# NEMA Standards Publication No. DC 20-1992 (R1998)

*Residential Controls--Class 2 Transformers*

*Published by:*

**National Electrical Manufacturers Association**
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# Foreword

This Standards Publication represents suggested standards for the construction and performance of Class 2 transformers designed primarily for use with residential controls. It has been developed in the public interest and is designed to promote a better understanding between the manufacturer and the user and to assist the user in selecting and obtaining the proper transformer for a particular application.

If a value for measurement as given in this Standards Publication is followed by an equivalent value in other units, the first stated value is to be regarded as the requirement. The given equivalent value may be only approximate.

This standard is periodically reviewed by the Residential Controls Section of NEMA for any revisions necessary to keep it up-to-date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W., Suite 300
Washington, DC 20037



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## Scope

This Standards Publication covers Class 2 transformers intended primarily for use in 30 volts rms maximum low-voltage residential control circuits. It includes definitions, electrical ratings, performance standards, mounting dimensions, and marking requirements.



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## History of Standards

In March 1958, the Residential Controls Section of NEMA adopted a standard regulation curve for Class 2 transformers. This standard was issued under the title "Voltage Ratings and Load Characteristics for Primary Control Equipment of 30 Volts and Less," and was a part of Publication No. DC 1, *General Standards for All Automatic Temperature Controls.*

At that time the transformer in general use by the industry was one having a 40-volt-ampere rating. It was, therefore, around this rating that the standard was developed. Subsequently, transformers having other ratings were introduced. These transformers, although they might have had the same electrical ratings, in many cases varied quite radically in performance. This presented problems from an interchangeability standpoint. Recognizing these problems, the Residential Controls Section in 1964 activated a program to write standards for all transformer sizes.

Publication No. ST 2-1973 was the result of the development and revision of several drafts developed by the Residential Controls Section of NEMA and approved by the Dry-Type and Specialty Transformer Section whose scope at that time included the products covered in this Standards Publication. It was reaffirmed and editorially revised in 1979. DC 20-1986 revises and supersedes ST 2-1973 (R 1979).

This current revision of the standard has deleted all requirements which are contained in ANSI/UL 1585, and references that document as appropriate. Other superfluous information has been deleted.



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# RESIDENTIAL CONTROLS-CLASS 2 TRANSFORMERS

## Section 1
## REFERENCED STANDARDS AND DEFINITIONS

### 1.1 REFERENCED STANDARDS

The following publications are adopted, in whole or in part as indicated, by reference in this Standards Publication and are available from the organizations and addresses shown below.

**National Fire Protection Association**
Batterymarch Park
Quincy, Massachusetts 02269

**American National Standards Institute**
11 West 42nd Avenue
New York, NY 10036

ANSI/NFPA 70-1990 — *National Electrical Code*

**Underwriters Laboratories, Inc.**
333 Pfingsten Road
Northbrook, IL 60062

**American National Standards Institute**
11 West 42nd Avenue
New York, NY 10036

ANSI/UL 514 A-1984 — *Metallic Outlet Boxes*
ANSI/UL 514 B-1983 — *Fittings for Conduit Outlet Boxes*
ANSI/UL 514 C-1982 — *Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers*
ANSI/UL 1585-1985 — *Safety Standard for Class 2 and 3 Transformers*

### 1.2 DEFINITIONS

#### 1.2.1 Class 2 Transformer

A Class 2 transformer is a step-down transformer of the low-secondary-voltage type, suitable for use in Class 2 remote-control low-energy circuits in accordance with ANSI/NFPA 70. It shall be of the energy-limiting type or of the non-energy-limiting type equipped with over-current protection.

NEMA Standard 11-20-1986

#### 1.2.2 Energy-Limiting Transformer

An energy-limiting transformer is a transformer that is intended for use on an approximately constant-voltage supply circuit and that has sufficient inherent impedance to limit the output current to a thermally safe maximum value.

NEMA Standard 11-20-1986

#### 1.2.3 Non-Energy-Limiting Transformer

A non-energy-limiting transformer is a constant-potential transformer which does not have sufficient inherent impedance to limit the output current to a thermally safe maximum value.

