4 inches in length.

3.7.4 Scale Design

(1) The value of each scale division shall be, wherever practicable, either 1, 2, or 5 of the units measured or an integral power of 10 or its reciprocal times these values. (See 6.22 of American National Standard Requirements for Electrical Analog Indicating Instruments, ANSI C39.1-1972.)

(2) Every tenth line shall be numbered.

(3) Lines of different length or different width, or both, shall be used for the main (M), intermediate (I), and subdivision (S) markings. In addition, the subdivision markings shall normally be bounded by arc lines.

(4) The scale divisions and numbering shall be as shown in Table 2. Typical scales are shown in Fig. 1.

(5) On a scale that includes decimal fractions, the following shall apply:

(a) All whole numbers shall be followed by .0 – for example, 1.0, 2.0.

(b) Decimal fractions shall be preceded by 0 or other whole numbers – for example, 0.1, 0.5, 1.5.

3.7.5 Scale Identification. The scale designation "kilowatts," "kW," or "KW" shall be located adjacent to the demand scale and preferably at the center.

Table 1
Full-Scale Values*
for Watthour-Thermal Watt Demand Meters

Class	One-Stator	Two-Stator	Three-Stator†	
	Meters Rated 120 Volts		Meters Rated 120 Volts	
5	0.5	1.0	1.5	
10	1.0	2.0	3.0	
50	6.0	12.0	18.0	
100	12.0	24.0	36.0	
200	–	48.0	72.0	
	Meters Rated 240 Volts		Meters Rated 240 or 277 Volts	Meters Rated 277 Volts
5	1.0	2.0	3.0	3.5
10	2.0	4.0	6.0	7.0
50	12.0	24.0	36.0	41.0
100	24.0	48.0	72.0	83.0
200	48.0	96.0	144.0	166.0
	Meters Rated 480 Volts			
5	2.0	4.0		
10	4.0	8.0		
50	24.0	48.0		
100	48.0	96.0		
200	96.0	192.0		

*The same full-scale values and markings also apply to separate thermal watt demand meters for corresponding circuit application.

†Also applies to two-stator meters with 3 current windings for 3-phase 4-wire service.

3.7.6 Finish. The finish of the scale shall be non-gloss white, or aluminum, or the equivalent.

3.8 Demand Pointers. The maximum demand pointer shall be black and so designed with relation to the scale that parallax errors are minimized. The thickness of that part of the pointer used for reading shall not exceed twenty-thousandths of an inch (0.020 inch). The pusher pointer, if provided, shall be red.

3.9 Multiplying Constants and Their Location

3.9.1 Multiplying Constants. Classes 50, 100, and 200 watthour-thermal watt demand meters shall be supplied with a multiplying constant of 1 for both the demand and the kilowatthour register.

Classes 5 and 10 watthour-thermal watt demand meters shall have scale markings and register ratios such that the required multiplying constant will be equal to the ratio of the current transformers or the product of the ratios of the current transformers and voltage transformers to which such a meter is intended to be connected.

However, watthour-thermal watt demand meters, having 100-division scales, require multiplying constants

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Table 2
Scale Divisions

Full-Scale Marking	Divisions	kW per Division	M*	I†	S‡
0.5	100	0.005	10	5	2
1.0	100	0.01	10	2	5
1.5	75	0.02	7	2	5 + 5
2.0	100	0.02	10	2	5
3.0	60	0.05	6	5	2
3.5	70	0.05	7	5	2
4.0	80	0.05	8	5	2
6.0	60	0.1	6	2	5
7.0	70	0.1	7	2	5
8.0	80	0.1	8	2	5
12.0	60	0.2	6	2	5
18.0	90	0.2	9	2	5
24.0	48	0.5	4	5	2 + 8
36.0	72	0.5	7	5	2 + 2
41.0	82	0.5	8	5	2 + 2
48.0	96	0.5	9	5	2 + 6
72.0	72	1.0	7	2	5 + 2
83.0	83	1.0	8	2	5 + 3
96.0	96	1.0	9	2	5 + 6
100.0	100	–	10	2	5
144.0	72	2.0	7	2	5 + 2
166.0	83	2.0	8	2	5 + 3
192.0	96	2.0	9	2	5 + 6

*M = Main (numbered) division markings in addition to zero
†I = Intermediate divisions
‡S = Subdivisions (the number following the plus sign denotes subdivisions beyond the last main division marking)

based on the full-scale values listed in Table 1 in addition to the multiplying constants necessary when used with instrument voltage and current transformers. The resulting multiplier is not necessarily the same as the multiplying constant for the watthour meter register.

3.9.2 Thermal Watt Demand Meters. A multiplying constant, when required, shall be adjacent to the scale and shall be preceded by the words "Multiply by."

3.9.3 Watthour-Thermal Watt Demand Meters

(1) A multiplying constant applicable to the demand reading only shall be adjacent to the kilowatt scale and shall be preceded by the words "Multiply kW by" or "Multiply KW by."

(2) A multiplying constant applicable to the kilowatthour reading only shall be adjacent to the kilowatthour dials and shall be preceded by the words "Multiply kWh by" or "Multiply KWH by."

(3) A multiplying constant applicable to both the demand reading and the kilowatthour reading shall be adjacent to either the kilowatt scale or the kilowatthour dials and shall be preceded by the words "Multiply Both (or All) Readings by."

3.9.4 Removable Plates

(1) Multiplying constants and their preceding word identifications may be on a removable plate.

(2) When multiplying constants are to be determined by the user, the identifying words as applied to 3.9.2 and 3.9.3 shall appear on a removable plate which also shall provide a minimum space of 3/4 inch X 1/4 inch for insertion of a multiplier.

3.10 Dual-Range Identification. Means shall be provided for identifying the proper demand scale with the measurement of the thermal element.

3.11 Dimensions. The mounting dimensions for thermal watt demand meters shall be the same as for the corresponding watthour meters.

3.12 Location of Voltage-Test-Link Terminals. The location and number of the voltage-test-link terminals shall be as shown in Fig. 2, 3, and 4.

3.13 Current and Voltage Connections. The current and voltage connections and the relative location of the respective terminals shall be the same as for the corresponding watthour meters insofar as practicable (see Fig. 3, 4, 5, and 6).

3.14 Sealing

3.14.1 Detachable Type. Thermal watt demand meters shall be provided with facilities for sealing the cover to the base by means of a lead-and-wire seal, a T-type seal, or the equivalent.

3.14.2 Bottom-Connected Type

(1) Thermal watt demand meters shall be provided with means to separately seal the cover.

(2) The terminal cover seal shall seal both the terminal cover and the demand meter cover.

3.14.3 Both Types. A method for resetting the maximum demand pointer shall be provided external to the meter cover and shall have facilities for sealing by means of a lead-and-wire seal, a wire padlock seal, or a T-type seal, or by other similar means.

