STD.NEMA DC 10-ENGL 1983 ■ 6470247 0524953 869 ■

STANDARDS PUBLICATION / NO. DC 10

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Residential Controls—Temperature Limit Controls for Electric Baseboard Heaters

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ● 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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NEMA Standards Publication DC 10-1983 (R1989, R1999)

Residential Controls—Surface-Type Controls for Electric Storage Water Heaters

Published by:

National Electrical Manufacturers Association
1300 North 17th Street
Rosslyn, VA 22209

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Foreword

This Standards Publication defines the basic standards for construction and performance of temperature limit controls for application on electric baseboard heaters. It has been developed in the public interest and is designed to promote a better understanding between the manufacturer and the user, to assist the user in selecting the proper control for his application and, where possible, to provide for direct interchangeability through industry standardization.

This publication was referred to the Electric Environmental Equipment Section of NEMA for review prior to publication.

These standards are periodically reviewed by the Residential Controls Section of NEMA for any revisions necessary to keep them up to date with advancing technology. Proposed or recommended revisions should be submitted to:

Manager, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

Scope

This Standards Publication describes constructional details, classifications, ratings, and other characteristics of temperature limit controls and control systems of the linear-sensing or spot types, which are suitable for mounting inside electric baseboard heaters for the purpose of disconnecting the electrical load when the heater reaches abnormally high temperatures.

The controls and control systems described in this Standards Publication are nonadjustable, operate at factory preset temperatures, and may be of the automatic- or manual-reset type.

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History of Standards

The Residential Controls Section of NEMA was formed in 1940 to promote the standardization of products within the scope of the Section. These product standards cover definitions, ratings, performance, testing, and dimensions. NEMA Standards are voluntary and are designed to eliminate misunderstandings between the purchaser and the manufacturer.

This publication is one of a series sponsored by the Residential Controls Section. Other publications in this series are identified as Pub. No. DC____ (followed by the year of issue).

The General Engineering Committee of the Residential Controls Section of NEMA first formed a subcommittee to develop temperature limit control standards for electric baseboard heaters in 1960. The deliberations of this committee resulted in the NEMA Standards Publication for *Temperature Limit Controls for Electric Baseboard Heaters*, DC 10-1964, which was later revised and superseded first by DC 10-1971, by DC 10-1977, and then by DC 10-1983.

The present publication, DC 10-1983 (R 1989), is published in accordance with NEMA's policy of periodic review and revision to keep NEMA Standards contemporary with industry needs and technological advancement. It reaffirms and revises the 1983 edition.

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Section 1
DEFINITIONS

1.1 AUTOMATIC-RESET CONTROL

A control which opens and recloses the circuit automatically.

NEMA Standard 1-21-1964.

1.2 CUT-IN TEMPERATURE

The temperature in degrees F at which the circuit to the electrical load is restored automatically or can be restored by manual resetting action.

NEMA Standard 5-15-1989.

1.3 CUT-OUT TEMPERATURE

The factory preset temperature in degrees F at which the control opens the circuit to the electrical load.

NEMA Standard 5-17-1971.

1.4 CUT-OUT TEMPERATURE DRIFT

The change in degrees F in the cut-out temperature as a result of continuous cycling of the temperature limit control.

NEMA Standard 5-17-1971.

1.5 DIFFERENTIAL

The difference between the cut-out and the cut-in temperatures.

NEMA Standard 1-21-1964.

1.6 HOT SPOT

The portion of the sensing element which causes the control to cut-out when it is subjected to the abnormally high temperature which it is intended to limit. It is stated in terms of a specific length. (See Table 4-1.)

NEMA Standard 5-17-1971.

1.7 LOAD, ELECTRICAL

The resistive noninductive controlled load expressed in volts and amperes or watts; or the inductive controlled load expressed in volts and amperes.

NEMA Standard 5-17-1971.

1.8 MANUAL-RESET CONTROL

A control which opens the circuit automatically and is reclosed manually.

NEMA Standard 5-17-1971.