NEMA Standard 11-20-1986

#### 1.2.4 Primary Winding

The primary winding is on the input side.

NEMA Standard 7-17-1973

#### 1.2.5 Secondary Winding

The secondary winding is on the output side.

NEMA Standard 7-17-1973

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### 1.2.6 Rating of Transformer

The rating of a transformer consists of a voltampere output, together with any other characteristics, such as voltage or current, other characteristics such as frequency and power factor may be included.

NEMA Standard 7-17-1973

### 1.2.7 Voltampere Rating of a Transformer

The voltampere rating of a transformer is the output which can be delivered continuously at rated secondary voltage and rated frequency without exceeding the specified temperature rise limitations.

NEMA Standard 11-20-1986

### 1.2.8 Load

The load of a transformer is expressed in voltamperes and is the product of the secondary voltage and the secondary current, expressed as voltamperes.

NEMA Standard 7-17-1973

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# Section 2
# RATINGS AND CLASSIFICATION

## 2.1 ELECTRICAL RATINGS

### 2.1.1 Primary Voltage Ratings

Primary voltage ratings shall be as follows:

120 volts at 60 hertz
208 volts at 60 hertz
240 volts at 60 hertz
277 volts at 60 hertz
480 volts at 60 hertz

Transformers with multiple rated primaries shall be tested at each primary voltage rating.

NEMA Standard 3-5-1992

### 2.1.2 Secondary Voltage Ratings

Secondary voltage ratings shall be as follows:

No load: 26.5 ± 0.5 volts
100 percent rated current: 24.0 ± 1.0 volts
200 percent rated current: 21.5 ± 1.5 volts

Secondary voltage ratings shall be applicable to all loads between 0.5 power factor and unity power factor with the primary connected to a source of rated voltage and frequency in accordance with 2.1.1.

NEMA Standard 3-5-1992

## 2.2 CLASSIFICATION

Class 2 transformers shall be one of the following types.

| NEMA Type | Rated Secondary Current (in Amperes) at Nominal 24 Volts |
|---|---|
| A | 0.4 |
| B | 0.8 |
| C | 1.2 |
| D | 1.6 |
| E | 2.0 |

Suggested Standard for Future Design 3-5-1992

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# Section 3
# MOUNTING

## 3.1 GENERAL

Class 2 transformers shall conform to ANSI/UL 1585.

NEMA Standard 11-20-1986

The enclosure of a Class 2 transformer shall be designed for mounting either on a plane surface or on an outlet box.

NEMA Standard 3-5-1992

## 3.2 PLANE-SURFACE MOUNTING

For mounting on a plane surface, the enclosure shall be so designed that it will make contact only at the points of support. An air space of not less than 1/4 inch (6.4 mm) shall be maintained between the enclosure and the supporting surface.