3.15 Hanger. Detachable types shall be provided with a hanging device on the back of the base.

3.16 Terminal Blocks. Bottom-connected types shall be provided with terminal blocks of arc-resistant material.

3.17 Nameplates

3.17.1 Minimum Information. The following minimum information shall be stamped or printed on suitable plates so as to be readily visible from the front of the meter:

(1) Form designation; indicate whether thermal watt demand meter or watthour-thermal watt demand meter
(2) Manufacturer's name or trademark
(3) Manufacturer's serial number
(4) Manufacturer's type
(5) Volts
(6) Wire
(7) Number of voltage elements (applies only to separate thermal watt demand meters)

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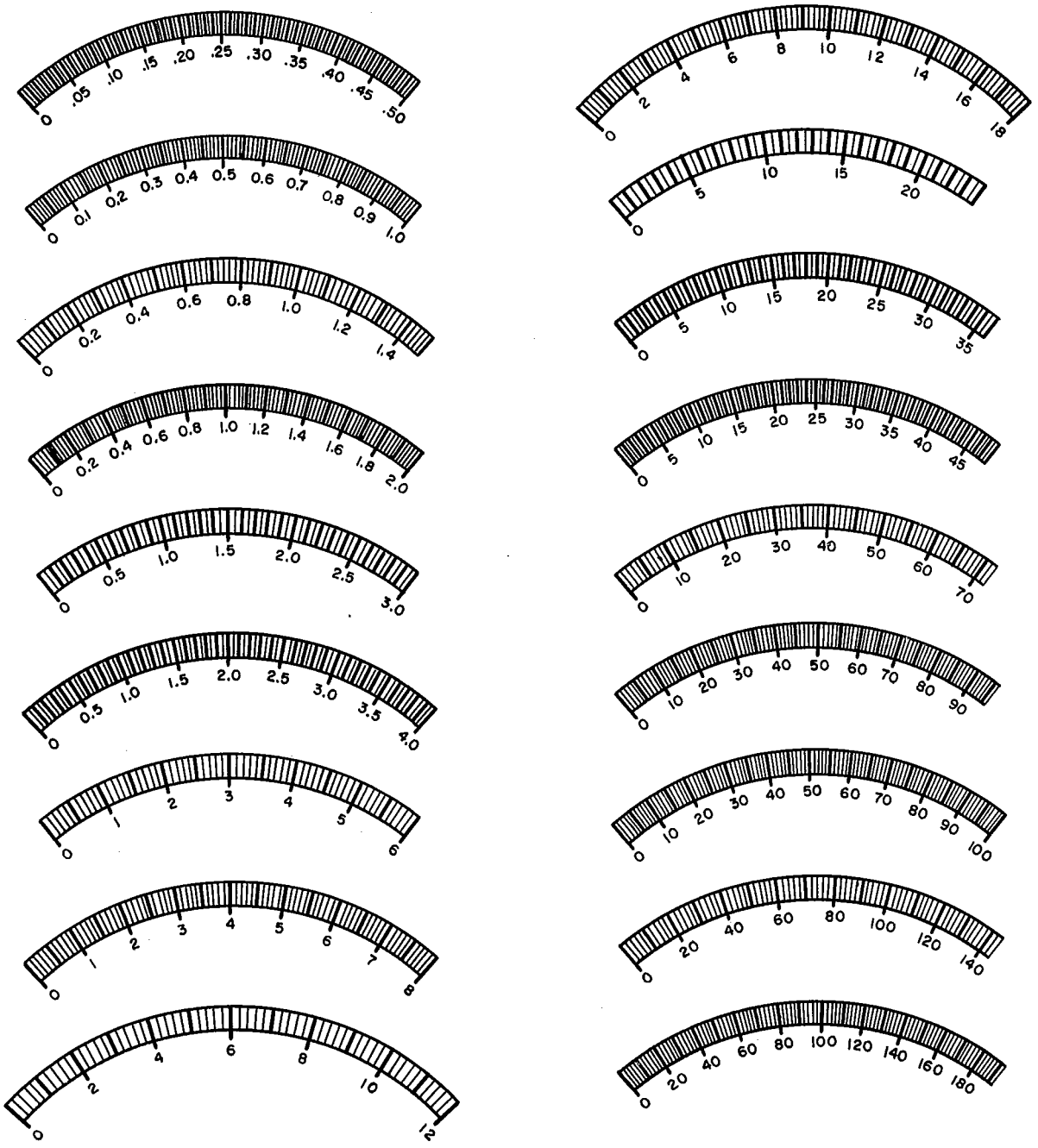
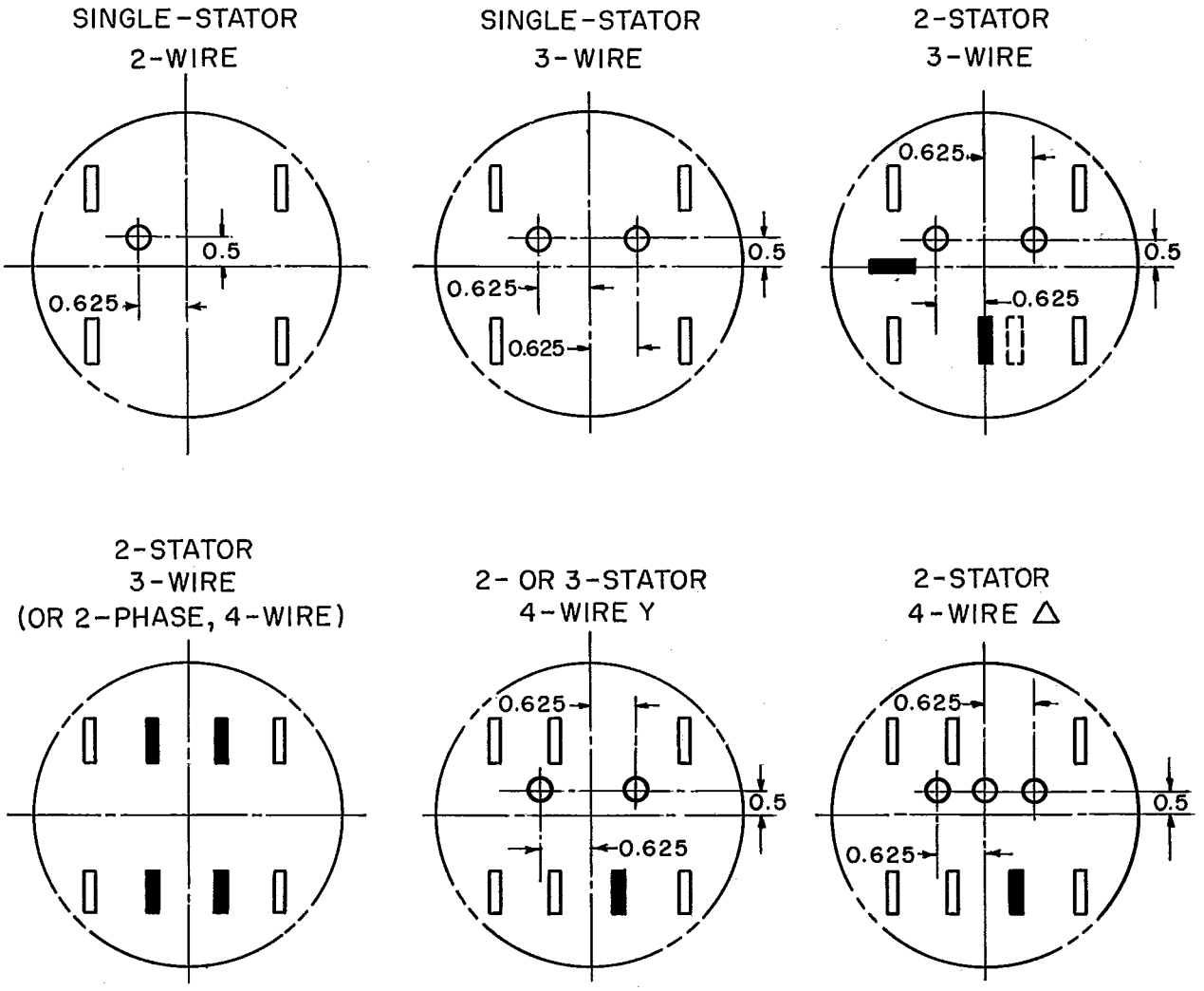


