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# Globar Bulk Ceramic Varistors

# Product Information

Globar bulk ceramic varistors, also called VDR's (voltage-dependent resistors), are non-linear resistors with large negative-voltage coefficients. Generally they are symmetrical in electrical characteristics.

The volt-ampere characteristic of the Globar varistor is expressed approximately as $I = KE^n$, where I = instantaneous current, E= instantaneous voltage, K = constant (amperes @ 1 volt), and n is an exponent with a normal value between 1 and 6. It is dependent on voltage gradient and, to some extent, on composition. It is not constant over the entire voltage range of any part and is, therefore, usually defined between two limiting voltages.

The equivalent circuit of a varistor is a parallel R-C network.

Globar varistors are highly stable, fired-ceramic components consisting of silicon carbide, selected and processed for special electrical properties, and dispersed in a ceramic matrix. Non-ohmic contacts are applied by metal-ceramic bonding techniques, and tinned-copper lead wires are soldered to the metal contacts. A dielectric coating is standard but optional. Special leads and coatings are available to meet special requirements.

Globar varistors are available in standard rod and disc forms in a variety of sizes to fit most applications. Special forms and sizes are tailored for special applications.

Depending on geometry and composition of the part, doubling the voltage across a Globar varistor results in the current increasing to as much as 30 times the steady-state value in rise-times ranging from 0.3 to 2.0 microseconds. This capability, combined with low cost, intrinsic ruggedness, nonpolarity, and high voltage-withstand ratings, makes varistors ideal solid-state devices for transient suppression, and has won them wide favor in this field over traditional approaches such as R-C networks and single or back-to-back diodes.

Popular applications include: voltage regulation and control; protecting components against the inductive "kick" in electromagnetic circuits (including contact arc suppression on relays and switches); protecting semiconductor devices against excessive reverse voltages, e.g., in transistor drive circuits; and protecting passive components such as electrolytic capacitors against voltage transients.

## Electrical Specifications

**Power ratings.** Continuous dc watt ratings are as shown for each part. The continuous ac watt rating is 0.9 times the dc rating.

**Temperature coefficient.** Globar varistors have a nonlinear negative temperature coefficient which is dependent on composition, resistivity, and voltage gradient. At 25°C, the coefficient is in the range −0.1 to −0.6%.

**Dielectric constant and response time.** Dielectric constant ranges from 50 to 300. Rise time (from 10% to 90% of the voltage pulse) ranges from 0.3 to 2.0 microseconds. Dielectric constant and response time are both governed by geometry, resistivity, and voltage gradient.

**Polarization.** Globar varistors display a maximum non-symmetry of 1%.

**Peak voltage rating.** Peak discharge voltage rating of a varistor is dependent on geometry and on maximum permissible temperature rise resulting from pulse-energy dissipation. Temperature rise from pulse operation is given by the equation: °C rise (above ambient) = joules/volume ($in.^3$) x .0328.

## Physical Specifications

**Temperature rating.** Maximum continuous operating temperature is 150°C. Maximum intermittent operating temperature is 175°C. Permissible operating temperatures are governed by characteristics of the organic impregnants or dielectric coatings used, and by the melting point of the solder used to attach leads. Rod-type parts using solderless capped-axial leads are available without coatings or impregnation for use at higher operating temperatures.

**Impregnants and dielectric coatings.** Impregnants are used normally on uncoated parts to minimize humidity effects. When insulation to ground is required, a standard dielectric coating is used. This coating also protects against moisture. Where extra-high ground insulation is required, special coatings are available.

**Effects of humidity.** Globar varistors are slightly sensitive to humidity if unprotected, rod styles less so than discs.

In impregnated or coated discs, maximum resistance change due to humidity effect is 4%, and in unimpregnated, impregnated, or coated rod styles, maximum change is 1% (when tested at 95% R.H. @ 40°C for 240 hours, per MIL-STD-202B, Method 103, Condition A, using standard impregnants or dielectric coatings).