NEMA Standard 3-5-1992

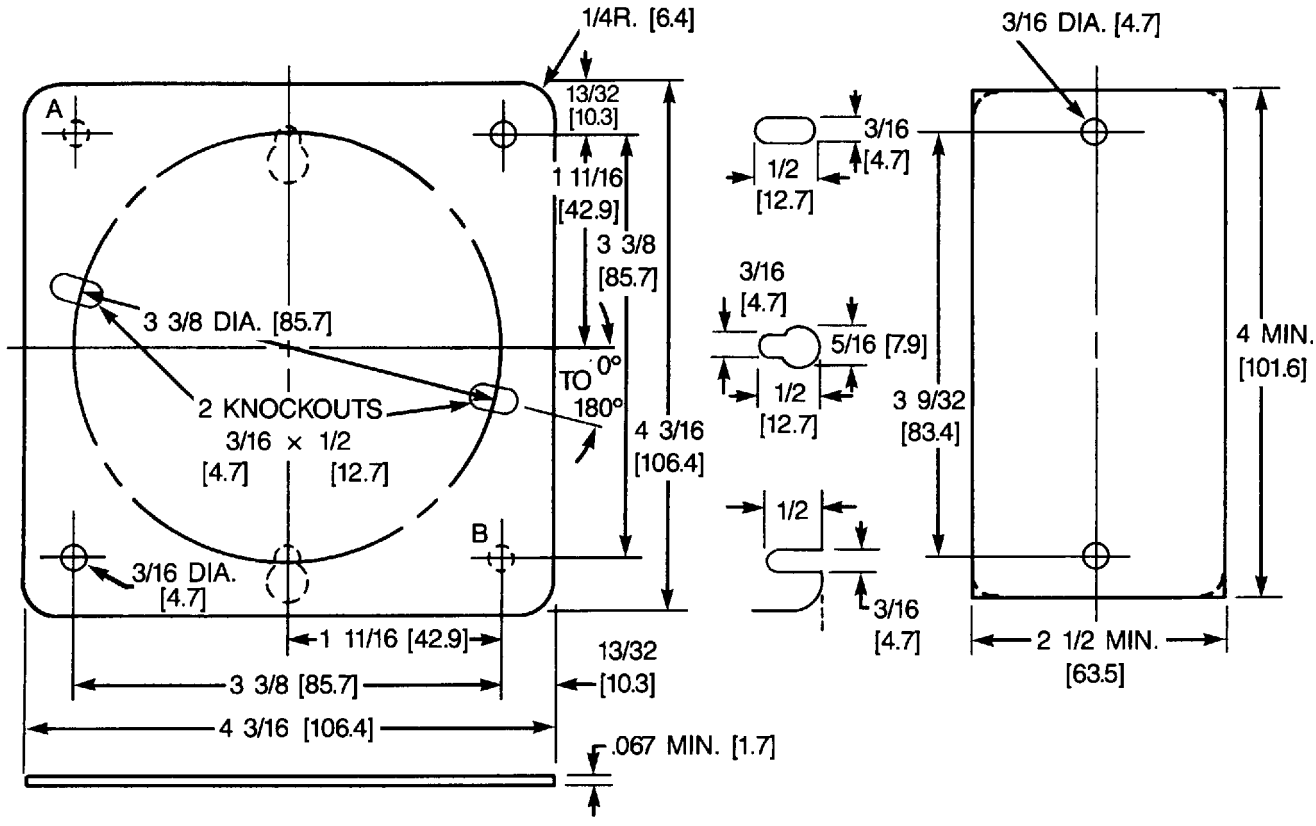
## 3.3 OUTLET-BOX MOUNTING

If a plate is provided for mounting on standard junction boxes, the dimensions and provisions for mounting shall be in accordance with Figure 3-1.

NEMA Standard 3-5-1992

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Note I - Holes A and B shall be optional.

Note II-3/16 inch (4.7) diameter holes shall be permitted to be any of the slotted shapes shown.

Note III-Openings into the box when the transformer is installed shall meet the requirements under "Closure of Openings" in ANSI/UL 514A.

Note IV- See 3.0 and ANSI/UL 1585, Section 8.

**Figure 3-1**
**DIMENSIONS (IN INCHES (MM)) FOR MOUNTING**

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# Section 4
# PERFORMANCE AND TEST

## 4.1 GENERAL

All transformers shall meet the performance requirements for Class 2 transformers as described in ANSI/UL 1585.

NEMA Standard 3-5-1992

## 4.2 REGULATION

Transformers classified according to 2.2 shall meet the appropriate requirements of this standard when tested at no load, 100 percent rated load, and 200 percent rated load at load factors between 0.5 and unity. Load tests shall be performed at an ambient temperature between 68°F (20°C) and 80°F (26.6°C).

NEMA Standard 11-20-1986

### 4.2.1 Test Equipment

The test equipment listed in this subclause should be of good quality instrumentation; the accuracy of the meters being within ±1 percent and periodically verified by the user.

To ensure accuracy of test results, it is important to verify that measuring and recording instruments provide true rms readings.

The test equipment should be connected in accordance with Figure 4-1. All resistance measurements should be measured at the load switch with an accurate resistance bridge.

a. Power Supply
   1. Should be of the nonregulating type.
   2. Should be capable of producing the rms test voltages of 120, 208, 240, 277, or 480 volts.