Fig. 1
Sample Scale Markings

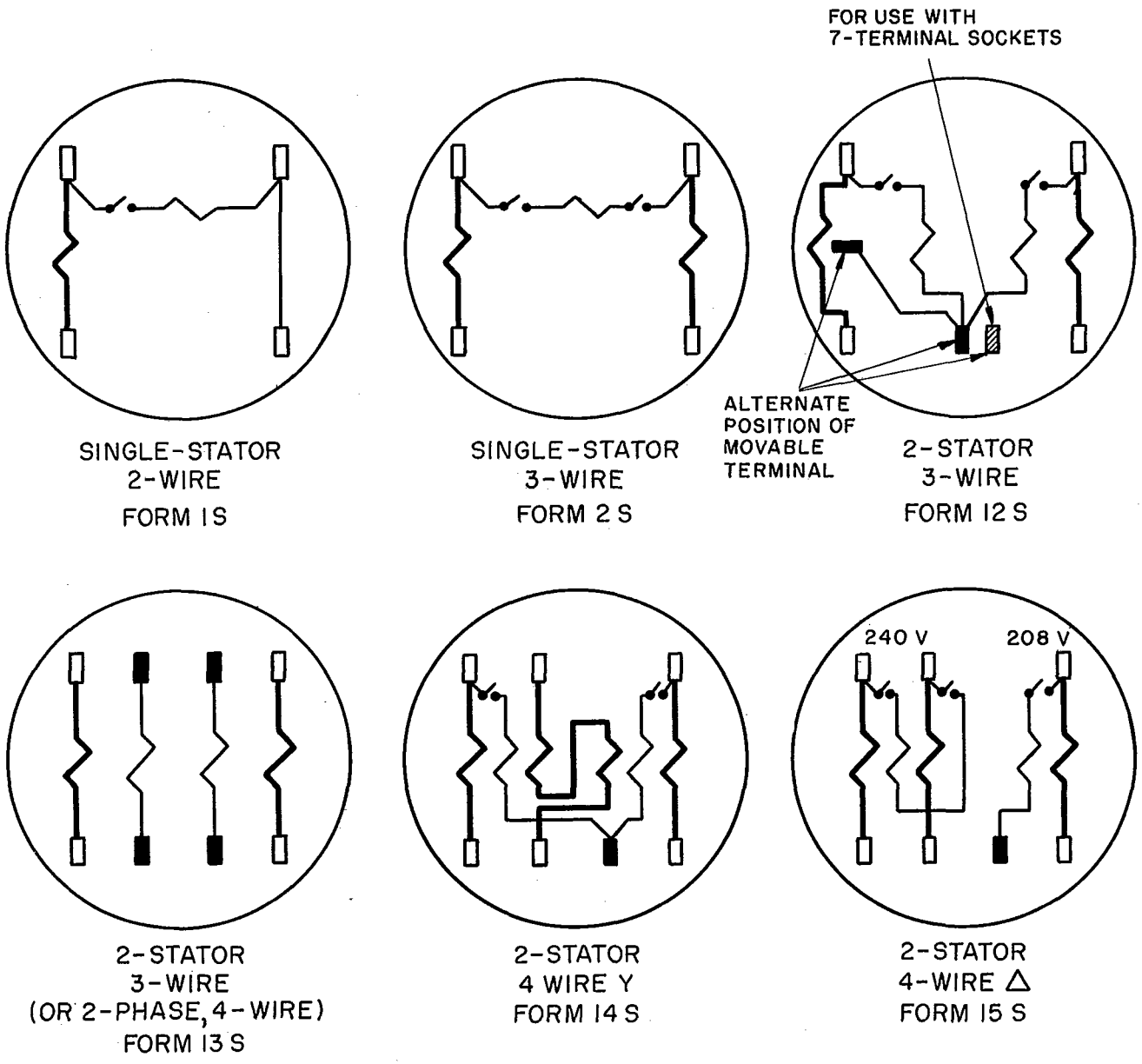
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NOTE: All dimensions are in inches. For metric conversion multiply inches by 25.4 to obtain millimeters; round off to nearest 0.02 mm.

