VISHAY INTERTECHNOLOGY, INC.

INTERACTIVE data book

VARISTORS

VISHAY BCCOMPONENTS

VSE-DB0054-0909

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VISHAY INTERTECHNOLOGY, INC.

VARISTORS

VISHAY BCCOMPONENTS

www.vishay.com

PRODUCT LISTINGS

SEMICONDUCTORS

RECTIFIERS
- Schottky (single, dual)
- Standard, Fast, and Ultra-Fast Recovery (single, dual)
- Bridge
- Superectifier®
- Sinterglass Avalanche Diodes

HIGH-POWER DIODES AND THYRISTORS
- High-Power Fast-Recovery Diodes
- Phase-Control Thyristors
- Fast Thyristors

SMALL-SIGNAL DIODES
- Schottky and Switching (single, dual)
- Tuner/Capacitance (single, dual)
- Bandswitching
- PIN

ZENER AND SUPPRESSOR DIODES
- Zener (single, dual)
- TVS (TransZorb®, Automotive, ESD, Arrays)

FETs
- Low-Voltage TrenchFET® Power MOSFETs
- High-Voltage TrenchFET® Power MOSFETs
- High-Voltage Planar MOSFETs
- JFETs

OPTOELECTRONICS
- IR Emitters and Detectors, and IR Receiver Modules
- Optocouplers and Solid-State Relays
- Optical Sensors
- LEDs and 7-Segment Displays
- Infrared Data Transceiver Modules
- Custom Products

ICs
- Power ICs
- Analog Switches
- RF Transmitter and Receiver Modules
- ICs for Optoelectronics

MODULES
- Power Modules (contain power diodes, thyristors, MOSFETs, IGBTs)
- DC/DC Converters

PASSIVE COMPONENTS

RESISTIVE PRODUCTS
- Foil Resistors
- Film Resistors
  - Metal Film Resistors
  - Thin Film Resistors
  - Thick Film Resistors
  - Metal Oxide Film Resistors
  - Carbon Film Resistors
- Wirewound Resistors
- Power Metal Strip® Resistors
- Chip Fuses
- Variable Resistors
  - Cermet Variable Resistors
  - Wirewound Variable Resistors
  - Conductive Plastic Variable Resistors
- Networks/Arrays
- Non-Linear Resistors
  - NTC Thermistors
  - PTC Thermistors
  - Varistors

MAGNETICS
- Inductors
- Transformers

CAPACITORS
- Tantalum Capacitors
  - Molded Chip Tantalum Capacitors
  - Coated Chip Tantalum Capacitors
  - Solid Through-Hole Tantalum Capacitors
  - Wet Tantalum Capacitors
- Ceramic Capacitors
  - Multilayer Chip Capacitors
  - Disc Capacitors
- Film Capacitors
- Power Capacitors
- Heavy-Current Capacitors
- Aluminum Capacitors
- Silicon RF Capacitors

STRAIN GAGE TRANSDUCERS AND STRESS ANALYSIS SYSTEMS
- PhotoStress®
- Strain Gages
- Load Cells
- Force Transducers
- Instruments
- Weighing Systems
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Varistors

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DISCLAIMER

Varistors

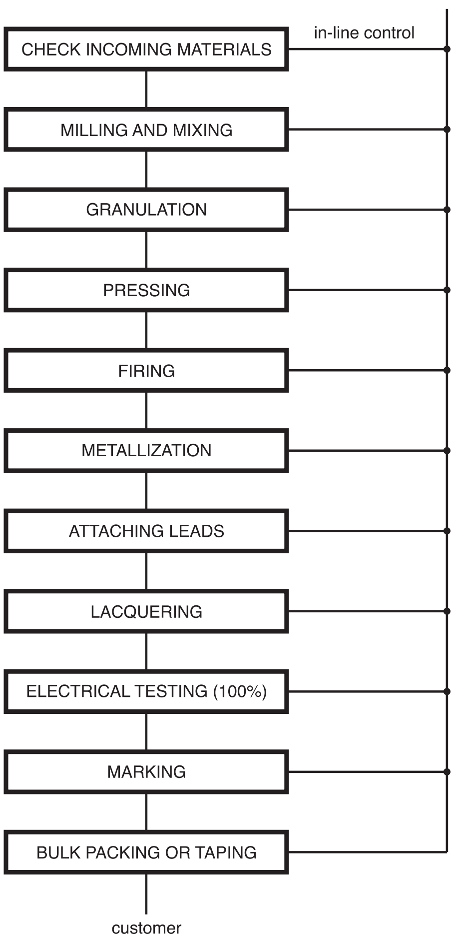
Varistors

GENERAL

Varistors provide reliable and economical protection against high voltage transients and surges which may be produced, for example, by lightning, switching or electrical noise on AC or DC power lines. They have the advantage over transient suppressor diodes in as much as they can absorb much higher transient energies and can suppress positive and negative transients.

When a transient occurs, the varistor resistance changes from a very high stand-by value to a very low conducting value. The transient is thus absorbed and clamped to a safe level, protecting sensitive circuit components.

Varistors are manufactured from a non-homogeneous material, giving a rectifying action at the contact points of two particles. Many series and parallel connections determine the voltage rating and the current capability of the varistor.



Manufacturing process flow chart

FEATURES

- Wide voltage range selection - from 14 V_{RMS} to 680 V_{RMS}. This allows easy selection of the correct component for the specific application.
- High energy absorption capability with respect to size of component.
- Response time of less than 20 ns, clamping the transient the instant it occurs.
- Low stand-by power - virtually no current is used in the stand-by condition.
- Low capacitance values, making the varistors suitable for the protection of digital switching circuitry.
- High body insulation - an ochre coating provides protection up to 2500 V, preventing short circuits to adjacent components or tracks.
- Available on tape with accurately defined dimensional tolerances, making the varistors ideal for automatic insertion.
- Approved to UL 1449 edition 3 (file number: E332800) and manufactured using UL approved flame retardant materials.
- Completely non flammable, in accordance with IEC, even under severe loading conditions.
- Non porous lacquer making the varistors safe for use in humid or toxic environments. The lacquer is also resistant to cleaning solvents in accordance with IEC 60068-2-45.

VARISTOR MANUFACTURING PROCESS

In order to guarantee top performance and maximum reliability, close in-line control is maintained over the automated manufacturing techniques. The manufacturing process flow chart shows each step of the manufacturing process, clearly indicating the emphasis on in-line control.

Each major step in the manufacturing process shown in the Manufacturing process flow chart is described in the following sections:

MILLING AND MIXING

Incoming materials are checked, weighed, milled and mixed for several hours to make a homogeneous mixture.

GRANULATION

A binder is added to produce larger granules for processing.

PRESSING

The surface area and thickness of the disc help to determine the final electrical characteristics of the varistor, therefore pressing is a very important stage in the manufacturing process. The granulated powder is fed into dies and formed into discs using a high speed rotary press.

For technical questions, contact: nlr@vishay.com
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FIRING

The pressed products are first pre-fired to burn out the binder. They are then fired for a controlled period and temperature until the required electrical characteristics are obtained. Regular visual and electrical checks are made on the fired batch.

METALLIZATION

The fired ceramic discs are metallized on both sides with a silver content layer to produce good low resisitive electrical contacts. Metallization is achieved by screen printing. Visual checks are made regularly and a solderability test is carried out in each production batch.

ATTACHING LEADS

Leads are automatically soldered to the metallized faces and regular strength tests are made. Three types of lead configuration are available; one with straight leads, one with straight leads and flange, and one with kinked leads.

LACQUERING

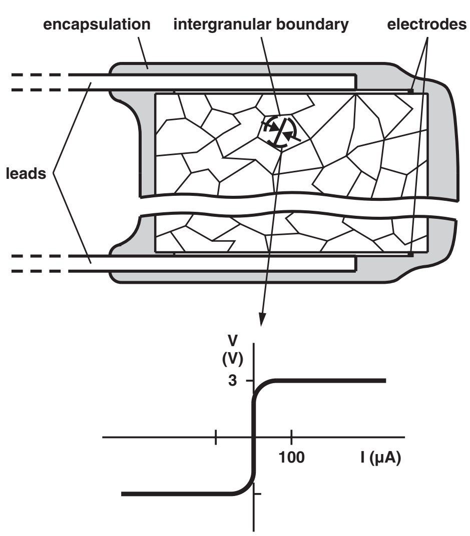
The components are coated by immersing them in a special non flammable ochre epoxy lacquer. Two coats are applied and the lacquer is cured. Regular tests to check the coating thickness are made.

ELECTRICAL TESTING (100 %)

The voltage of each component is normally checked at two reference currents (1 mA and another according to the application). Any rejects are automatically separated for further evaluation.

MARKING

All components are laser marked with type identification, voltage rating and date code.



QUALITY

APPROVALS

- UL 1449 ed. 3 according file E332800
- VDE following IEC 61051-1/2 according file 40002622 or 40013495
- CSA file 219883 and cUL according file E332800

The term ‘QUALITY ASSESSMENT’ is defined as the continuous surveillance by the manufacturer of a product to ensure that it conforms to the requirements to which it was made.

PRODUCT AND PROCESS RELEASE

Recognized reliability criteria are designed into each new product and process from the beginning. Evaluation goes far beyond target specifications and heavy emphasis is placed upon reliability. Before production release, new varistors must successfully complete an extended series of life tests under extreme conditions.