**Effects of shock, vibration, and pressure.** The electrical characteristics of Globar varistors are unaffected by shock, vibration, or pressure. Under severe conditions, special shock mountings may be required to prevent physical damage.

## Dimensions

**Standard rods:**
Diameters — 3/16" and 1/4".
Lengths — 5/8" and 1".
Leads — tinned copper, radial or axial. Optional formed leads available at extra cost.

**Standard discs:**
Diameters — 1/4" through 1 1/4".
Thickness — 1/16" through 1/4".
Leads — tinned copper, radial. Optional formed leads available at extra cost.

**Special discs and washer styles:**
Diameters — to 3 1/2" maximum.
Thickness — to 1/2" maximum.
Leads — special as required. Standard brackets available.

**Special rods:**
Diameters — to 1 1/2" maximum.
Lengths — to 18" maximum.
Leads — special as required. Standard ferrules also available for fuse-clip mounting.

## How to Specify

The standard method of specifying Globar varistors is the voltage/current ratio method:

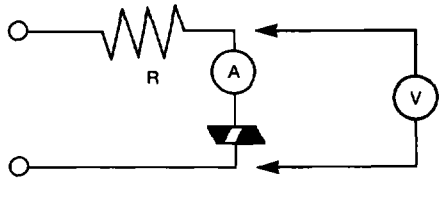
a) Specify a voltage plus a tolerance at a desired constant-current value.
b) Specify a voltage ratio for a given current ratio. (Voltage ratio substitutes for "n" value in formula $I = KE^n$.)
Example: Cesiwid Part 432BNR-102 is specified as follows:
a) 1 milliamp @ 10 volts dc ±10%, and
b) Ratio of $\frac{\text{volts @ 1 mil}}{\text{volts @ 0.1 mil}}$ = 2,3 max.

Standard tolerance on voltage in example (a) is ±10%. Closer tolerances are optional at extra cost, wider tolerances at lower cost.

### How to Calibrate Varistors

Incoming calibration checks cannot be made by ohmmeter or by bridge resistance circuits, since varistors are voltage sensitive. Using the voltammeter method, readings must be taken quickly to reduce possible self-heating effects. The standard steady-state calibrating circuit is:

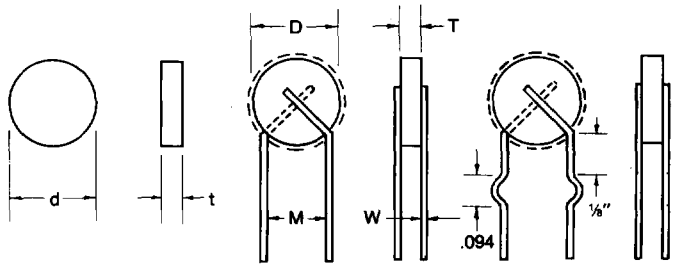
Where R = current-limiting resistor
A = ammeter
V = high-resistance voltmeter
▼▲ = test varistor




Note: Where pulse calibration is required, correlation of methods and equipment is recommended to avoid errors.

**Dimensions Over Coating**

Fig. 1 Fig. 2 Fig. 3




Coating (Dielectric & Moisture Resistant) — Fig. 1 — None. Figures 2 & 3 — PVC or Red Enamel (Glyptal®). Standard Leads are Tinned Copper.