Fig. 2
Location of Test-Link Terminals Connected to Voltage Coils in Self-Contained Detachable Thermal Watt Demand Meters and Watthour-Thermal Watt Demand Meters (Front Views)

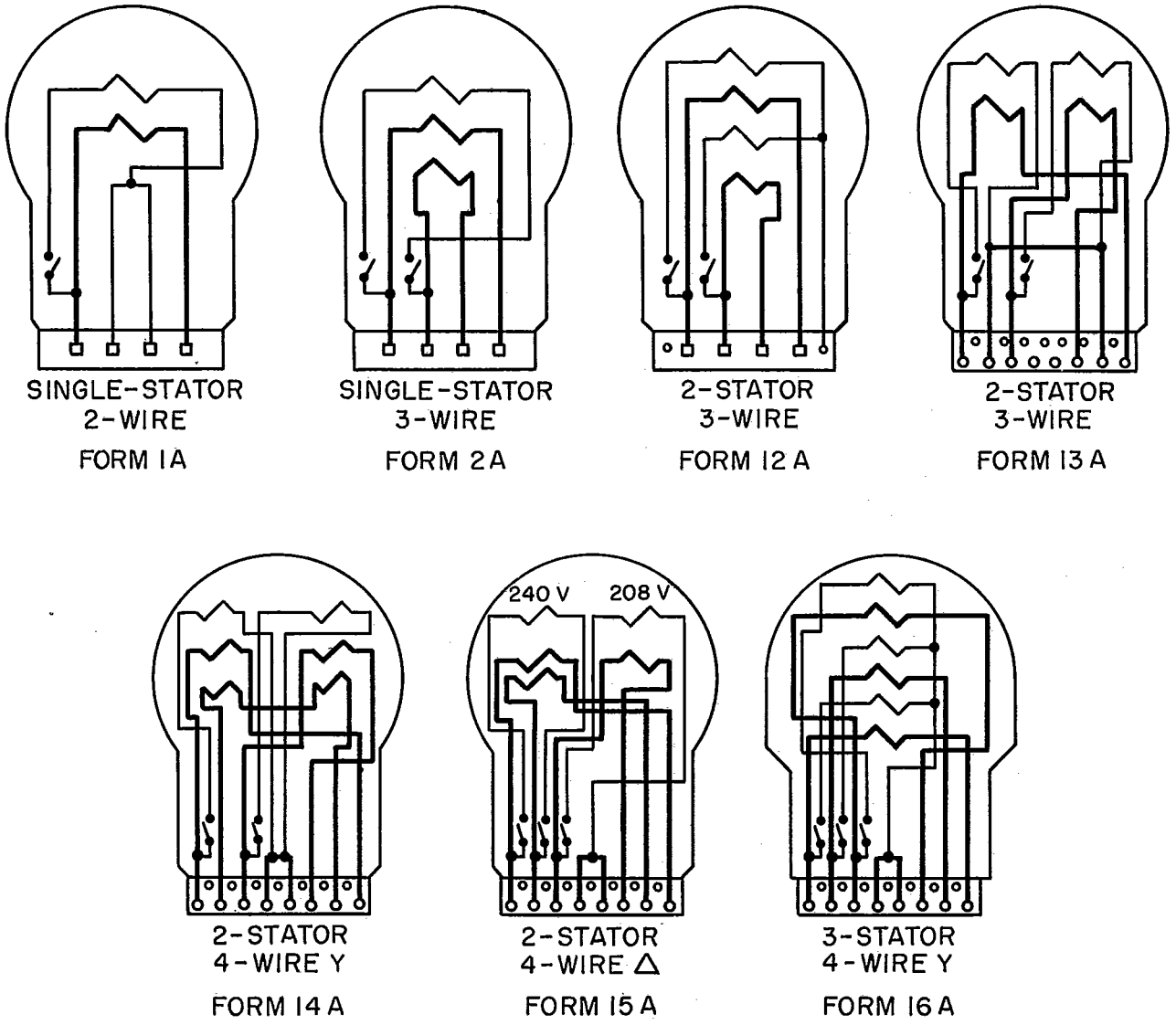
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NOTE: These diagrams are schematic only. They do not imply any specific direction of movement or connections of the test links when open.

Fig. 3
Internal Connections for Self-Contained Detachable Thermal Watt Demand Meters and Watthour-Thermal Watt Demand Meters (Front Views)

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NOTE: These diagrams are schematic only. They do not imply any specific direction of movement or connection of the test links when open.

Fig. 4
Internal Connections for Self-Contained Bottom-Connected Thermal Watt Demand Meters and Watthour-Thermal Watt Demand Meters (Front Views)

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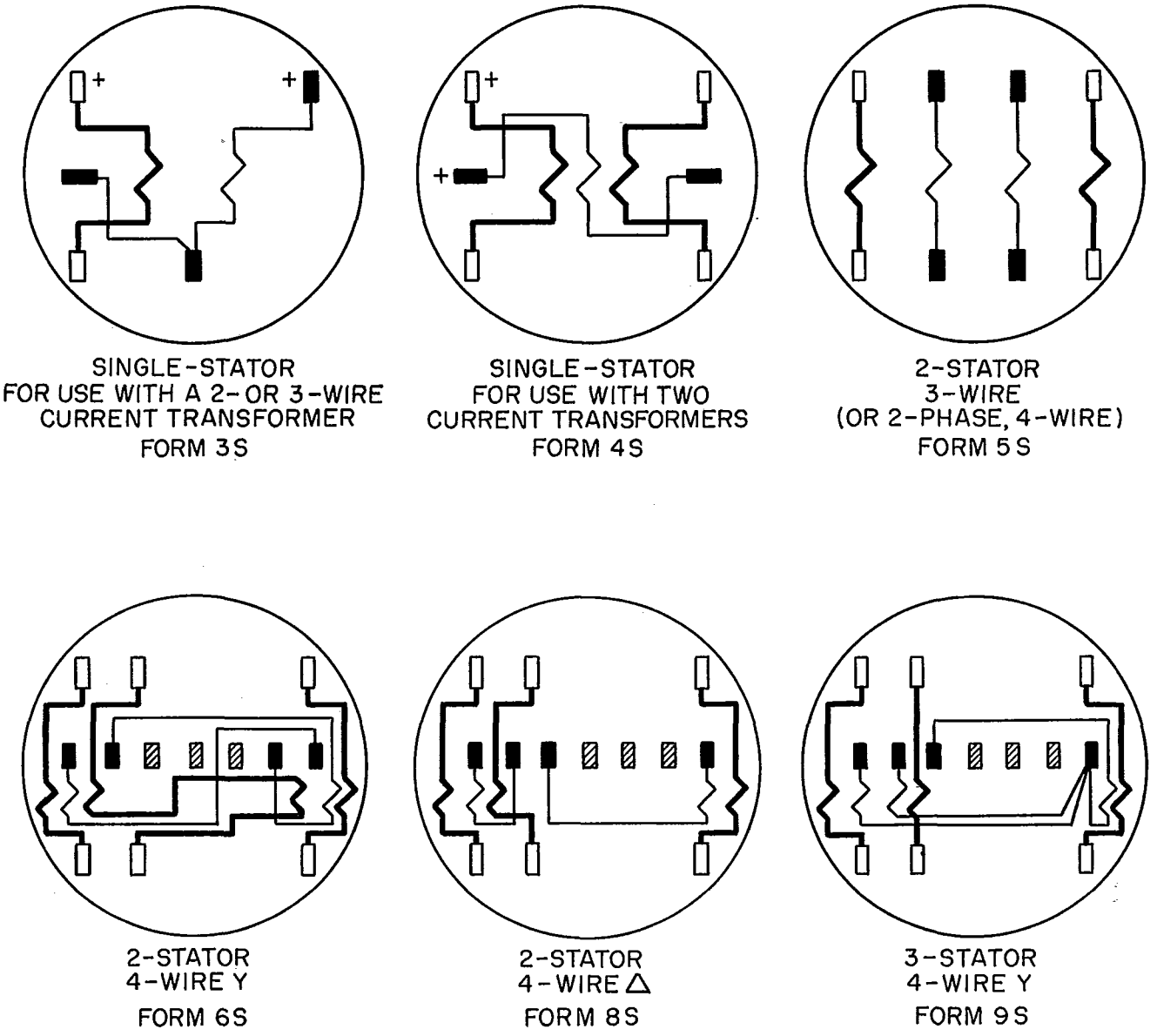