MONITORING INCOMING MATERIALS

Apart from carrying out physical and chemical checks on incoming raw materials, a very close liaison with material suppliers is maintained. Incoming inspection and product results are gradually fed back to them, so ensuring that they also maintain the highest quality standards.

IN-LINE CONTROL

The manufacturing centre operates in accordance with the requirements of IEC 61051-1 and UL 1449. Each operator is actively engaged in quality checking. In addition, in-line inspectors and manufacturing operators make regulated spot checks as a part of our Statistical Process Control (SPC).

FINAL INSPECTION AND TEST (100 %)

At the end of production, each varistor is inspected and tested prior to packing.

LOT TESTING

Before any lot is released, it undergoes a series of special lot tests under the supervision of the Quality department.

PERIODIC SAMPLE TESTING

Component samples are periodically sent to the Quality laboratory for rigorous climatic and endurance tests to IEC/UL requirements. Data from these tests provide a valuable means of exposing long term trends that might otherwise pass unnoticed. The results of these tests are further used to improve the production process.

FIELD INFORMATION

The most accurate method of assessing quality is monitoring performances of the devices in the field. Customer feedback is actively encouraged and the information is used to study how the components may be further improved. This close relationship with customers is based on mutual trust built up over many years of co-operation.

DEFINITIONS

MAXIMUM CONTINUOUS VOLTAGE

The maximum voltage which may be applied continuously between the terminals of the component. For all types of AC voltages, the voltage level determination is given by the crest voltage x 0.707.

VOLTAGE AT 1 mA OR VARISTOR VOLTAGE

The voltage across a varistor when a current of 1 mA is passed through the component. The measurement shall be made in as short a time as possible to avoid heat perturbation.

The varistor voltage is essentially a point on the V/I characteristic permitting easy comparison between models and types.

MAXIMUM CLAMPING VOLTAGE

The maximum voltage between two terminals when a standard pulse current of rise time 8 µs and decreasing time 20 µs (8 µs to 20 µs) is applied through the varistor in accordance with IEC 60060-2, section 6.

The specified current for this measurement is the class current.

MAXIMUM NON REPETITIVE SURGE CURRENT

The maximum peak current allowable through the varistor is dependent on pulse shape, duty cycle and number of pulses. In order to characterize the ability of the varistor to withstand pulse currents, it is generally allowed to warrant a 'maximum non repetitive surge current'. This is given for one pulse characterized by the shape of the pulse current of 8 µs to 20 µs following IEC 60060-2, with such an amplitude that the varistor voltage measured at 1 mA does not change by more than 10 % maximum.

A surge in excess of the specified withstanding surge current may cause short circuits or package rupture with expulsion of material; it is therefore recommended that a fuse be put in the circuit using the varistor, or the varistor be used in a protective box

If more than one pulse is applied or when the pulse is of a longer duration, derating curves are applied (see relevant information in the datasheet); these curves guarantee a maximum varistor voltage change of ± 10 % at 1 mA.

MAXIMUM ENERGY

During the application of one pulse of current, a certain energy will be dissipated by the varistor. The quantity of dissipation energy is a function of:

- The amplitude of the current
- The voltage corresponding to the peak current
- The rise time of the pulse
- The decrease time of the pulse; most of the energy is dissipated during the time between 100 % and 50 % of the peak current
- The non-linearity of the varistor

In order to calculate the energy dissipated during a pulse, reference is generally made to a standardized wave of current. The wave prescribed by IEC 60060-2 section 6 has a shape which increases from zero to a peak value in a short time, and thereafter decreases to zero either at an approximate exponential rate, or in the manner of a heavily damped sinusoidal curve. This curve is defined by the virtual lead time (t_1) and the virtual time to half value (t_2) as shown in the maximum energy curve (page 5).

The calculation of energy during application of such a pulse is given by the formula: $E = (V_{peak} \times I_{peak}) \times t_2 \times K$

where:

I_{peak} = peak current
V_{peak} = voltage at peak current
β = given for $I = ½ \times I_{peak}$ to I_{peak}

K is a constant depending on t_2, when t_1 is 8 µs to 10 µs (see table on page 8).

A low value of β corresponds to a low value of V_{peak} and then to a low value of E.

The maximum energy published does not represent the quality of the varistor, but can be a valuable indication when comparing the various series of components which have the same varistor voltage. The maximum energy published is valid for a standard pulse of duration 10 µs to 1000 µs giving a maximum varistor voltage change of ± 10 % at 1 mA

When more than one pulse is applied, the duty cycle must be so that the rated average dissipation is not exceeded. Values of the rated dissipation are:

0.1 W for series 2381 592/582 .....
0.25 W for series 2381 593/583 .....
0.4 W for series 2381 594/584 .....
0.6 W for series 2381 595/585 .....
1 W for series 2381 596/586 .....

ELECTRICAL CHARACTERISTICS

Typical V/I characteristic of a ZnO varistor

The relationship between voltage and current of a varistor can be approximated to: $V = C \times I^{\beta}$

where:

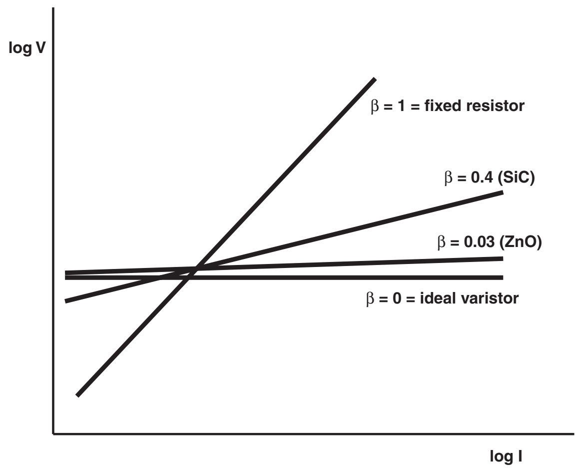
V = voltage
C = varistor voltage at 1 A
I = actual working current
β = tangent of angle curve deviating from the horizontal

Examples

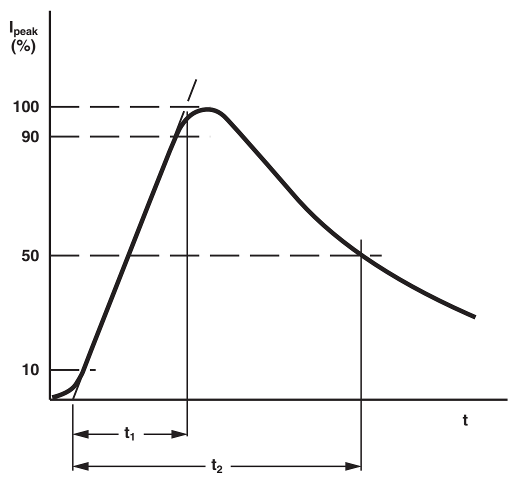
When:

C = 230 V at 1 A
β = 0.035 (ZnO)
$I = 10^{-3}$ A or 10^2 A
$V = C \times I^{\beta}$

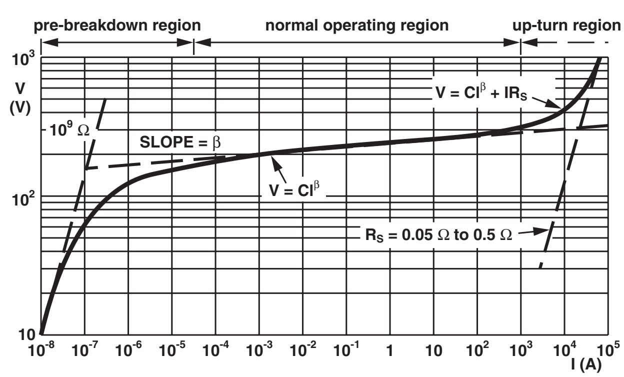
so that for current of 10^{-3} A: $V = 230 \times (10^{-3})^{0.035} = 180$ V and for a current of 10^2 A: $V = 230 \times (10^2)^{0.035} = 270$ V



Varistor characteristics using different β values



Maximum energy curve



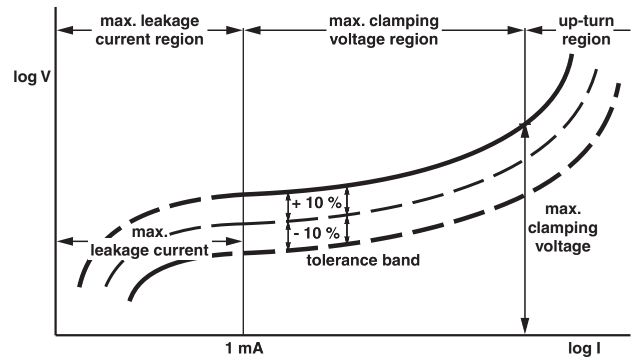
Typical V/I curve

Pre-breakdown region: $V \approx \propto I$; highly temperature dependent

Normal operating region: $V = C \times I^{\beta}$

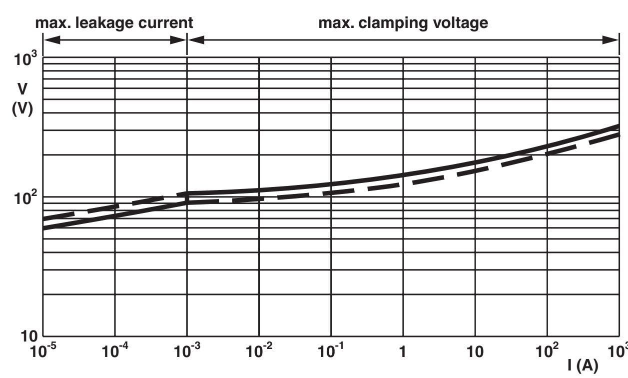
Up-turn region: $V = C \times I^{\beta} + I \times R_S$