## Disc Varistor

| Part Number | Voltage DC ±10% @ 1 ma | Max. Ratio E @ 1.0 ma / E @ 0.1 ma | Nominal "N" |
|---|---|---|---|
| 551BNR-26 | 9.0 | 2.4 | 3.1 |
| 551BNR-27 | 11.0 | 2.3 | 3.7 |
| 551BNR-28 | 14.0 | 2.2 | 3.7 |
| 551BNR-29 | 18.0 | 2.1 | 3.9 |
| 551BNR-30 | 24.0 | 2.0 | 4.2 |
| 551BNR-31 | 29.0 | 1.9 | 4.5 |
| 551BNR-32 | 40.0 | 1.8 | 4.8 |
| 551BNR-33 | 54.0 | 1.8 | 4.9 |
| 551BNR-34 | 68.0 | 1.8 | 5.0 |
| 551BNR-35 | 88.0 | 1.8 | 5.1 |
| 432BNR-101 | 6.0 | 2.9 | 2.5 |
| 432BNR-102 | 7.5 | 2.5 | 3.0 |
| 432BNR-103 | 10.0 | 2.3 | 3.2 |
| 432BNR-104 | 12.0 | 2.2 | 3.3 |
| 432BNR-105 | 17.0 | 2.0 | 3.7 |
| 432BNR-106 | 24.0 | 1.8 | 4.2 |
| 432BNR-107 | 30.0 | 1.8 | 4.2 |
| 432BNR-108 | 40.0 | 1.8 | 4.2 |
| 432BNR-109 | 48.0 | 1.8 | 4.6 |
| 432BNR-110 | 70.0 | 1.8 | 4.6 |
| 432BNR-111 | 90.0 | 1.7 | 4.8 |
| 379BNR-10 | 12.0 | 2.9 | 2.5 |
| 379BNR-11 | 15.0 | 2.5 | 3.0 |
| 379BNR-12 | 20.0 | 2.3 | 3.2 |
| 379BNR-13 | 24.0 | 2.2 | 3.3 |
| 379BNR-14 | 34.0 | 2.0 | 3.7 |
| 379BNR-15 | 48.0 | 1.9 | 4.2 |
| 379BNR-16 | 60.0 | 1.8 | 4.2 |
| 379BNR-17 | 80.0 | 1.8 | 4.2 |
| 379BNR-18 | 100.0 | 1.8 | 4.6 |
| 379BNR-19 | 135.0 | 1.8 | 4.6 |
| 379BNR-20 | 180.0 | 1.7 | 4.8 |
| 328BNR-40 | 2.0 | 3.0 | 2.2 |
| 328BNR-41 | 3.0 | 2.7 | 2.5 |
| 328BNR-42 | 4.5 | 2.6 | 2.6 |
| 328BNR-43 | 6.0 | 2.4 | 3.0 |
| 328BNR-44 | 8.0 | 2.4 | 3.0 |
| 328BNR-45 | 12.0 | 2.2 | 3.7 |
| 328BNR-46 | 14.0 | 2.0 | 3.7 |
| 328BNR-47 | 18.0 | 1.9 | 4.2 |
| 328BNR-48 | 24.0 | 1.8 | 4.2 |
| 328BNR-49 | 33.0 | 1.8 | 4.2 |

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## Disc Varistor (Con't.)

| Part Number | Voltage DC ± 10% @ 1 ma | Max. Ratio E @ 1.0 ma E @ 0.1 ma | Nominal "N" |
|---|---|---|---|
| 328BNR-50 | 48.0 | 1.8 | 4.6 |
| 328BNR-51 | 60.0 | 1.8 | 4.6 |
| 328BNR-52 | 80.0 | 1.7 | 4.8 |
| 925BNR-10 | 12.0 | 2.4 | 3.0 |
| 925BNR-11 | 16.0 | 2.4 | 3.0 |
| 925BNR-12 | 24.0 | 2.0 | 3.7 |
| 925BNR-13 | 28.0 | 2.0 | 3.7 |
| 925BNR-14 | 36.0 | 1.9 | 4.0 |
| 925BNR-15 | 48.0 | 1.9 | 4.2 |
| 925BNR-16 | 68.0 | 1.8 | 4.2 |
| 925BNR-17 | 90.0 | 1.8 | 4.6 |
| 925BNR-18 | 120.0 | 1.8 | 4.6 |
| 925BNR-19 | 160.0 | 1.7 | 4.8 |