Fig. 5
Internal Connections for Transformer-Rated Detachable Thermal Watt Demand Meters and Watthour-Thermal Watt Demand Meters (Front Views)

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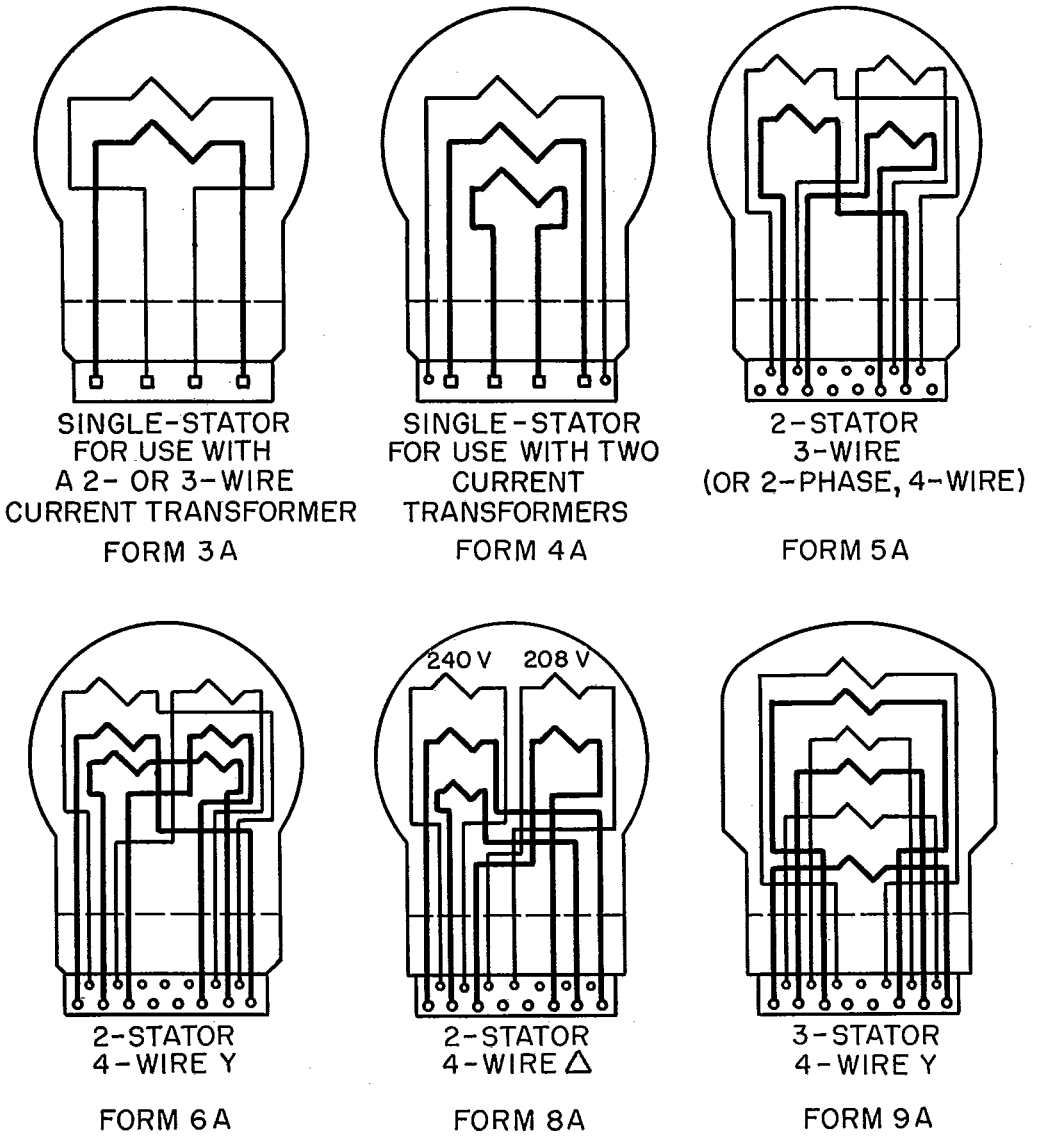


Fig. 6
Internal Connections for Transformer-Rated Bottom-Connected Thermal Watt Demand Meters and Watthour-Thermal Watt Demand Meters (Front Views)

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(8) "Y" or "Δ" as required
(9) Hertz
(10) Class
(11) Full-scale value (secondary value on transformer rated meters)

(a) Single-range meters shall show the value in kilowatts.

(b) Dual-range meters shall show both values in kilowatts.

Transformer-rated meters shall contain space for the following additional information:

(12) Current transformer ratio, as required – for example, 200:5.
(13) Voltage transformer ratio, as required – for example, 120:1.

3.17.2 Additional Information. The nameplate of a watthour-thermal watt demand meter shall contain the following additional information:

(1) Test current
(2) Watthour constant
(3) Primary watthour constant, as required
(4) Number of stators

3.17.3 Permissible Abbreviations

FM = form
V = volts
W = wire
CL = class
kW or KW = kilowatts
Hz = hertz
F.S. = full-scale value
ST = stator
TA = test current
K_h = watthour constant
PK_h = primary watthour constant
CTR = current transformer ratio
VTR = voltage transformer ratio

3.17.4 Location of Nameplate. The nameplate shall be so located as to be readily visible for reading from the front of the thermal watt demand meter.

3.17.5 Material. The nameplate shall be made of durable material that will not discolor when exposed to sunlight.

3.17.6 Space for Company Number. A space not less than 2-1/2 inches or more than 2-3/4 inches long shall be provided for holding a 1/2-inch wide badge or for marking of the company number. A 3/32-inch hole in the same space or above that space shall also be provided for attaching a company badge.

3.18 Typical Form Designations. The form designations for thermal watt demand meters and watthour-thermal watt demand meters are listed in Table 3.