SPECIFICATION OF A VARISTOR CURVE



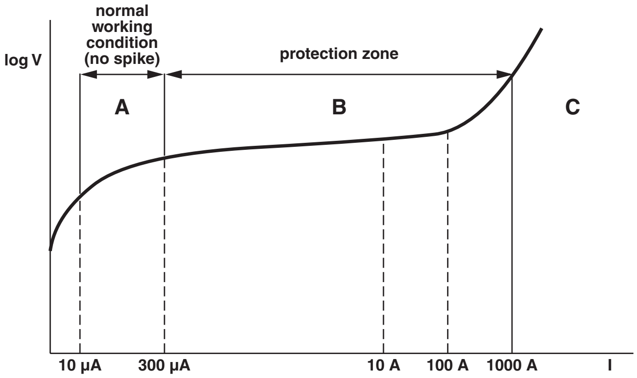
Working points on a varistor curve

The drawing below shows the various working points on the varistor curve using the series 2381 593 ....., 60 V type as an example. The electrical characteristic values are shown in the Electrical Characteristics table below.



Curve for varistor type 2381 593 .606

ELECTRICAL CHARACTERISTICS	
PARAMETER	**VALUE**
Maximum RMS voltage	60 V
Maximum DC working voltage	√2 x 60 V = 85 V
Varistor voltage	100 V ± 10 %
Maximum clamping voltage at 10 A	165 V
Maximum non-repetitive current	1200 A
Leakage current at 85 V_{DC}	10^{-5} A to 5 x 10^{-4} A
Transient energy	10 µs to 1000 µs: 8.3 J



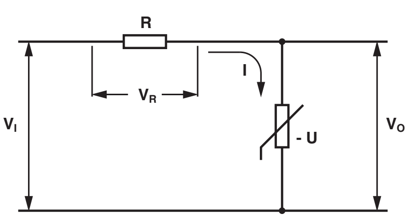
Definitions of the varistor curve

The points A, B and C shown on the curve are defined in the Varistor Curve Definitions table.

VARISTOR CURVE DEFINITIONS	
POINT	**DESCRIPTION**
A	Normal working zone: current is kept as low as possible in order to have low dissipation during continuous operation (between 10 µA to 300 µA).
B	Maximum clamping voltage: the maximum voltage for a given (class) current (peak current based upon statistical probability determined by standardization authorities).
C	Maximum withstanding surge current: the maximum peak current that the varistor can withstand (only) once in its lifetime.

TRANSIENT VOLTAGE LIMITATION WITH ZnO VARISTORS

Principles of voltage limitation



Voltage limitation using a varistor

In the Voltage limitation using a varistor drawing above, the supply voltage V_I is derived by the resistance R (e.g. the line resistance) and the varistor (-U) selected for the application.

$V_I = V_R + V_O$

$V_I = R \times I + C \times I^{\beta}$

If the supply voltage varies by an amount of ΔV_I the current variation is ΔI and the supply voltage may be expressed as:

$(V_I + \Delta V_I) = R\,(I + \Delta I) + C\,(I + \Delta I)^{\beta}$

Given the small value of β (0.03 to 0.05), it is evident that the modification of $C \times I^{\beta}$ will be very small compared to the variation of R x I when V_I is increased to $V_I + \Delta V_I$.

A large increase of V_I will induce a large increase of V_R and a small increase of V_O.

Examples

The varistor is a typical component of the series 2381 592 52716 (C = 520; β = 0.04) and R = 250 Ω.

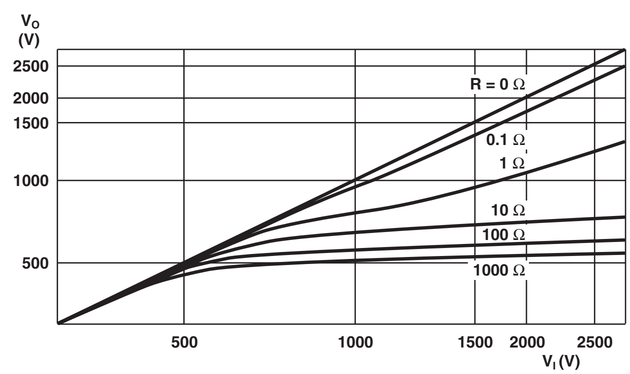
For V_I = 315 V (crest voltage of the 220 V supply voltage): $I = 10^{-5}$ A, $V_R = 2.5 \times 10^{-3}$ V and V_O = 315 V

For V_I = 500 V: $I = 10^{-1}$ A, V_R = 25 V and V_O = 475 V

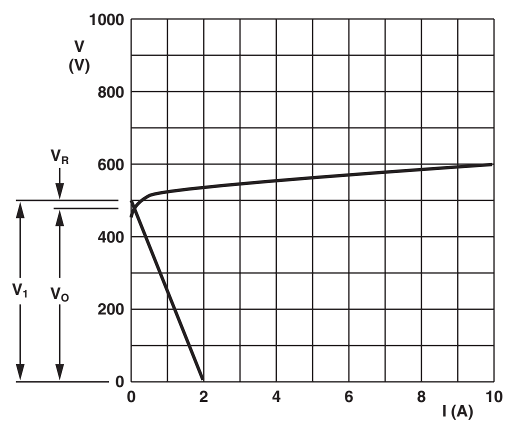
For V_I = 1000 V: I = 1.88 A, V_R = 470 V and V_O = 530 V

The influence of a series resistance on the varistor drawing shows the influence of different values of series resistors on the varistor efficiency.

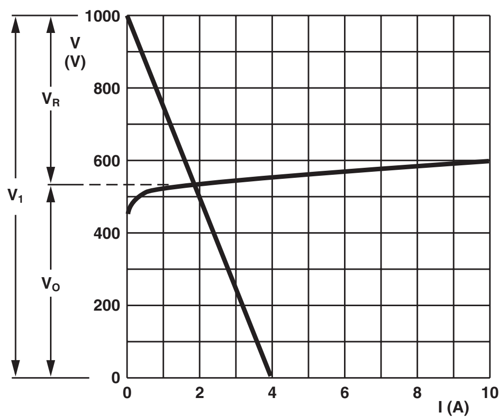
By drawing the load line, it is also possible to estimate the variation of the voltages V_R and V_O when V_I is increased to 500 V or 1000 V. This effect is shown in the graphs below.



Influence of a series resistance on the varistor



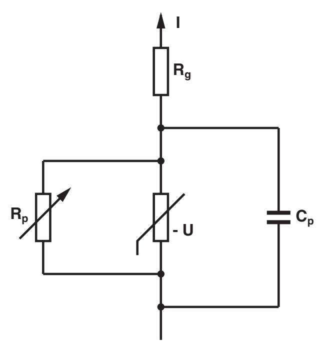
Influence on varistor when V_1 is 500 V (R = 250 Ω)



Influence on varistor when V_1 is 1000 V (R = 250 Ω)

EQUIVALENT CIRCUIT MODEL

A simple equivalent circuit representing a metal oxide varistor as a capacitance in parallel with a voltage dependent resistor is shown in the Equivalent circuit model drawing. C_p and R_p are the capacitance and resistance of the intergranular layer respectively; R_g is the ZnO grain resistance. For low values of applied voltages, R_p behaves as an ohmic loss.



Equivalent circuit model

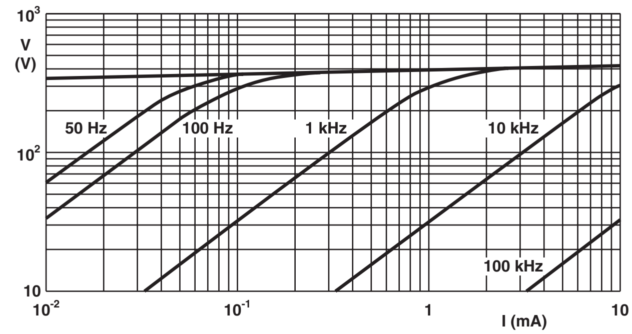
CAPACITANCE

Depending on area and thickness of the device, the capacitance of the varistor increases with the diameter of the disc, and decreases with its thickness.

In DC circuits, the capacitance of the varistor remains approximately constant provided the applied voltage does not rise to the conduction zone, and drops abruptly near the rated maximum continuous DC voltage.

In AC circuits, the capacitance can affect the parallel resistance in the leakage region of the V/I characteristic. The relationship is approximately linear with the frequency and the resulting parallel resistance can be calculated from 1/ωC as for a usual capacitor.

Nevertheless, due to the structural characteristic of the zinc oxide varistors, the capacitance itself decreases slightly with an increase in frequency. This phenomenon is emphasized when the frequency reaches approximately 100 kHz. See the effect of HF alternating current on the varistor type 2381 595 52516; C = 480 pF drawing.