| Part Number | Voltage DC ± 10% @ 5 ma | Max. Ratio E @ 5.0 ma E @ 0.5 ma | Nominal "N" |
|---|---|---|---|
| 463BNR-30 | 16 | 2.2 | 3.3 |
| 463BNR-31 | 24 | 2.2 | 3.3 |
| 463BNR-32 | 28 | 2.0 | 3.7 |
| 463BNR-33 | 36 | 2.0 | 3.7 |
| 463BNR-34 | 48 | 1.9 | 4.2 |
| 463BNR-35 | 62 | 1.8 | 4.2 |
| 463BNR-36 | 85 | 1.8 | 4.2 |
| 463BNR-37 | 110 | 1.7 | 4.8 |
| 463BNR-38 | 140 | 1.7 | 4.8 |
| 463BNR-39 | 190 | 1.7 | 5.0 |
| 927BNR-19 | 9 | 2.7 | 2.6 |
| 927BNR-20 | 15 | 2.4 | 3.0 |
| 927BNR-21 | 25 | 2.3 | 3.1 |
| 927BNR-22 | 40 | 2.3 | 3.2 |
| 927BNR-23 | 70 | 2.2 | 3.5 |
| 927BNR-24 | 100 | 2.1 | 3.7 |
| 927BNR-25 | 140 | 1.9 | 4.8 |

The complete part number for a disc varistor consists of the number shown above with the figure number inserted after the letter R. For example, a varistor per 432BNR-103 with figure 2 leads would be called 432BNR2-103.

Fig. 1 Basic Body Size

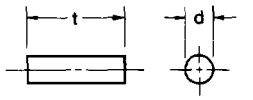



Fig. 4

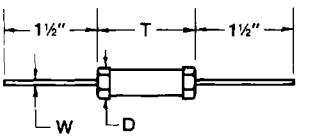
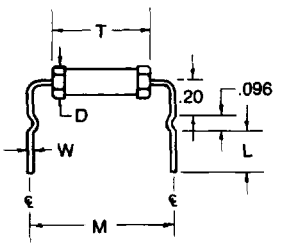



Fig. 7




Coating — Figures 1, 4, 7 — None — Parts are varnish impregnated. Standard leads are tinned copper.

## Rod Varistor

| Part Number | Voltage DC ± 10% @ 1 ma | Max. Ratio E @ 1.0 ma E @ 0.1 ma | Nominal "N" |
|---|---|---|---|
| 231BNR-18 | 100 | 2.1 | 3.1 |
| 231BNR-19 | 135 | 2.0 | 3.4 |
| 231BNR-20 | 180 | 1.9 | 3.6 |
| 231BNR-21 | 240 | 1.8 | 4.1 |
| 231BNR-22 | 320 | 1.8 | 4.1 |
| 231BNR-23 | 430 | 1.7 | 4.7 |
| 231BNR-24 | 575 | 1.7 | 4.8 |
| 231BNR-25 | 750 | 1.7 | 4.8 |
| 233BNR-30 | 68 | 2.2 | 3.3 |
| 233BNR-31 | 88 | 2.2 | 3.3 |
| 233BNR-32 | 110 | 2.0 | 3.7 |
| 233BNR-33 | 140 | 2.0 | 3.7 |
| 233BNR-34 | 175 | 1.8 | 4.2 |
| 233BNR-35 | 250 | 1.8 | 4.2 |
| 233BNR-36 | 320 | 1.8 | 4.2 |
| 233BNR-37 | 410 | 1.7 | 4.8 |
| 233BNR-38 | 520 | 1.7 | 4.8 |
| 233BNR-39 | 710 | 1.7 | 5.0 |
| 234BNR-42 | 135 | 2.2 | 3.3 |
| 234BNR-43 | 175 | 2.2 | 3.3 |
| 234BNR-44 | 220 | 2.0 | 3.7 |
| 234BNR-45 | 290 | 2.0 | 3.7 |
| 234BNR-46 | 350 | 1.9 | 4.2 |
| 234BNR-47 | 500 | 1.8 | 4.2 |
| 234BNR-48 | 680 | 1.8 | 4.2 |
| 234BNR-49 | 825 | 1.7 | 4.8 |
| 234BNR-50 | 1050 | 1.7 | 4.8 |