Table 3
Typical Form Designations

Form Designation	Stators	Current Circuits	External Circuit Wires	See Fig.
1S	One	One	Two	3
2S	One	One	Three	3
3S	One	One	Two	5
4S	One	Two	Three	5
5S	Two	Two	Three (or four)	5
6S	Two	Three	Four wye	5
8S	Two	Three	Four delta	5
9S	Three	Three	Four wye	5
12S	Two	Two	Three	3
13S	Two	Two	Three (or four)	3
14S	Two	Three	Four wye	3
15S	Two	Three	Four delta	3
1A	One	One	Two	4
2A	One	Two	Three	4
3A	One	One	Two	6
4A	One	Two	Three	6
5A	Two	Two	Three (or four)	6
6A	Two	Three	Four wye	6
8A	Two	Three	Four delta	6
9A	Three	Three	Four wye	6
12A	Two	Two	Three	4
13A	Two	Two	Three	4
14A	Two	Three	Four wye	4
15A	Two	Three	Four delta	4
16A	Three	Three	Four wye	4

4. Classes and Test Requirements for General-Purpose and Corrosion-Resistant Finishes for Thermal Demand Meters

4.1 Classes of Finish

4.1.1 Class I: General-Purpose Finish. A general-purpose finish shall be standard for indoor and outdoor installations.

4.1.2 Class II: Corrosion-Resistant Finish. A corrosion-resistant finish shall meet finish requirements in excess of Class I, such as exceptional corrosion hazards, etc.

4.2 Tests for Class I (General-Purpose Finish). Apparatus with a Class I finish shall withstand the following tests. Each sample shall consist of the complete apparatus. New samples shall be used for each test.

4.2.1 Weatherometer Test. The sample meter shall be mounted in the normal operating position in the weatherometer.[2] Bottom-connected meters shall be tested without housing accessories. Detachable meters shall be tested with a standard socket and sealing ring and with the conduit holes sealed against moisture.

The meters then shall be exposed for 14 days to the following weatherometer conditions:

[2] Atlas Electric Devices Company, Chicago, Illinois, BWM-C weatherometer, or the equivalent.

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(1) Direct ultraviolet radiation throughout approximately 93% of the weatherometer cycle.

(2) Fresh-water spray applied to the front and top of the meter throughout approximately 7% of the weatherometer cycle, the time for the complete cycle being 18 minutes.

After this test, covers, terminal covers, etc, shall be readily removable, and there shall be no progressive corrosion or electrolytic action that will adversely affect the functioning of any part of the apparatus. Also, there shall be no evidence of deleterious discoloration or fading of finishes or materials.

4.2.2 Salt-Spray Test. The sample meter shall be mounted in its normal operating position in a salt-spray chamber and subjected to a 25-hour salt-spray test in accordance with the current edition of American National Standard Method of Salt Spray (Fog) Testing, ANSI/ASTM B117-73 [Z118.1-1974]. Bottom-connected meters shall be tested without housing accessories. Detachable meters shall be tested with a standard socket and sealing ring and with the conduit holes sealed against moisture.

After this test, covers, terminal covers, etc, shall be readily removable, and there shall be no progressive corrosion or electrolytic action that will adversely affect the functioning of any part of the apparatus.

4.3 Tests for Class II (Corrosion-Resistant) Finish. Apparatus with a Class II finish shall withstand the following tests. Samples shall consist of complete apparatus. New samples shall be used for each test.

4.3.1 Weatherometer Test. This test shall be the same as for the Class I finish.

4.3.2 Salt-Spray Test. This test shall be the same as for the Class I finish except that the duration shall be 500 hours.

5. Revisions of American National Standards Referred to in This Document

When the following American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

American National Standard Code for Electricity Metering, ANSI C12-1975

American National Standard for Watthour Meters, ANSI C12.10-1978

American National Standard Requirements for Electrical Analog Indicating Instruments, ANSI C39.1-1972

American National Standard Method of Salt Spray (Fog) Testing, ANSI/ASTM B117-73 [Z118.1-1974]

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Appendixes

(These Appendixes are not a part of American National Standard for Thermal Demand Meters, ANSI C12.5-1978, but are included for information purposes only.)

Appendix A
Definitions

The following definitions, reprinted from American National Standard Code for Electricity Metering, ANSI C12-1975, apply specifically to the subject covered by this publication. For additional related definitions, see ANSI C12-1975.

2.12 Demand. The average value of power or a related quantity over a specified interval of time.

NOTE: Demand is expressed in kilowatts, kilovolt-amperes, kilovars, or other suitable units.

2.14 Demand Deviation. The difference between the indicated or recorded demand and the true demand, expressed as a percentage of the full-scale value of the demand meter or demand register.

2.17 Demand – Maximum. The highest demand measured over a selected period of time, such as 1 month.

2.18 Demand Meter. A metering device that indicates or records the demand, maximum demand, or both.

NOTE: Since demand involves both an electrical factor and a time factor, mechanisms responsive to each of these factors are required, as well as an indicating or recording mechanism. These mechanisms may be either separate from or structurally combined with one another.

2.20 Demand Meter – Indicating. A demand meter equipped with a readout that indicates demand, maximum demand, or both.

2.22 Demand Meter – Lagged. A meter that indicates demand by means of thermal or mechanical devices having an approximately exponential response.

2.23 Demand Meter – Time Characteristic (Lagged-Demand Meter). The nominal time required for 90% of the final indication, with constant load suddenly applied.

NOTE: The time characteristic of lagged-demand meters describes the exponential response of the meter to the applied load. The response of the lagged-demand meter to the load is continuous and independent of selected discrete time intervals.

2.109 Watthour Meter– Class Designation. The maximum of the load range in amperes.

2.111 Watthour Meter – Form Designation. An alphanumeric designation denoting the circuit arrangement for which the meter is applicable and its specific terminal arrangement. The same designation is applicable to equivalent meters of all manufacturers.

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Appendix B
Performance Requirements

The following performance requirements are reprinted from 5.2.10 and 5.1.8.14 of American National Standard Code for Electricity Metering, ANSI C12-1975, and are repeated here for ease of reference. They apply specifically to the subject covered by this publication.

5.2.10.1 Initial Conditions. Where the demand meter is a component part of the watthour meter, the watthour meter shall be subjected to the tests for acceptance of meters in 5.1 of this standard. The limits of permissible variation for an acceptable meter shall be the same as fixed in 5.1 for a corresponding watthour meter independent of the demand meter, except for loss in watts in current and potential circuits.

For the tests described in 5.2.10.3 through 5.2.10.8 the demand meters shall be in good operating condition and shall be adjusted as closely as practicable to correct calibration at zero and at some convenient point upscale, preferably at or above 50%. The tests are normally made at nameplate voltage, unless otherwise specified.

Each test shall be made with the demand indicator at zero at the start, and the load of the prescribed amount shall be applied suddenly.