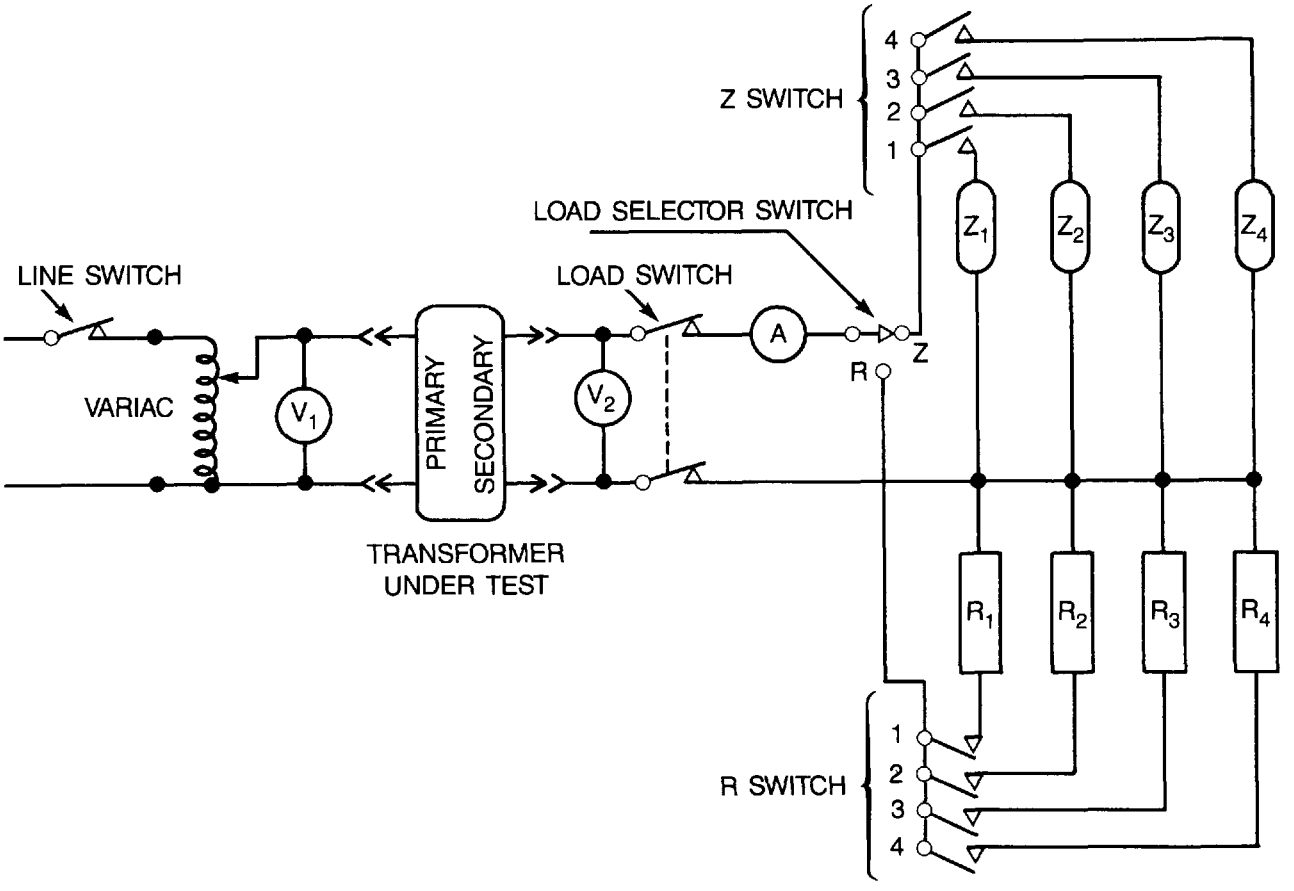



**Figure 4-1**
**TEST CIRCUIT**

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3. Should have a minimum capacity of 500 volt-amperes.

b. Rms Voltmeter (for Primary)
   1. Should be of a proper range to provide accurate readings.

c. Rms Voltmeter (for secondary)
   1. Should be of a proper range to provide accurate readings.