The complete part number for a rod varistor consists of the number shown above with the figure number inserted after the letter R. For example, a varistor per 233BNR-37 with figure 4 leads would be called 233BNR4-37.

| | Style Number | d ±.030 | t ±.030 | D max. | T max. | w nom. | M | Peak Voltage | Power Watts |
|---|---|---|---|---|---|---|---|---|---|
| Disc Styles | 551BNR2- | 0.250 | 0.062 | 0.400 | 0.350 | 0.020 | 0.125 | 100 | 0.300 |
| | 432BNR2- | 0.500 | 0.062 | 0.650 | 0.350 | 0.032 | 0.250 | 100 | 0.500 |
| | 379BNR2- | 0.500 | 0.125 | 0.650 | 0.400 | 0.032 | 0.250 | 200 | 0.500 |
| | 328BNR2- | 0.750 | 0.062 | 0.900 | 0.380 | 0.032 | 0.375 | 100 | 0.750 |
| | 925BNR2- | 0.750 | 0.100 | 0.900 | 0.380 | 0.032 | 0.375 | 150 | 0.750 |
| | 463BNR2- | 1.000 | 0.125 | 1.150 | 0.400 | 0.032 | 0.375 | 200 | 1.500 |
| | 927BNR2- | 1.250 | 0.100 | 1.400 | 0.380 | 0.032 | 0.375 | 150 | 2.250 |
| Rod Styles | 231BNR4- | 0.156 | 0.625 | 0.200 | 0.812 | 0.032 | 1.00 min. | 80 | 0.750 |
| | 233BNR4- | 0.250 | 0.625 | 0.375 | 0.812 | 0.032 | 1.00 min. | 800 | 1.000 |
| | 234BNR4- | 0.250 | 1.000 | 0.375 | 1.188 | 0.032 | 1.37 min. | 1500 | 1.500 |

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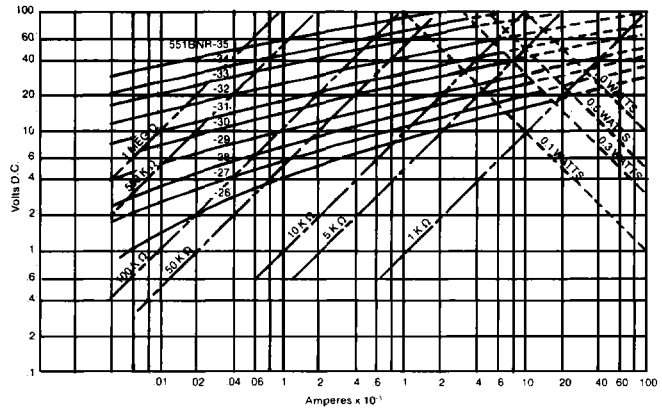
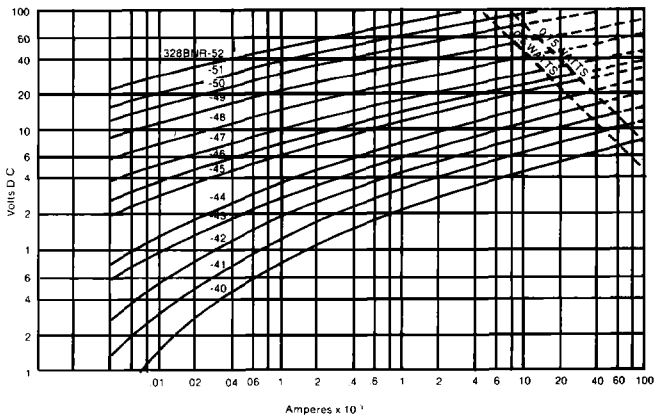
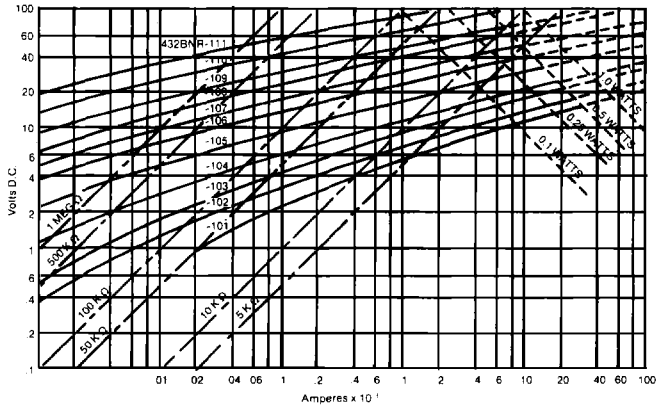
## Type 551BNR Varistor Typical E vs I Characteristic Curves