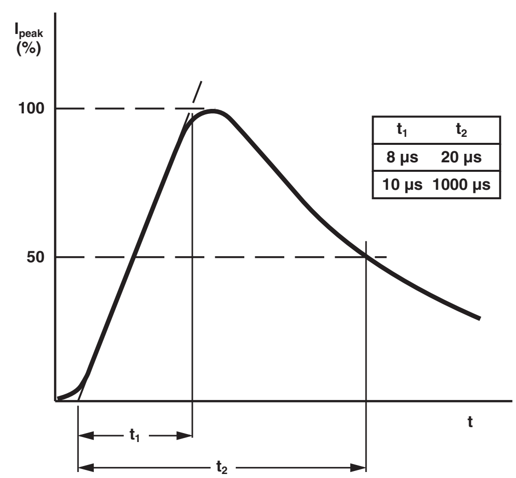
Effect of HF alternating current on varistor type 2381 595 52516; C = 480 pF

ENERGY HANDLING

Maximum allowable peak current and maximum allowable energy are standardized using defined pulses:

- Peak current (A); 8 µs to 20 µs, 1 pulse
- Energy (J); 10 µs to 1000 µs, 1 pulse

INTERNATIONALLY ACCEPTED PULSES



t_1	t_2
8 µs	20 µs
10 µs	1000 µs

Standard pulse for current and maximum allowable energy calculation

Examples

Pulse life time rating of 2381 593 ....., 60 V type.

Energy capability: $E = K \times V_p \times I_p \times t_2$

1 pulse; 8 µs to 20 µs: 1200 A = 1 x 8 J

10 pulses; 8 µs to 20 µs: 300 A = 10 x 1.45 J

1 pulse; 10 µs to 1000 µs: 33A = 1 x 8.3 J

10 pulses; 10 µs to 1000 µs: 11 A = 10 x 2.5 J

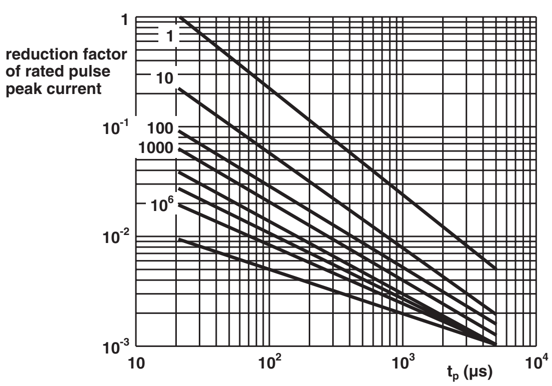
The maximum specified energy is defined for a maximum shift ($\Delta V/V$) 1 mA ≤ 10 %:

I_p = pulse current

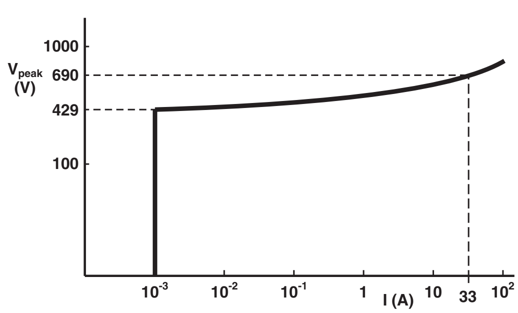
V_p = corresponding clamping voltage

K DEPENDS ON T2 WHEN T1 IS 8 µs TO 10 µs	
t_2 (µs)	K
20	1
50	1.2
100	1.3
1000	1.4

Typical surge life rating curves (number of surges allowed as a function of pulse time and maximum current) are shown in drawing below.

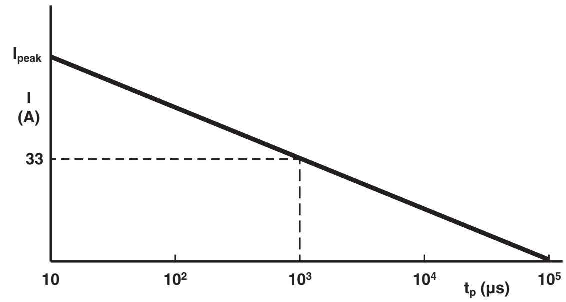


Maximum peak current for various number of pulses as a function of pulse duration



$E = K \times V_{peak} \times I_{peak} \times t_2 = 1.4 \times 700 \times 33 \times 10^{-3} = 32$ J

Example of calculation of energy for a 2381 593 52516 type, at the maximum peak current (33 A) for a duration $t_2 = 1000$ µs (K = 1.4)



Maximum energy (10 x 1000 µs): 1 pulse

Example: 2381 593 52516 (250 V)

Example of selection of the maximum peak current as a function of pulse duration.

DISSIPATED POWER

DC DISSIPATION

The power dissipated in a varistor is equal to the product of the voltage and current, and may be written:
$W = I \times V = C \times I^{\beta + 1}$ or $K \times V^{\alpha + 1}$

When the coefficient $\alpha = 30$ ($\beta = 0.033$), the power dissipated by the varistor is proportional to the 31^{st} power of the voltage. A voltage increase of only 2.26 % will, in this case, double the dissipated power. Consequently, it is very important that the applied voltage does not rise above a certain maximum value, or the permissible rating will be exceeded.

This is even more cogent as the varistors have a negative temperature coefficient, which means that at a higher dissipation (and accordingly at a higher temperature) the resistance value will decrease and the dissipated power will increase further.

AC DISSIPATION

When a sinusoidal alternating voltage is applied to a varistor, the dissipation cannot be calculated from the same formula as in a DC application. The calculation requires an integration of the V x I product.

The instantaneous dissipated power is given by:

$$P_{INST} = V \times I = V\,(K \times V^{\alpha}) = K \times V^{\alpha + 1}$$

In the above equation, the value $V = V_{peak} \times \sin \omega t$.

During a half cycle, the dissipated power is given by:

$$P_{RMS} = \frac{1}{\pi}\int_{0}^{\pi} K \times V_{peak}^{\alpha + 1} \times (\sin\,\omega t)^{\alpha + 1} \times d$$

Since $V_{peak} = V_{RMS} \times \sqrt{2}x$

$$P_{RMS} = \frac{1}{\pi} \times K \times V_{RMS}^{\alpha + 1} \times (\sqrt{2})^{a + 1} \times \int_{0}^{\pi} (\sin\,\omega t)^{\alpha + 1} \times dt$$

This integration is not easy to solve because of the exponent ($\alpha + 1$) of sin ωt.

It is generally easier to use the quotient of the AC power on the DC power:

$P = P_{AC}/P_{DC}$

This quotient depends only on the value of α and not more on the K value as shown in the formula:

$$P = \frac{\frac{1}{\pi} \times K \times V_{rms}^{\alpha+1} \times 2^{(a+1)/2} \times \int_0^{\pi} (\sin \omega t)^{\alpha+1} \times dt}{K \times V^{a+1}}$$

$$P = \frac{1}{\pi} \times 2^{(a+1)/2} \times \int_0^{\pi} (\sin \omega t)^{\alpha+1} \times dt$$

P has been calculated by successive application of a reduction formula; see Power Ratios table.

POWER RATIOS

α	P	α	P	α	P	α	P	α	P
1	1.0	11	14.4	21	344	31	9135	41	255 646
2	1.2	12	19.6	22	477	32	12 776	42	358 778
3	1.5	13	26.8	23	658	33	17 734	43	499 673
4	1.92	14	36.7	24	915	34	24 822	44	701 611
5	2.5	15	50.3	25	1264	35	34 482	45	977 622
6	3.29	16	69	26	1763	36	48 301	46	1 373 365
7	4.375	17	95	27	2439	37	67 149	47	1 914 510
8	5.85	18	131	28	3404	38	94 126	48	2 690 675
9	7.875	19	180	29	4715	39	130 941	49	3 752 439
10	10.64	20	249	30	6587	40	183 660	50	5 275 834

TEMPERATURE COEFFICIENT

In the leakage current region of the V/I characteristic, the normal equation $V = C \times I^{\beta}$ of the varistor becomes less applicable.

This is due to a parallel resistance which shows a very important temperature coefficient, created by thermal conduction. This temperature coefficient decreases when the current density increases. Then, the temperature coefficient at 1 mA is higher for a large varistor than for a small varistor.

This phenomena induces an increase in leakage current when the varistor is used at high temperatures. The relationship between the temperature and the current at a given voltage can be expressed by:

$I = I_0 \times e^{KT}$

where:

I_0 is the limiting current at 0 K

K is a constant including the band gap energy of the zinc oxide and the Boltzmann's constant.

Practically, the maximum temperature coefficient is guaranteed on the voltage for a current of 1 mA in % per K.

SURGE PROTECTION

Varistors provide protection against surges which may be generated in the following ways:

ELECTROMAGNETIC ENERGY

Atmospheric, lightning

Switching of inductive loads:

- Relays
- Pumps
- Actuators
- Spot welders
- Thermostats
- Fluorescent chokes
- Discharge lamps
- Motors
- Transformers
- Air conditioning units
- Fuses

ELECTROSTATIC DISCHARGES

For example, discharges caused by synthetic carpets (approximately 50 kV), due to the inductance of the connecting leadwires, the reaction time of leaded VDR's might be too slow to clamp properly fast rising ESD pulses.

SOURCE OF TRANSIENT

The energy dissipated by switching of an inductive load is completely transferred into the capacitance of the coil which is generally very low.