1.9 PILOT DUTY

A class of operation in which the ultimate electrical load is controlled by auxiliary means.

NEMA Standard 5-17-1971.

1.10 RATING, ELECTRICAL

The maximum specified electrical load capability of the control.

NEMA Standard 11-3-1983.

1.11 SENSING ELEMENT

A continuous temperature-sensing element of the control, generally mounted horizontally inside the baseboard heater in a protected location and in a manner which enables it to sense abnormally high temperatures.

NEMA Standard 1-21-1964.

1.12 TEMPERATURE LIMIT CONTROLS

1.12.1 Linear-Sensing Type

A control body and a sensing element no less than 14 inches long, capable of sensing and reacting to temperature changes along its length.

NEMA Standard 11-3-1983.

1.12.2 Spot-Sensing Type

A control body with an integral sensing element capable of sensing and reacting to temperature changes at a particular location.

NEMA Standard 11-3-1983.

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Section 2
RATINGS AND CLASSIFICATIONS

2.1 VOLTAGE RATINGS

Temperature limit controls shall have voltage ratings within the range of 120 to 480 volts, ac, inclusive.

NEMA Standard 11-3-1983.

2.2 CURRENT RATINGS

Temperature limit controls shall have at least one of the following current ratings:

Volts	
120	
208	
240	25 amperes or less
277	
480	

NEMA Standard 11-3-1983.

NOTE: These controls may also carry a pilot duty rating of 125 voltamperes at 120, 240, or 277 volts or a pilot duty rating of 250 voltamperes at 480 volts, or both.

Authorized Engineering Information 11-3-1983.

2.3 FUNCTIONAL CLASSIFICATIONS

2.3.1 Linear-Sensing Type

A control that incorporates a linear sensing element which opens the control switch as a function of a hot spot at any point along the entire length of the sensing element. The sensing element is not connected into the electrical circuit.

2.3.2 Spot-Sensing Type

A control having an integral sensing element which opens the control switch as a function of a hot spot at the control location.

NEMA Standard 11-3-1983.

The sensing element may or may not be connected directly into the electrical circuit.

Authorized Engineering Information 11-3-1983.

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Section 3
CONSTRUCTION

3.1 ENVELOPE DIMENSIONS

3.1.1 Linear-Sensing Type

The sensing element is generally a sensing tube (capillary) containing a temperature-sensing fluid.

Generally, the outside diameter of the tube-type sensing element does not exceed 1/8 inch, and its length is no less than 14 inches and no more than 12 feet.

The control body is generally of such a size as to be suitable for mounting in a space of 2 1/4 inches deep behind the mounting face.

3.1.2 Spot-Sensing Type

These controls are generally tubular or round and are supplied with or without mounting means by the manufacturer. The envelope dimensions depend on the type of configuration but should be within 2 3/4 inch x 1 inch x 5/8 inch.

Authorized Engineering Information 5-17-1971.

3.2 MOUNTING

Temperature limit controls shall be suitable for mounting inside a baseboard heater.

NEMA Standard 5-17-1971.

3.2.1 Linear-Sensing Type

Provision should be made for mounting the control with two No. 6 or No. 8 screws or equivalent means. The distance between the centerline of mounting holes should be 1 5/8 or 2 inches.

3.2.2 Spot-Sensing Type

If mounting means are not provided by the control manufacturer, the user shuld securely mount the control(s) along the length of the baseboard heater.

Authorized Engineering Information 11-3-1983.

3.3 CONNECTIONS

3.3.1 Terminals

If terminals are provided, they shall be of a type which meets the requirements of Underwriters Laboratories, Inc.'s Safety Standard for *Electrical Temperature-Indicating and -Regulating Equipment,** UL 873.

3.3.2 Wiring

If external wire leads are provided as a part of the control, the size of wire shall be in accordance with UL 873.

NEMA Standard 11-3-1983.