d. Rms Current Meter
   1. Should be of a proper range to provide accurate readings.
   2. There should be a circuit impedance to meter resistance ratio of at least 50:1.

e. Resistance Bridge

f. Switches
   1. Should have a maximum contact resistance of 0.02 ohms at 5 amperes rms.

g. Resistive Loads

There should be four resistive loads, as follows:
1. 60 ohms + 1 percent, 25 watts (R1)
2. 30 ohms + 1 percent, 50 watts (R2)
3. 15 ohms + 1 percent, 75 watts (R3)
4. 7.5 ohms + 1 percent, 100 watts (R4)

The resistors should be arranged so that they can be switched into the circuit, singly or in parallel, to produce the rated current or 200 percent rated current, as follows:
5. 60 ohms for 0.4 ampere (R1)
6. 30 ohms for 0.8 ampere (R2)
7. 60 plus 30 ohms for 1.2 amperes (R1 + R2)
8. 15 ohms for 1.6 amperes (R3)
9. 60 plus 15 ohms for 3.0 amperes (R1 + R3)
10. 30 plus 15 ohms for 2.4 amperes (R2 + R3)
11. 7.5 ohms for 3.2 amperes (R4)
12. 30 plus 7.5 ohms for 4.0 amperes (R2 + R4).

h. Inductive Loads

There should be four inductive loads constructed as follows:
1. Reactor for 60-ohm load (Z1)
   a) Iron: a 7/8-inch square stack of 7/8-inch (22.22 mm) E-1 laminations. Gage 24 (.64 mm). Type M-27.
   b) Coil: Random wound on a 7/8-inch (22.22 mm) square bobbin, with #24 gage (.205 $mm^2$) insulated copper wire. The total turns should be 520.
   c) Gap: An 0.040 ± 0.001-inch (1.016 ± .0254 mm) gap should be maintained between the lamination E's (inserted from one side of the bobbin) and the lamination I's. A piece of 0.040-inch (1.016 mm) hard fiber board may be used for the gap. The reactor should be clamped with aluminum brackets and varnish dipped and baked so that the gap will not change.
   d) Resistor should be 12 watts and 30 ohms adjustable and should be connected in series with the reactor coil. The resistor should be adjusted until the total direct-current resistance of the resistor plus the coil is 25 ohms.
2. Reactor for 30-ohm load (Z2) should be the same as for the 60-ohm load except:
   a) Coil should be 375 turns of #22 gage (.324 $mm^2$) insulated wire.
   b) Resistor should be 25 watts and 15 ohms adjustable. The resistor should be adjusted until the total direct-current resistance of the resistor plus the coil is 12.5 ohms.
3. Reactor for 15-ohm load (Z3) should be the same as for 60-ohm load except:
   a) Coil should be 265 turns of #20 gage (.519 $mm^2$) insulated wire.
   b) The resistor should be 50 watts and 10 ohms adjusted. The resistor should be adjustable until the total direct-current resistance of the resistor plus the coil is 6.25 ohms.
4. Reactor for 7.5-ohm load (Z4) should be the same as for 60-ohm load except.
   a) Coil should be 188 turns of #19 gage (.653 $mm^2$) insulated wire.
   b) The resistor should be 75 watts and 5 ohms adjustable. The resistor should be adjusted until the total direct-current resistance of the resistor plus the coil is 3.10 ohms.

The reactors should be arranged so they can be switched into the circuit, singly or in parallel, to produce the rated current or twice rated current, as follows:
5. 60 ohms for 0.4 ampere (Z1)
6. 30 ohms for 0.8 ampere (Z2)
7. 60 plus 30 ohms for 1.2 amperes (Z1 + Z2)
8. 15 ohms for 1.6 amperes (Z3)
9. 60 plus 15 ohms for 2.0 amperes (Z1 + Z3)
10. 30 plus 15 ohms for 2.4 amperes (Z2 + Z3)
11. 7.5 ohms for 3.2 amperes (Z4)
12. 30 plus 7.5 ohms for 4.0 amperes (Z2 + Z4).

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### 4.2.2 Test Procedure

Transformers should be tested for each primary rating as follows:

a. Place the transformer under test into the test circuit as shown in Figure 4-1.