$E = ½ \times L \times I^2 = ½ \times C \times V^2$

Examples, using the following values:

Mains voltage = 220 V_{RMS};
allowable peak voltage = 340 V

Line inductance: L = 20 µH = 20 x 10^{-6} H

Line capacitance: C = 300 nF = 0.3 x 10^{-6} H

Line resistance: 0.68 Ω

In the event of a short circuit:

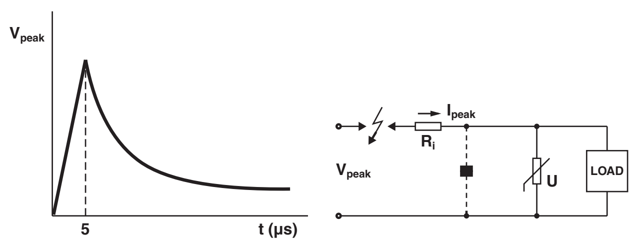
Load current: $I_L = \frac{V}{R} = \frac{340\ V}{0.68\ \Omega} = 500\ A$

Energy stored: E = ½ x 20 x 10^{-6} x 25 x 10^4 = 2.5 J (Ws)

In the event of a fuse going open circuit:

The energy goes from inductance L towards line capacitance:

$$V_C = \sqrt{\frac{2E}{C}} = \sqrt{\frac{2 \times 2.5}{0.3 \times 10^{-6}}} = 4082\ V$$



Source of transient

The line impedance becomes high when the fuse goes open circuit (resistance against high voltage peak in a very short time).

$R_i = \omega L = 2\ \pi\ f\ L$

Since the rise time of the pulse is 5 µs, the frequency f = 50 kHz.

$R_i = 6.28\ \Omega \times 50 \times 10^3 \times 20 \times 10^{-6} = 6.28\ \Omega$

$Z_i = 6.28\ \Omega + 0.68\ \Omega = 6.96\ \Omega$

$V_{Ri} = 6.96\ V \times 500\ V = 3480\ V$

$V_{VDR} = 4082\ V - 3480\ V = 602\ V$

VARISTOR APPLICATIONS

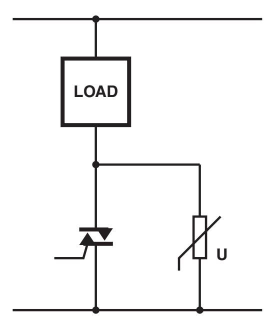
Varistors may be used in many applications, including:

- Computers
- Timers
- Amplifiers
- Oscilloscopes
- Medical analysis equipment
- Street lighting
- Tuners
- Televisions
- Controllers
- Industrial power plants
- Telecommunications
- Automotive
- Gas and petrol appliances
- Electronic home appliances
- Relays
- Broadcasting
- Traffic facilities
- Electromagnetic valves
- Railway distribution/vehicles
- Agriculture
- Power supplies
- Line ground (earth protection)
- Microwave ovens
- Toys, etc.

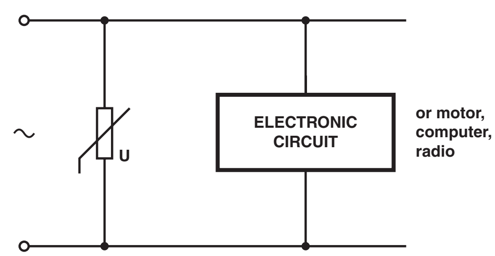
APPLICATION EXAMPLES

For suppression of mains-borne transients in domestic appliances and industrial equipment, see Suppression via load, Suppression directly across mains, Switched-mode power supply protection and Protection of a thyristor bridge in a washing machine drawings.

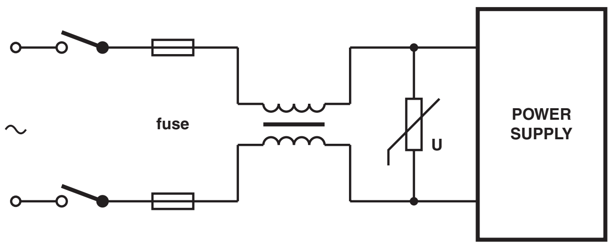
Type 2381 592 ..... or 2381 593 .....



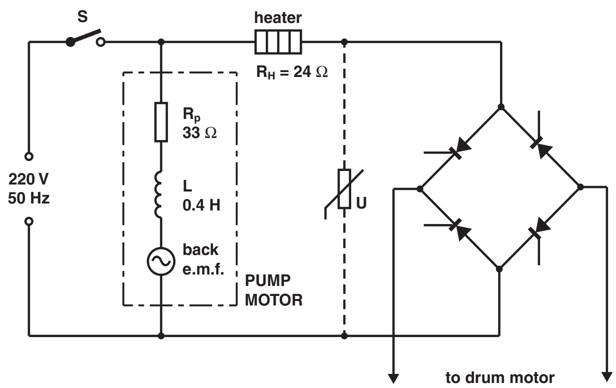
Suppression via load



Suppression directly across mains



Switched-mode power supply protection



Protection of a thyristor bridge in a washing machine

BEHAVIOUR OF THE CIRCUIT WITHOUT VARISTOR PROTECTION

The measured peak current through the pump motor when S is closed is 1 A (see protection of a thyristor bridge in a washing machine drawing). The energy expended in establishing the electromagnetic field in the inductance of the motor is therefore:

$$I^2 \times \frac{L}{2} = \frac{0.4}{2} = 200 \text{ mJ}$$

Without varistor protection, an initial current of 1 A will flow through the thyristor bridge when S is opened, and a voltage sufficient to damage or destroy the thyristors will be developed. Arching will occur across the opening contacts of the switch.

BEHAVIOUR OF THE CIRCUIT WITH VARISTOR 2381 593 52516 INSERTED

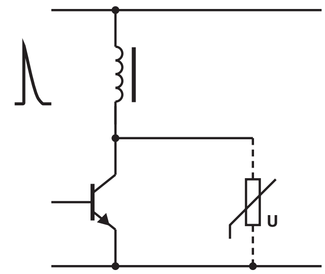
On opening switch S, the peak voltage developed across the varistor is: $V = C_{max.} \times I^{\beta} = 600$ V

The thyristors in the bridge can withstand this voltage without damage.

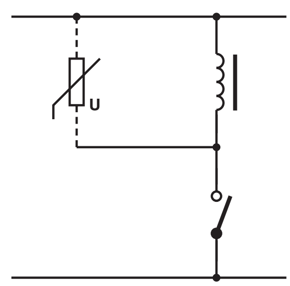
The total energy returned to the circuit is 200 mJ. Of this 200 mJ. 15.1 mJ is dissipated in the heater, and 184.3 mJ is dissipated in the varistor. The varistor can withstand more than 10^5 transients containing this amount of energy.

For suppression of internally generated spikes in electronic circuits, see Varistor used across a transistor or coil in a television circuit and Varistor used across a switch or coil drawings.

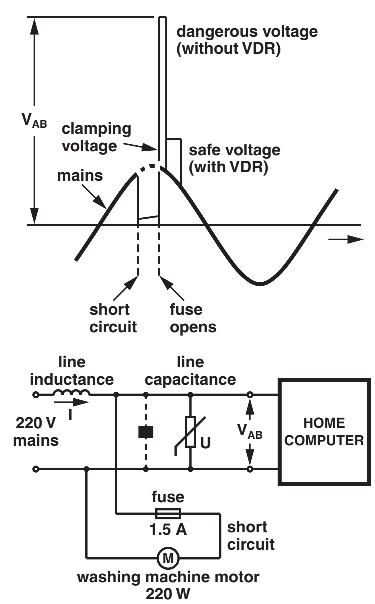
In both examples shown in the drawings Varistor used across a transistor or coil in a television circuit and Varistor used across a switch or coil, type 2381 592 ..... should be used for up to approximately 50 A, and type 2381 593 ..... up to approximately 120 A.