*Copies are available from the Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

3.4 OPERATING MECHANISM

1. The limit control shall withstand without damage or loss of calibration the effects of overriding temperature on the sensing element to the degree which may be anticipated for the expected service and as specified by the manufacturer.
2. A limit control, which is actuated by a change in the pressure of fluid confined in a self-contained bulb or capillary tube, shall be designed so that the control contacts assume the open position if the sensing element ruptures.
3. The manual-reset control shall operate on temperature rise to limit a temperature and to keep the circuit open until an operator mechanically resets the contacts. The reset mechanism shall be trip-free; that is, the construction shall be such that the contacts cannot be held in the closed position above the cut-out temperature regardless of the position of the resetting means.

NEMA Standard 11-3-1983.

The reset mechanism may permit the control to automatically cycle and limit the temperature even with the reset button depressed.

Authorized Engineering Information 11-3-1983.

3.5 ENCLOSURE

An enclosure of insulating materials shall be of such thickness and so formed that it will protect operating parts against mechanical injury.

Metallic parts, forming part of the control enclosure, shall be of adequate strength and shall comply with the requirements of UL 873.

NEMA Standard 11-11-1976.

3.6 CORROSION PROTECTION

Iron and steel parts (except in the case of bimetals, bearings, and so forth, where such protection is impracticable) shall be suitably protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

NEMA Standard 5-17-1971.

3.7 ADJUSTMENTS

Temperature limit controls shall be factory calibrated with a preset nonadjustable cut-out temperature. The means for calibration, if accessible or apparent, shall be modified, guarded, or sealed to effectively prevent manipulation by hand or ordinary tools subsequent to the factory calibration.

NEMA Standard 5-17-1971.

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Section 4
PERFORMANCE

4.1 CUT-OUT SETTINGS

Temperature limit controls shall be factory calibrated with a preset nonadjustable cut-out temperature. The rated cut-out setting shall be subject to a maximum tolerance of plus or minus 15°F when determined in accordance with 4.3.

Linear-sensing-type temperature limit controls shall be capable of responding to hot spots at any location along the sensing element (in accordance with Table 4-1) when applied to electric baseboard heaters.

NEMA Standard 5-15-1989.

TABLE 4-1

Sensing Element Length, inches	Hot Spot Length in Inches for Cut-out Temperatures of: Less than200°F	200°F thru 300°F	Above 300°F
Less than 73	14	18	20
73 to 108	15	22	26
Greater than 108	16	27	30

4.2 CUT-IN SETTINGS

Temperature limit controls shall have a cut-in temperature of not less than 75°F. Comformance shall be determined in accordance with 4.3.

NEMA Standard 5-17-1971.

4.3 DETERMINATON OF CUT-OUT AND CUT-IN TEMPERATURES

The temperature of the control being tested shall be raised until the control cuts out, and then lowered until it cuts in. The test shall then be repeated to determine conformance with 4.1 and 4.2.

NEMA Standard 11-3-1983.

4.3.1 Linear-Sensing-Type Controls

1. *Test Equipment and Procedures* – The test equipment shall be so constructed as to permit the specified hot spot length (see Table 4-1) to be subjected to higher temperatures while the remainder of the sensing element is held at a temperature of 75°F plus or minus 10°F, corresponding to normal variations in room ambient termperature. During this test, the hot-spot length shall be immersed in a well-agitated liquid bath. Furthermore, the bath shall be checked for uniformity of temperatures in the cross-sectional area where the hot-spot length is to be tested. All portions of the sensing element shall be kept in a nearly horizontal plane.

NEMA Standard 5-15-1989.

The temperature of the sensing element section corresponding to the hot-spot length shall be raised and lowered at a rate not exceeding 1°F per minute to obtain the cut-out and cut-in switching events.

The test shall then be repeated, except that the entire length of the sensing element shall be immersed in the well-agitated liquid bath.

Cut-out and cut-in temperatures established by both tests shall conform with the requirements of 4.1 and 4.2.

For devices which are sensitive to barometric pressure, all test data shall be corrected to an atomospheric pressure corresponding to a reading of 29.0 inches on a mercury barometer. Such correction shall be made in accordance with information furnished by the manufactruer of the temperature limit control.