If the meter is of an indicating type, the tests shall be made with the pusher pointer in contact with the maximum demand pointer when upscale readings are taken, but the pusher pointer shall not be in contact with the maximum demand pointer when on-zero readings of the pusher pointer are taken.

The potential circuits of thermal demand meters shall be energized for at least 3 hours prior to the initial test and then remain continuously energized for the remainder of the tests.

Test numbers 2, 3, 4, and 5 (see 5.2.10.4 through 5.2.10.7) do not apply to mechanically lagged meters.

5.2.10.2 Insulation. The insulation between current-carrying parts of separate circuits and between current-carrying parts and other metallic parts shall be capable of withstanding the application of a sinusoidal voltage of 2.5 kV rms, 60 Hz, for 1 minute.

5.2.10.3 Test No. 1: Load Performance. The demand deviation shall not exceed that specified in Table 25.

5.2.10.4 Test No. 2: Effect of Variation of Power Factor. The demand shall not differ from the reference performance by an amount exceeding that specified in Table 26.

5.2.10.5 Test No. 3: Effect of Variation of Voltage. The demand shall not differ from the reference performance by an amount exceeding that specified in Table 27.

5.2.10.6 Test No. 4: Effect of Variation of Frequency. The demand shall not differ from the reference performance by an amount exceeding that specified in Table 28. This test may be omitted except for applications where it is expected that the frequency may vary by more than ± 2% from the rated frequency.

5.2.10.7 Test No. 5: Equality of Current Circuits. The demand of meters having more than one current circuit, when each current circuit is used separately, shall not differ from the reference performance by an amount exceeding that specified in Table 29.

5.2.10.8 Test No. 6: Effect of Variation of Ambient Temperature. Three demand meters shall be placed in a space having a temperature of 23°C ± 5°C, and allowed to stand for not less than 3 hours with the voltage circuits of the meters energized at nameplate voltage. The test load shall then be applied for four rated intervals and the indicated demands shall be recorded. This operation shall be repeated at the various values of temperature and power factor given in Table 30. Conditions (2) and (4) do not apply to mechanically lagged demand registers.

5.1.8.14 Test No. 12: Temperature Rise.[9] The test shall be made at nameplate voltage, rated frequency, with the specified current applied to all current circuits in series adding, and at an ambient temperature of 23°C ± 5°C. This test shall be applied to one meter of each class.

The temperature rise of any of the current-carrying parts of the watthour meter, tested under the specified conditions, shall not exceed 55°C, except that a higher temperature rise is permissible when suitable insulating materials are used in conformance with the general principles of temperature rating as specified by IEEE Std 1-1969, General Principles for Temperature Limits in the Rating of Electric Equipment. [10]

All tests shall be performed with the meter cover in place and in a room essentially free from drafts. The meter shall be mounted in a conventional manner on a suitably rated meter mounting. Not less than 4 feet (8-foot jumper between terminals) of stranded, insu-

[9] This test may be omitted where certified data are furnished by the manufacturer.

[10] Available from the Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, N.Y. 10017.

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Table 25
Load Performance, Lagged-Demand Meters

Condition	Test Point in Approximate Percent of Full Scale	Permissible Demand Deviation in Percent at End of Four Rated Intervals
Condition (1)	50	± 3.0
Condition (2)	90	± 3.0

NOTE: The time required to reach 90% of final indication is the actual time characteristic of the demand meter and shall not be less than 98% of the rated time characteristic.

Table 26
Effect of Variation of Power Factor, Lagged-Demand Meters

Condition	Test Point in Approximate Percent of Full Scale	Power Factor	Permissible Deviation from Reference Demand in Percent at End of Four Rated Intervals
Reference performance for condition (1)	50	1.0	–
Reference performance for condition (2)	75	1.0	–
Condition (1)	50	0.5 lag	± 3.0
Condition (2)	75	0.75 lag	± 3.0

Table 27
Effect of Variation of Voltage, Lagged-Demand Meters

Condition	Test Point in Approximate Percent of Full Scale	Percent of Nameplate Voltage	Permissible Deviation from Reference Demand in Percent at End of Four Rated Intervals
Reference performance for conditions (1) and (3)	50	100	–
Reference performance for conditions (2) and (4)	90	100	–
Condition (1)	50	90	± 1.5
Condition (2)	90	90	± 1.5
Condition (3)	50	110	± 1.5
Condition (4)	90	110	± 1.5

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Table 28
Effect of Variation of Frequency, Lagged-Demand Meters

Condition	Test Point in Approximate Percent of Full Scale	Percent Rated Frequency	Permissible Deviation from Reference Demand in Percent at End of Four Rated Intervals
Reference performance for conditions (1) and (3)	50	100	–
Reference performance for conditions (2) and (4)	90	100	–
Condition (1)	50	95	± 1.5
Condition (2)	90	95	± 1.5
Condition (3)	50	105	± 1.5
Condition (4)	90	105	± 1.5

Table 29
Equality of Current Circuits, Lagged-Demand Meters

Condition	Test Point in Approximate Percent of Full Scale	Connection of Current Circuits	Permissible Deviation from Reference Demand in Percent at End of Four Rated Intervals
Reference performance	100/*N**	All circuits in series	–
Condition (1)	100/*N**	First circuit only	± 2.0
Condition (2)	100/*N**	Second circuit only	± 2.0
Conditions (3), (4), etc	100/*N**	Third, fourth, etc., circuit only	± 2.0

**N* represents the total number of current circuits in the meter.

Table 30
Effect of Variation of Ambient Temperature, Lagged-Demand Meters

Condition	Test Point in Approximate Percent of Full Scale	Power Factor	Ambient Temperature	Permissible Deviation* from Reference Demand in Percent at End of Four Rated Intervals
Reference performance for conditions (1) and (3)	50	1.0	23°C ± 5°C	–
Reference performance for conditions (2) and (4)	50	0.5 lag	23°C ± 5°C	–
Condition (1)	50	1.0	50°C ± 5°C	± 2.0
Condition (2)	50	0.5 lag	50°C ± 5°C	± 2.5
Condition (3)	50	1.0	–20°C ± 5°C	± 3.5
Condition (4)	50	0.5 lag	–20°C ± 5°C	± 4.5

*When the actual temperature difference between two tests differs from the nominal temperature difference specified for the two tests, the change in deviation shall be adjusted proportionately.

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Table 15
Temperature-Rise Test Specifications

Meter Class	Wire Size (AWG)	Test Amperes	Detachable Meters	
			Socket Rating Amperes	Simulated Meter
10	No. 10	10	20 (min)	None
20	No. 10	20	20 (min)	None
100	No. 2	100	100	Fig. 1
200	No. 4/0	200	200	Fig. 2

lated copper conductor shall be connected to the line and load current terminals of the meter or socket. For detachable (Type S) meters the opening where the conductors enter and leave the socket and any other openings shall be closed with suitable material to prevent drafts. The conductor size, test current, and, where applicable, the socket rating and simulated meter are specified in Table 15.