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b. Open the load switch and close the line switch. Allow the transformer to acclimate for 1 hour with rated voltage supplied to the primary ($V_1$).
c. After 1 hour acclimation, read and record the open-circuit secondary voltage ($V_2$).
d. Close the R switch (or switches) for test point 1 as shown in Table 4-1.
e. Close the load switch, and read and record the secondary voltage ($V_2$) and current (A) for test point 1. Open the load switch.
f. Repeat steps 4.2.2.d and e for test points 2, 3, and 4.

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*CAUTION*—During this test, the load shall not be connected to the transformer for more than 15 seconds total time for all four test points. If the test is not completed within this time, the load switch shall be opened to allow the transformer to acclimate for 30 minutes, as in 4.2.2.b, before proceeding.

NEMA Standard 11-20-1986

### 4.2.3 Curves

Due to transformer or load variations, the data secured in accordance with 4.2.2 may not exactly coincide with the 100 and 200 percent secondary current rating of the transformer (see 2.2). Therefore, this data may be graphed on the regulation curve as shown, for example, in Figure 4-2.

Test points 1 and 2 are representative of unity power factor regulation. Test points 3 and 4 are representative of 50 percent power factor regulation. Both regulation curves should lie between the maximum and minimum of the NEMA Standard Regulation Curve in Figure 4-2.

Authorized Engineering Information 11-20-1986

### 4.2.4 Data Sheet

The data secured in accordance with 4.2.2 should be recorded on a data sheet. The form of this sheet should have, as a minimum, the information shown in Table 4-2.

Authorized Engineering Information 11-20-1986

**Table 4-1**
**TEST POINTS**

| NEMA Type | Unity Power Factor | | 0.5 Power Factor | |
|---|---|---|---|---|
| | Test Point 1 | Test Point 2 | Test Point 3 | Test Point 4 |
| A | R1 | R2 | Z1 | Z2 |
| B | R2 | R3 | Z2 | Z3 |
| C | R1 + R2 | R2 + R3 | Z1 + Z2 | Z2 + Z3 |
| D | R3 | R4 | Z3 | Z4 |
| E | R1 + R3 | R2 + R4 | Z1 + Z3 | Z2 + Z4 |

**Table 4-2**
**EXAMPLE DATA SHEET**

Tested by: J. Doe — Date: Sheet 1 o 1

| Mf. | Part No. | NEMA Type | Amb. Temp. | No Load V2 | Point 1 | | Point 2 | | Point 3 | | Point 4 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | V2 | A | V2 | A | V2 | A | V2 | A |
| XYZ | 123-456 | B | 78 | 26.6 | 24.2 | .78 | 21.2 | 1.57 | 24.7 | .81 | 22.4 | 1.62 |