2. *Test Results* – The hot-spot temperature at which the normally closed contacts open shall be deemed the cut-out temperature of the control.

The hot-spot temperature at which the contacts reclose shall be deemed the cut-in (reset) temperature of the control.

NEMA Standard 5-15-1989.

4.3.2 Spot-Sensing-Type Controls

The calibration of the temperature-responsive control(s) shall be determined in an air oven. The air oven shall be equipped with a fan to provide good air circulation. Futhermore, the oven shall be checked for uniformity of temperatures in the cross-sectional area where the control(s) is to be tested. The heaters inside the test oven shall be so baffled that radiant heat will not be allowed to come in contact with the temperature sensing element.

The air oven temperature shall be raised and lowered at a rate not exceeding 1°F per minute to obtain the cut-out and cut-in temperature values. The control shall be allowed to saturate at an ambient 15°F below the cut-out temperature.

Temperature measurements shall be made by the use of a thermocouple which is attached to the frame holding the temperature sensing element.

NEMA Standard 11-3-1983.

4.4 ENDURANCE

Automatic-reset controls shall be capable of withstanding an endurance test of 100,000 cycles, and manual reset controls shall be capable of withstanding an endurance test of 6000 cycles (1000 cycles at rated

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load and 5000 cycles at no load) at a rate not exceeding 6 cycles per minute, making and breaking the rated current of the control while connected to a circuit of rated voltage and resistance load.

Following the endurance test, the cut-out temperature for either type of control shall not rise above the initial cut-out temperature, as determined by 4.3, by more than 2 percent of the rated Fahrenheit cut-out temperature.

NEMA Standard 11-11-1976.

Section 5
MARKING

5.1 MARKING

Markings shall be of a permanent nature. If paper labels, stampings, or decalcomanias are used, they shall be located where they will not be exposed to mechanical damage. The following information shall appear on each control:

1. The manufacturer's or vendor's name or trademark.
2. A distinctive catalog number or the equivalent.
3. If space permits, the electrical rating. (Ratings may also be shown in watts.)
4. The set point (cut-out setting).

NEMA Standard 11-11-1976.

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Section 6
APPLICATION

6.1 INSTALLATION

In installing a temperature limit control in a baseboard heater, the sensing element should be supported in an essentially horizontal plane.

Authorized Engineering Information 5-17-1971.

6.2 WIRING

6.2.1 Spot-Sensing Type

Controls shall be so interconnected and applied to baseboard heaters that the unit will operate to cut off the heating element when the cut-out temperature is reached at any sensing element.

NEMA Standard 5-17-1971.

6.2.2 Linear-Sensing Type

The control shall be so connected and applied to baseboard heaters that the unit will operate to cut off the heating element when the cut-out temperature is reached.

NEMA Standard 5-17-1971.

6.3 INSTRUCTIONS

Manufacturers of temperature limit controls should furnish suitable instructions for the proper mounting and application of these controls to baseboard heaters.

Authorized Engineering Information 5-17-1971.

6.4 SPOT-TYPE CONTROL SYSTEMS

Spot-type temperature limit control systems consist of one or more controls connected in series.

NEMA Standard 5-17-1971.

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status, are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below.

Purpose of Standards

National Electrical Manufacturers Association standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist purchasers in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard. *(Standardization Policies and Procedures, p. 1)*

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.
(Standardization Policies and Procedures, p. 2)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.
(Standardization Policies and Procedures, p.8)

Categories of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 7 & 16)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.
(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment, and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.
(Standardization Policies and Procedures, pp. 7 & 16)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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RESIDENTIAL CONTROLS SECTION
OF THE
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

APCOM, Inc.
Franklin, TN 37064

Eaton Corporation
Controls Division
Carol Stream, IL 60187

Emerson Electric Company
White-Rodgers Division
St. Louis, MO 63123

General Electric Company
Morrison, IL 61270

GTE Products Corporation
Control Device Operation
Standish, ME 04084

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