Varistor used across a transistor or coil in a television circuit



Varistor used across a switch or coil



Influence of a transient on the mains voltage

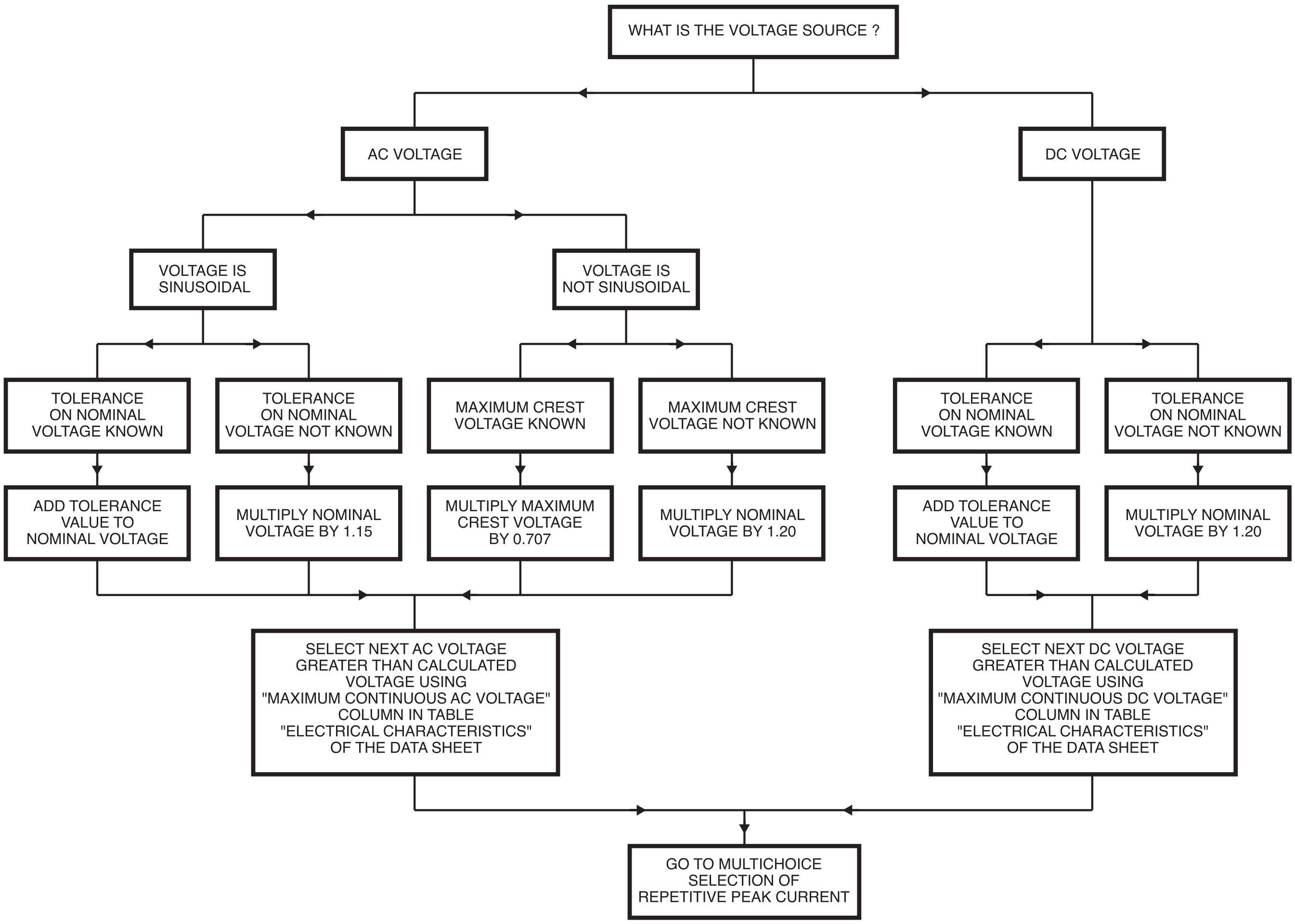
SELECTION OF THE CORRECT VARISTOR TYPE

In order to select a ZnO varistor for a specific application, the following points must first be considered:

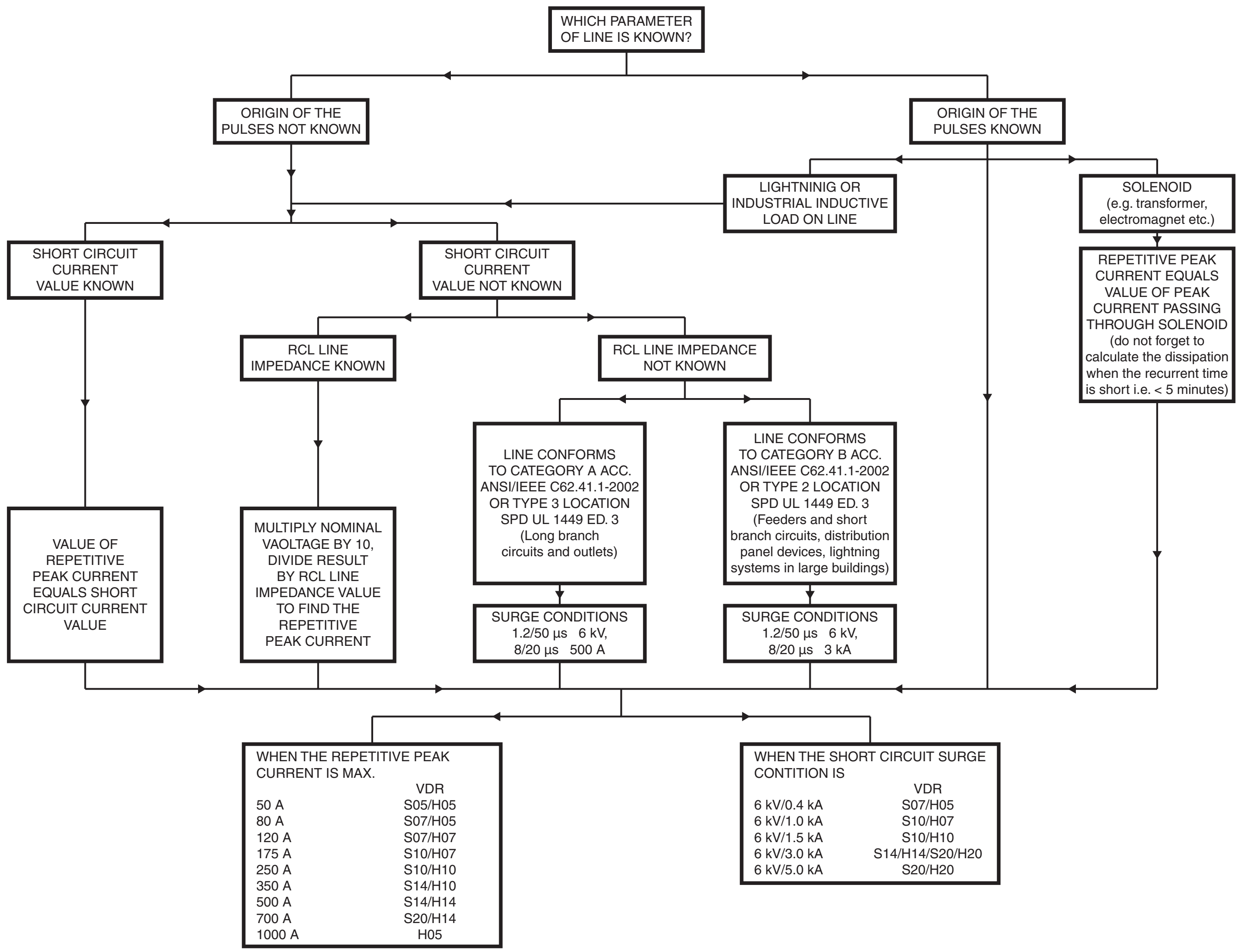
1. The normal operating conditions of the apparatus or system, AC or DC voltage?
2. What is the maximum RMS or DC voltage?

To ensure correct selection of varistor type, two multi choice selection charts have been prepared, see charts below.

The first chart determines the necessary steady state voltage rating (i.e. working voltage) and the second chart determines the correct size (i.e. correct energy absorption).



Multi choice selection chart to determine the necessary steady state voltage rating (i.e. working voltage)

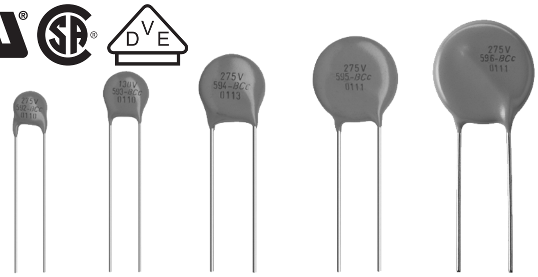


Multi choice selection chart to determine the correct size (i.e. correct energy absorption)

Leaded Varistors

Contents

VDR Metal Oxide Varistors Standard



QUICK REFERENCE DATA		
PARAMETER	**VALUE**	**UNIT**
Maximum continuous voltage in operating temperature range:		
RMS	14 to 680	V
DC	18 to 895	V
Maximum non-repetitive transient current I_{NRP} (8 x 20 µs)	100 to 6500	A
Detailed specification	Based on IEC 61051-1 IEC 61051-2 IEC 61051-2-2	
Storage temperature	- 40 to + 125	°C
Operating temperature	- 40 to + 85	°C

ORDERING INFORMATION

The varistors are available in a number of packaging options:

- Bulk
- On tape on reel
- On tape in ammopack

The basic ordering code for each option is given in tables mutitled Varistors on Tape on Reel, Varistors on Tape in Ammopack and Varistors in Bulk. To complete the catalog number and to determine the required operating parameters, see Electrical Data and Ordering Information table.

FEATURES

- Zinc oxide disc, epoxy coated
- Straight leads
- Straight leads with flange (2381 592 and 593 series only)
- Kinked leads
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC
- Certified according to UL 1449 edition 3, VDE/IEC 61051-1/2 and CSA

RoHS COMPLIANT

APPLICATION

- Overvoltage and transient voltage protection

DESCRIPTION

The varistors consist of a disc of low-ß ceramic material with two tinned solid copper leads. They are coated with a layer of ochre coloured epoxy, which provides electrical, mechanical and climatic protection. The encapsulation is resistant to all cleaning solvents in accordance with IEC 60068-2-45.

MOUNTING

The varistors are suitable for processing on automatic insertion and cutting and bending equipment.

Varistors with flanged leads provide better positioning on printed-circuit boards (PCB) and more accurate control over component height. This is important for hand mounting and automatic insertion techniques; see outlines of flanged leads drawing.

Typical soldering

235 °C, duration: 5 s (Pb-bearing)

245 °C, duration: 5 s (lead (Pb)-free)

Resistance to soldering heat

260 °C, duration: 10 s max.