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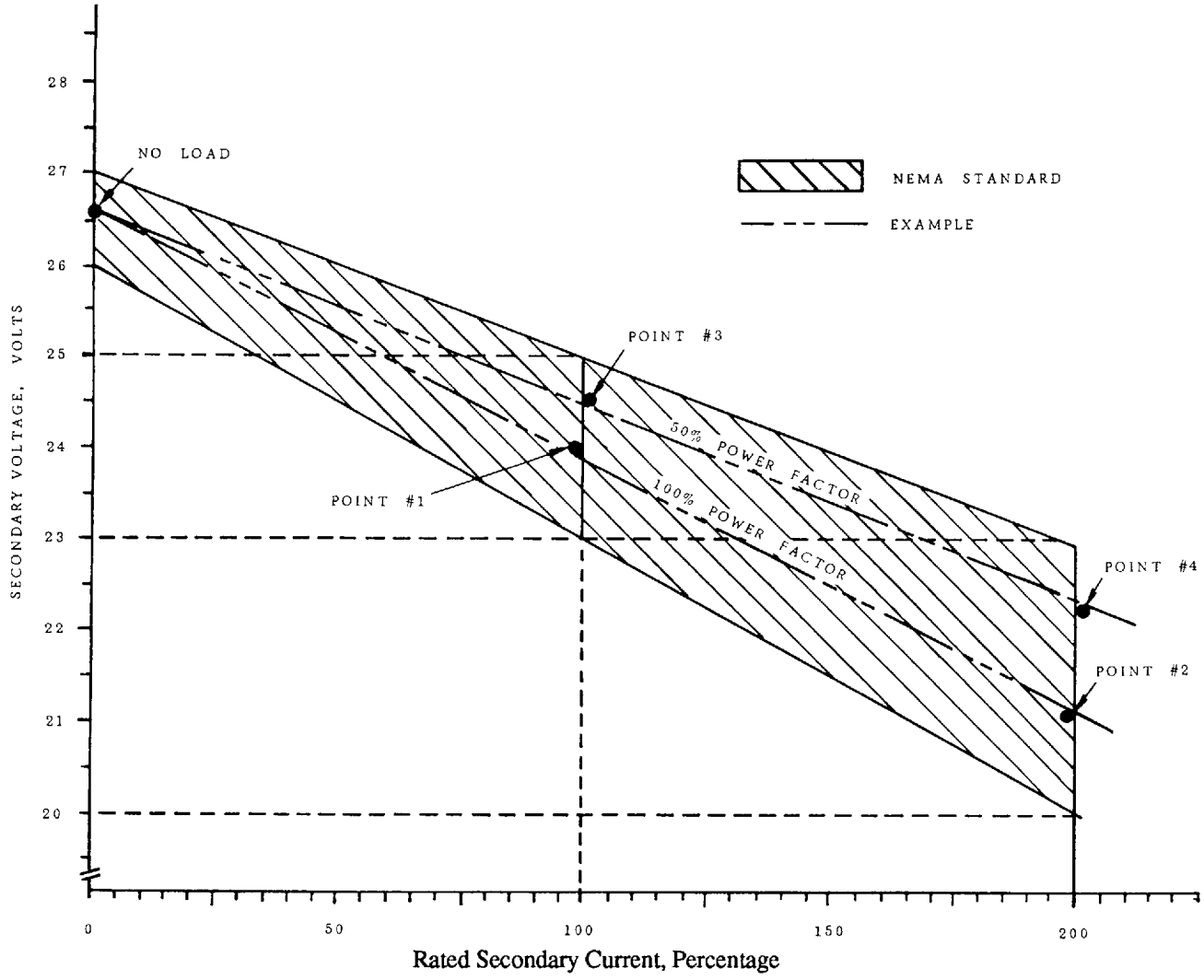



**Figure 4-2**
**EXAMPLE DATA SHEET**

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# Section 5
# MARKING

## 5.1 GENERAL

Class 2 transformers shall be marked in accordance with ANSI/UL 1585, with additional marking as required in 5.2.

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## 5.2 ADDITIONAL MARKING

Class 2 transformers shall be marked with the following information:

a. Primary shall be marked "Line or primary."

b. Secondary shall be marked "Load or secondary."

c. NEMA type, shown as
"NEMA A"
"NEMA B"
"NEMA C"
"NEMA D"
"NEMA E"

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# NEMA STANDARDIZIATION BACKGROUND

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 the purchaser 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.

## 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, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

*(Standardization Policies and Procedures, p. 1)*

## 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. 6)*

## Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.
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.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

*(Standardization Policies and Procedures, pp. 5)*

## 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 received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

*(Standardization Policies and Procedures, pp. 5)*

## Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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Automotive & Appl. Controls Division
Carol Stream, IL 60188

Emerson Electric Company
St. Louis, MO 63123-5329

GE
Appliance Controls
Morrison, IL 61270

GTE Control Devices, Inc.
Standish, ME 04084-0175

Honeywell, Inc.
Golden Valley, MN 55422-3992

Johnson Controls, Inc.
Watertown, WI 53094

Kidde-Fenwal, Inc.
Ashland, MA 01721

Mallory Controls
Indianapolis, IN 46224

Ranco
Plain City, OH 43064-0145

Texas Instruments, Inc.
Attleboro, MA 02703

Therm-O-Disc
Mansfield, OH 44907

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Huntington, IN 46750

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