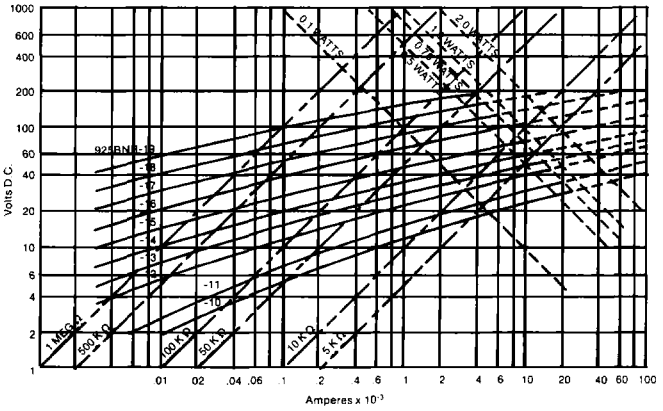

## Type 328BNR Varistor Typical E vs I Characteristic Curves



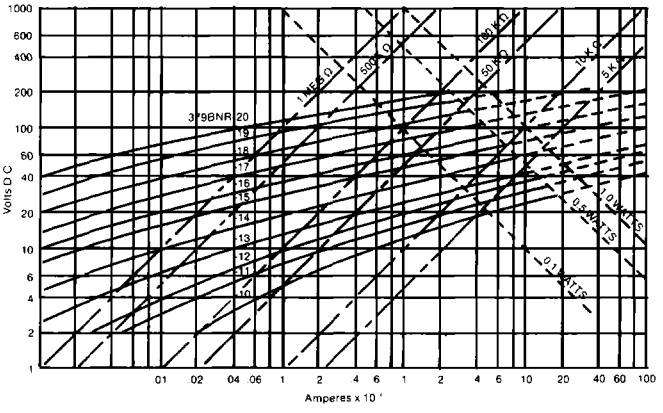

## Type 432BNR Varistor Typical E vs I Characteristic Curves



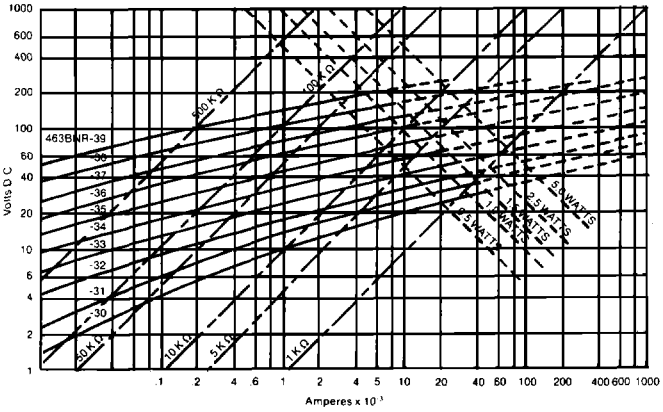

## Type 925BNR Varistor Typical E vs I Characteristic Curves




## Type 379BNR Varistor Typical E vs I Characteristic Curves




## Type 463BNR Varistor Typical E vs I Characteristic Curves





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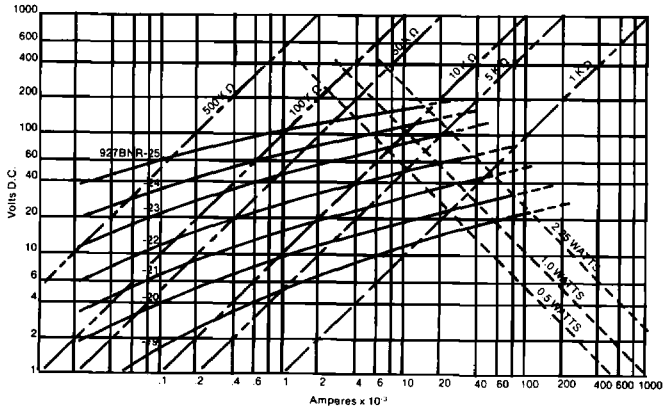