MARKING

The varistors are marked with the following information:

- Maximum continuous RMS voltage
- Series number (592, 593, 594, 595 or 596)
- Manufacturers logo
- Date of manufacture (YYWW)

INFLAMMABILITY

The varistors are non-flammable.

The encapsulation is made of flammable resistant epoxy in accordance with UL 94 V-0.

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE [3] at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY [4] (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT [5] I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS [1]	
RMS [2] (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC [6]	SAP [7]
14	18	22	48	1.0	0.5	100	1300	4.1	0.7 ± 0.3	2381 592 x140y	VDRS05A014xyE
			43	2.5	1.7	250	2800	4.1	0.7 ± 0.3	2381 593 x140y	VDRS07B014xyE
			43	5.0	4.3	500	6000	4.4	0.9 ± 0.3	2381 594 x140y	VDRS10D014xyE
			43	10.0	5.4	1000	15 000	4.4	0.9 ± 0.3	2381 595 x140y	VDRS14G014xyE
			43	20.0	8.0	2000	30 000	4.6	1.1 ± 0.3	2381 596 x140y	VDRS20M014ByE

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE [3] at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY [4] (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT [5] I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS [1]	
RMS [2] (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC [6]	SAP [7]
17	22	27	60	1.0	0.7	100	1050	4.1	0.8 ± 0.3	2381 592 x170y	VDRS05A017xyE
			53	2.5	2.0	250	2000	4.1	0.8 ± 0.3	2381 593 x170y	VDRS07B017xyE
			53	5.0	5.3	500	4000	4.4	1.0 ± 0.3	2381 594 x170y	VDRS10D017xyE
			53	10.0	6.9	1000	10 000	4.4	1.0 ± 0.3	2381 595 x170y	VDRS14G017xyE
			53	20.0	10.0	2000	20 000	4.6	1.2 ± 0.3	2381 596 x170y	VDRS20M017ByE
20	26	33	73	1.0	0.8	100	900	4.1	1.0 ± 0.3	2381 592 x200y	VDRS05A020xyE
			65	2.5	2.5	250	1500	4.1	1.0 ± 0.3	2381 593 x200y	VDRS07B020xyE
			65	5.0	6.5	500	3000	4.4	1.2 ± 0.3	2381 594 x200y	VDRS10D020xyE
			65	10.0	8.8	1000	7500	4.4	1.2 ± 0.3	2381 595 x200y	VDRS14G020xyE
			65	20.0	12.0	2000	15 000	4.8	1.4 ± 0.3	2381 596 x200y	VDRS20M020ByE
25	31	39	86	1.0	0.9	100	500	4.2	1.2 ± 0.3	2381 592 x250y	VDRS05A025xyE
			77	2.5	3.0	250	1350	4.2	1.2 ± 0.3	2381 593 x250y	VDRS07B025xyE
			77	5.0	7.7	500	2600	4.6	1.4 ± 0.3	2381 594 x250y	VDRS10D025xyE
			77	10.0	9.4	1000	6500	4.6	1.4 ± 0.3	2381 595 x250y	VDRS14G025xyE
			77	20.0	14.0	2000	13 000	5.0	1.6 ± 0.3	2381 596 x250y	VDRS20M025ByE
30	38	47	96	1.0	1.1	100	700	4.4	1.4 ± 0.5	2381 592 x300y	VDRS05A030xyE
			93	2.5	3.6	250	1600	4.4	1.4 ± 0.5	2381 593 x300y	VDRS07B030xyE
			93	5.0	9.2	500	2700	4.8	1.6 ± 0.5	2381 594 x300y	VDRS10D030xyE
			90	10.0	12.0	1000	6000	4.8	1.6 ± 0.5	2381 595 x300y	VDRS14G030xyE
			93	20.0	17.0	2000	12 000	5.2	1.8 ± 0.5	2381 596 x300y	VDRS20M030ByE
35	45	56	123	1.0	1.4	100	560	4.8	1.7 ± 0.5	2381 592 x350y	VDRS05A035xyE
			115	2.5	4.4	250	1300	4.8	1.7 ± 0.5	2381 593 x350y	VDRS07B035xyE
			110	5.0	11.0	500	2200	5.2	1.9 ± 0.5	2381 594 x350y	VDRS10D035xyE
			105	10.0	14.0	1000	4800	5.2	1.9 ± 0.5	2381 595 x350y	VDRS14G035xyE
			110	20.0	20.0	2000	9600	5.6	2.1 ± 0.5	2381 596 x350y	VDRS20M035ByE
40	56	68	145	1.0	1.6	100	460	5.1	2.1 ± 0.5	2381 592 x400y	VDRS05A040xyE
			135	2.5	5.2	250	1000	5.1	2.1 ± 0.5	2381 593 x400y	VDRS07B040xyE
			130	5.0	13.0	500	1800	5.5	2.3 ± 0.5	2381 594 x400y	VDRS10D040xyE
			130	10.0	17.0	1000	3800	5.5	2.3 ± 0.5	2381 595 x400y	VDRS14G040xyE
			135	20.0	24.0	2000	7600	5.9	2.5 ± 0.5	2381 596 x400y	VDRS20M040ByE
50	65	82	145	5.0	2.6	400	370	4.1	0.6 ± 0.3	2381 592 x500y	VDRS05C050xyE
			140	10.0	7.0	1200	900	4.1	0.6 ± 0.3	2381 593 x500y	VDRS07H050xyE
			140	25.0	12.0	2500	1500	4.4	0.8 ± 0.3	2381 594 x500y	VDRS10P050xyE
			140	50.0	21.0	4500	3100	4.4	0.8 ± 0.3	2381 595 x500y	VDRS14T050xyE
60	85	100	165	5.0	2.9	400	290	4.1	0.7 ± 0.3	2381 592 x600y	VDRS05C060xyE
			165	10.0	8.3	1200	700	4.1	0.7 ± 0.3	2381 593 x600y	VDRS07H060xyE
			165	25.0	15.0	2500	1200	4.4	0.9 ± 0.3	2381 594 x600y	VDRS10P060xyE
			165	50.0	24.0	4500	2300	4.4	0.9 ± 0.3	2381 595 x600y	VDRS14T060xyE
			165	100.0	56.0	6500	4700	4.5	1.1 ± 0.3	2381 596 x600y	VDRS20W060ByE
75	100	120	190	5.0	3.4	400	240	4.1	0.9 ± 0.3	2381 592 x750y	VDRS05C075xyE
			200	10.0	10.0	1200	530	4.1	0.9 ± 0.3	2381 593 x750y	VDRS07H075xyE
			200	25.0	18.0	2500	1000	4.4	1.1 ± 0.3	2381 594 x750y	VDRS10P075xyE
			200	50.0	29.0	4500	1900	4.4	1.1 ± 0.3	2381 595 x750y	VDRS14T075xyE
			200	100.0	64.0	6500	3900	4.8	1.3 ± 0.3	2381 596 x750y	VDRS20W075ByE
95	125	150	230	5.0	4.1	400	180	4.2	1.1 ± 0.3	2381 592 x950y	VDRS05C095xyE
			250	10.0	13.0	1200	450	4.2	1.1 ± 0.3	2381 593 x950y	VDRS07H095xyE
			250	25.0	22.0	2500	800	4.6	1.3 ± 0.3	2381 594 x950y	VDRS10P095xyE
			250	50.0	37.0	4500	1500	4.6	1.3 ± 0.3	2381 595 x950y	VDRS14T095xyE
			250	100.0	88.0	6500	3000	5.2	1.5 ± 0.3	2381 596 x950y	VDRS20W095ByE