5.1.8.14.1 Test on Class 10 and Class 20 Meters. The temperature-rise test shall be made by determining the increase in resistance of the current circuits.

Before the meter is energized, the resistances of the meter current circuits and the ambient (room) temperature shall be determined. The resistance measurements shall be made by a means capable of determining the change in resistance to an accuracy of ± 0.5% or better.

The meter shall be energized at the specified conditions for a minimum period of 2 hours. At the end of the prescribed period, the meter shall be deenergized, noting the time that this action was taken. Resistance readings shall be taken on each current circuit and recorded along with the time at which each measurement was taken. The resistance and time readings shall be repeated until three sets of data have been obtained for each current circuit. These readings shall be taken as quickly as practicable, but in no case should the overall time between deenergization and the last resistance reading exceed 5 minutes. The temperature rise of the current circuit corresponding to each resistance reading should be calculated by the following formulas:

$$\left(T = 258 \quad \frac{R}{r} - 1\right) \text{ (for copper windings)}$$

$$\left(T = 251 \quad \frac{R}{r} - 1\right) \text{ (for aluminum windings)}$$

where

T = temperature rise in degrees Celsius
R = hot resistance
r = cold resistance

To determine the temperature rise at the time of deenergization, the temperature rise corresponding to the resistance values for each current circuit shall be plotted against time, and the graph extrapolated to the time of deenergization.

5.1.8.14.2 Test on Class 100 and Class 200 Meters. The temperature-rise test shall be made by means of temperature detectors in intimate contact with the metal of the current circuit and located at the approximate electrical center of the current coils.

In the case of meters provided with terminal compartments (Type A), the test shall be conducted under the test conditions specified in 5.1.8.14 until the current-circuit temperatures have stabilized. The temperature rise shall be considered the difference in degrees Celsius between the stabilized temperature and ambient (room) temperature.

For detachable meters (Type S), the test installation shall be standardized using a simulated meter as specified in Table 15 (Fig. 1 or 2). The simulated meter shall have the same cover and number of current jumper bars as current circuits in the meter to be tested. A temperature-rise test shall be conducted on the simulated meter by applying the test current to all jumper bars in series until the temperature as indicated by the temperature detector has stabilized. This temperature shall then be recorded and the simulated meter replaced by the meter to be tested. The temperature-rise test shall be conducted on the watthour meter under the test conditions specified in 5.1.8.14. When the temperatures of the meter current circuits have stabilized, the temperatures shall be measured and the empirical temperature-rise values of the meter current circuits shall be calculated as follows:

$$\text{Empirical temperature rise} = \theta_m - (\theta_s - 55°C)$$

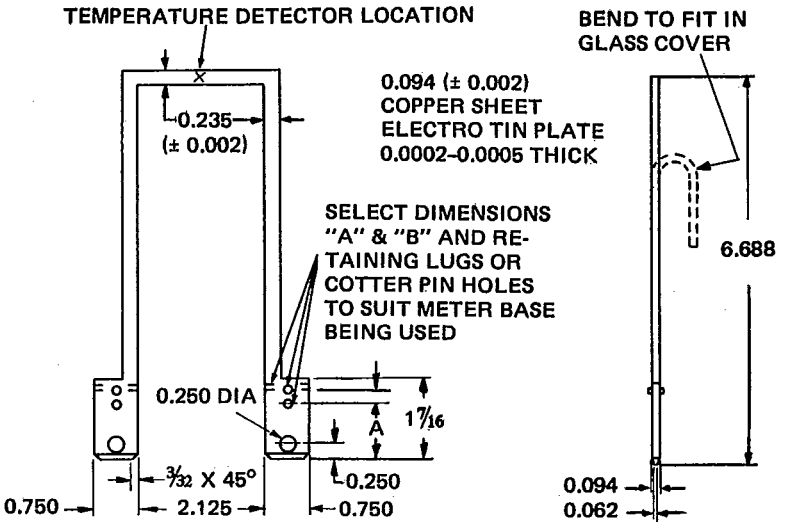
where

θ_m = measured final temperature rise of current circuit of meter under test
θ_s = measured final temperature rise of simulated meter jumper bar for the same current phase

NOTE: The foregoing tests shall not be considered conclusive if θ_s exceeds 65°C.

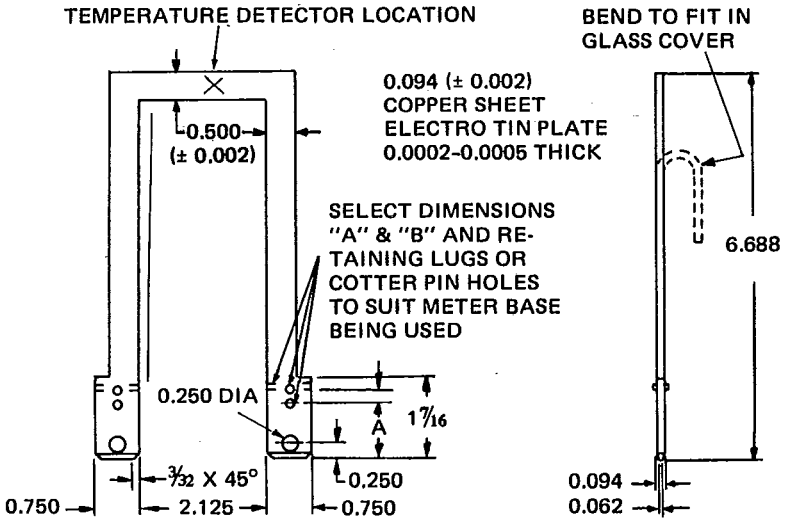
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NOTES:
(1) All dimensions are in inches.
(2) Unless otherwise specified, tolerances are ± 0.005.
(3) The temperature detectors shall be so attached, and shall be of such a type, that their presence will not appreciably affect the temperature rise of the jumper bars.

Fig. 1
Dimensions for Jumper Bars of Simulated Meter Temperature-Rise Test for Single-Phase and Polyphase Meters, 100-Ampere Maximum Rating



NOTES:
(1) All dimensions are in inches.
(2) Unless otherwise specified, tolerances are ± 0.005.
(3) The temperature detectors shall be so attached, and shall be of such a type, that their presence will not appreciably affect the temperature rise of the jumper bars.

Fig. 2
Dimensions for Jumper Bars of Simulated Meter Temperature-Rise Test for Single-Phase and Polyphase Meters, 101-to-200-Ampere Rating

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American National Standards

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