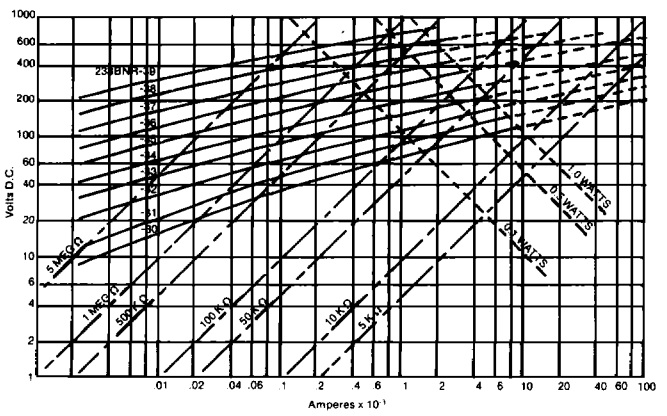
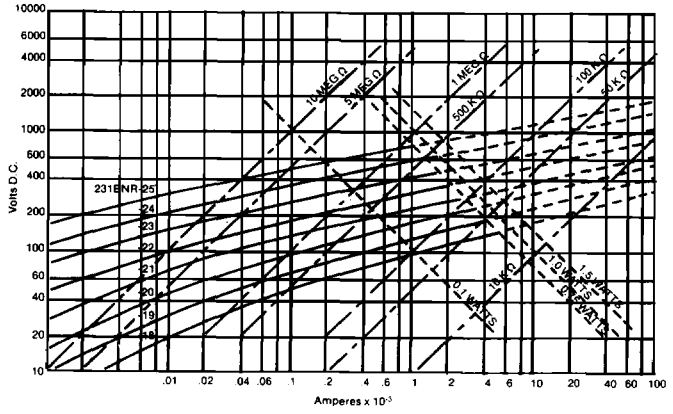
## Type 927BNR Varistor Typical E vs I Characteristic Curves



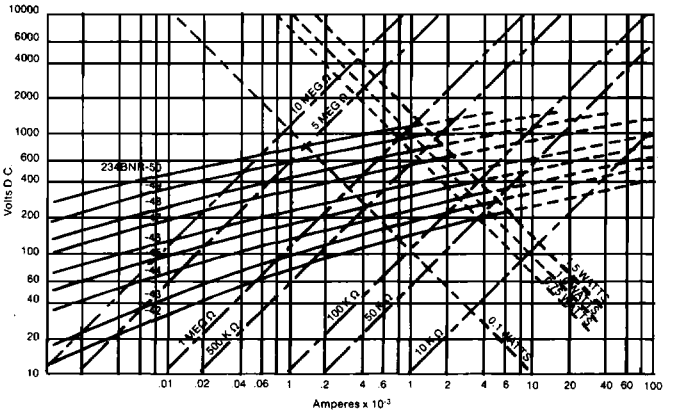

## Type 233BNR Varistor Typical E vs I Characteristic Curves




## Type 231BNR Varistor Typical E vs I Characteristic Curves




## Type 234BNR Varistor Typical E vs I Characteristic Curves

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