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE (3) at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY (4) (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT (5) I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS (1)	
RMS (2) (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC (6)	SAP (7)
130	170	205	310	5.0	5.5	400	130	4.2	1.0 ± 0.3	2381 592 x131y	VDRS05C130xyE
			340	10.0	17.0	1200	320	4.2	1.0 ± 0.3	2381 593 x131y	VDRS07H130xyE
			340	25.0	30.0	2500	580	4.6	1.2 ± 0.3	2381 594 x131y	VDRS10P130xyE
			340	50.0	56.0	4500	1050	4.6	1.2 ± 0.3	2381 595 x131y	VDRS14T130xyE
			340	100.0	114.0	6500	2100	5.3	1.4 ± 0.3	2381 596 x131y	VDRS20W130ByE
140	180	220	350	5.0	6.3	400	120	4.4	1.0 ± 0.3	2381 592 x141y	VDRS05C140xyE
			370	10.0	21.0	1200	290	4.4	1.0 ± 0.3	2381 593 x141y	VDRS07H140xyE
			370	25.0	33.0	2500	540	4.8	1.2 ± 0.3	2381 594 x141y	VDRS10P140xyE
			370	50.0	57.0	4500	950	4.8	1.2 ± 0.3	2381 595 x141y	VDRS14T140xyE
			360	100.0	124.0	6500	1900	5.4	1.5 ± 0.3	2381 596 x141y	VDRS20W140ByE
150	200	240	395	5.0	7.1	400	110	4.4	1.1 ± 0.3	2381 592 x151y	VDRS05C150xyE
			400	10.0	20.0	1200	270	4.4	1.1 ± 0.3	2381 593 x151y	VDRS07H150xyE
			400	25.0	36.0	2500	490	4.8	1.3 ± 0.3	2381 594 x151y	VDRS10P150xyE
			400	50.0	59.0	4500	850	4.8	1.3 ± 0.3	2381 595 x151y	VDRS14T150xyE
			395	100.0	134.0	6500	1700	5.5	1.6 ± 0.3	2381 596 x151y	VDRS20W150ByE
175	225	275	410	5.0	7.3	400	90	4.6	1.3 ± 0.3	2381 592 x171y	VDRS05C175xyE
			455	10.0	23.0	1200	230	4.6	1.3 ± 0.3	2381 593 x171y	VDRS07H175xyE
			455	25.0	41.0	2500	430	5.0	1.5 ± 0.3	2381 594 x171y	VDRS10P175xyE
			455	50.0	67.0	4500	750	5.0	1.5 ± 0.3	2381 595 x171y	VDRS14T175xyE
			455	100.0	158.0	6500	1500	5.7	1.7 ± 0.3	2381 596 x171y	VDRS20W175ByE
230	300	360	560	5.0	10.0	400	70	4.9	1.7 ± 0.8	2381 592 x231y	VDRS05C230xyE
			600	10.0	30.0	1200	170	4.9	1.7 ± 0.8	2381 593 x231y	VDRS07H230xyE
			600	25.0	54.0	2500	320	5.4	1.9 ± 0.8	2381 594 x231y	VDRS10P230xyE
			600	50.0	88.0	4500	540	5.4	1.9 ± 0.8	2381 595 x231y	VDRS14T230xyE
			595	100.0	208.0	6500	1100	6.2	2.2 ± 0.8	2381 596 x231y	VDRS20W230ByE
250	320	390	600	5.0	11.0	400	60	4.9	1.9 ± 0.8	2381 592 x251y	VDRS05C250xyE
			650	10.0	33.0	1200	160	4.9	1.9 ± 0.8	2381 593 x251y	VDRS07H250xyE
			650	25.0	58.0	2500	300	5.4	2.1 ± 0.8	2381 594 x251y	VDRS10P250xyE
			650	50.0	96.0	4500	480	5.4	2.1 ± 0.8	2381 595 x251y	VDRS14T250xyE
			650	100.0	240.0	6500	960	6.4	2.3 ± 0.8	2381 596 x251y	VDRS20W250ByE
275	350	430	695	5.0	12.0	400	55	4.9	2.0 ± 0.8	2381 592 x271y	VDRS05C275xyE
			710	10.0	36.0	1200	140	4.9	2.0 ± 0.8	2381 593 x271y	VDRS07H275xyE
			710	25.0	63.0	2500	270	5.4	2.2 ± 0.8	2381 594 x271y	VDRS10P275xyE
			710	50.0	104.0	4500	440	5.4	2.2 ± 0.8	2381 595 x271y	VDRS14T275xyE
			710	100.0	264.0	6500	900	6.6	2.5 ± 0.8	2381 596 x271y	VDRS20W275ByE
300	385	470	750	5.0	13.0	400	50	5.3	2.2 ± 0.8	2381 592 x301y	VDRS05C300xyE
			800	10.0	40.0	1200	130	5.3	2.2 ± 0.8	2381 593 x301y	VDRS07H300xyE
			800	25.0	71.0	2500	240	5.9	2.4 ± 0.8	2381 594 x301y	VDRS10P300xyE
			800	50.0	117.0	4500	400	5.9	2.4 ± 0.8	2381 595 x301y	VDRS14T300xyE
			775	100.0	280.0	6500	810	6.9	2.7 ± 0.8	2381 596 x301y	VDRS20W300ByE
320	420	510	800	5.0	15.0	400	45	5.5	2.4 ± 0.8	2381 592 x321y	VDRS05C320xyE
			850	10.0	44.0	1200	120	5.5	2.4 ± 0.8	2381 593 x321y	VDRS07H320xyE
			850	25.0	77.0	2500	220	6.2	2.6 ± 0.8	2381 594 x321y	VDRS10P320xyE
			850	50.0	120.0	4500	370	6.2	2.6 ± 0.8	2381 595 x321y	VDRS14T320xyE
			842	100.0	296.0	6500	750	7.1	2.9 ± 0.8	2381 596 x321y	VDRS20W320ByE
350	460	560	940	5.0	19.5	400	42	5.8	2.7 ± 0.8	2381 592 x351y	VDRS05C350xyE
			920	10.0	39.0	1200	110	5.8	2.7 ± 0.8	2381 593 x351y	VDRS07H350xyE
			920	25.0	78.0	2500	200	6.6	2.9 ± 0.8	2381 594 x351y	VDRS10P350xyE
			920	50.0	156.0	4500	325	6.6	2.9 ± 0.8	2381 595 x351y	VDRS14T350xyE
			920	100.0	312.0	6500	660	7.4	3.2 ± 0.8	2381 596 x351y	VDRS20W350ByE

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE [3] at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY [4] (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT [5] I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS [1]	
RMS [2] (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC [6]	SAP [7]
385	505	620	1000	5.0	18.0	400	40	6.0	3.0 ± 0.8	2381 592 x381y	VDRS05C385xyE
			1025	10.0	51.0	1200	95	6.0	3.0 ± 0.8	2381 593 x381y	VDRS07H385xyE
			1025	25.0	67.0	2500	180	6.6	3.2 ± 0.8	2381 594 x381y	VDRS10P385xyE
			1025	50.0	110.0	4500	280	6.6	3.2 ± 0.8	2381 595 x381y	VDRS14T385xyE
			1025	100.0	328.0	6500	570	7.7	3.5 ± 0.8	2381 596 x381y	VDRS20W385ByE
420	560	680	1100	5.0	20.0	400	35	6.1	3.2 ± 0.8	2381 592 x421y	VDRS05C420xyE
			1120	10.0	56.0	1200	85	6.1	3.2 ± 0.8	2381 593 x421y	VDRS07H420xyE
			1120	25.0	73.0	2500	165	6.6	3.4 ± 0.8	2381 594 x421y	VDRS10P420xyE
			1120	50.0	120.0	4500	250	6.6	3.4 ± 0.8	2381 595 x421y	VDRS14T420xyE
			1120	100.0	344.0	6500	510	8.1	3.7 ± 0.8	2381 596 x421y	VDRS20W420ByE
460	615	750	1200	5.0	21.0	400	30	6.4	3.6 ± 0.8	2381 592 x461y	VDRS05C460xyE
			1240	10.0	63.0	1200	75	6.4	3.6 ± 0.8	2381 593 x461y	VDRS07H460xyE
			1240	25.0	82.0	2500	150	6.8	3.8 ± 0.8	2381 594 x461y	VDRS10P460xyE
			1240	50.0	135.0	4500	225	6.8	3.8 ± 0.8	2381 595 x461y	VDRS14T460xyE
			1240	100.0	360.0	6500	460	8.5	4.1 ± 0.8	2381 596 x461y	VDRS20W460ByE
510	670	820	1355	25.0	89.0	2500	135	7.2	4.1 ± 0.8	2381 594 x511y	VDRS10P510xyE
			1355	50.0	145.0	4500	220	7.2	4.1 ± 0.8	2381 595 x511y	VDRS14T510xyE
			1355	100.0	376.0	6500	450	8.9	4.4 ± 0.8	2381 596 x511y	VDRS20W510ByE
550	745	910	1500	25.0	98.0	2500	120	7.9	4.5 ± 0.8	2381 594 x551y	VDRS10P550xyE
			1500	50.0	160.0	4500	180	7.9	4.5 ± 0.8	2381 595 x551y	VDRS14T550xyE
			1500	100.0	408.0	6500	370	9.5	4.9 ± 0.8	2381 596 x551y	VDRS20W550ByE
625	825	1000	1650	100.0	448.0	6500	320	10.1	5.3 ± 0.8	2381 596 x621y	VDRS20W625ByE
680	895	1100	1815	100.0	496.0	6500	270	10.6	5.8 ± 0.8	2381 596 x681y	VDRS20W680ByE

Notes

(1) The products are certified according to (c)UL (E332800), VDE (40002622) and CSA (219883)

(2) The sinusoidal voltage is assumed as the normal operating condition. If a non-sinusoidal voltage is present, type selection should be based on multiplying the peak voltage by a factor of 0.707.

(3) The voltage measured at 1 mA meets the requirements of IEC 61051.
The tolerance on the voltage at 1 mA is ± 10 %.

(4) High energy surges are generally of longer duration. The maximum energy for one pulse of 10 x 1000 µs is given as a reference for longer duration pulses. This pulse can be characterised by peak current (I_p) and pulse width t_2 (virtual time of half I_p value, following IEC 60060-2, section 6). If V_p is the clamping voltage corresponding to I_p, the energy absorbed in the varistor is determined by the formula:
$E = K \times V_p \times I_p \times t_2$
where:
a) K is dependent on the value of t_2 when the value of t_1 is between 8 µs and 10 µs; see Peak Current as a Function of Pulse Width drawing.

(5) A current wave of 8 x 20 µs is used as a standard for pulse current and clamping voltage ratings. The maximum non-repetitive transient current is given for one pulse applied during the life of the component.

(6) For composition of the 12NC part number replace “x” and “y” by figures from the sections “Varistors in Bulk”, “Varistors on Tape in Ammopack” and “Varistors on Tape on Reel”.

(7) For composition of the SAP part number:

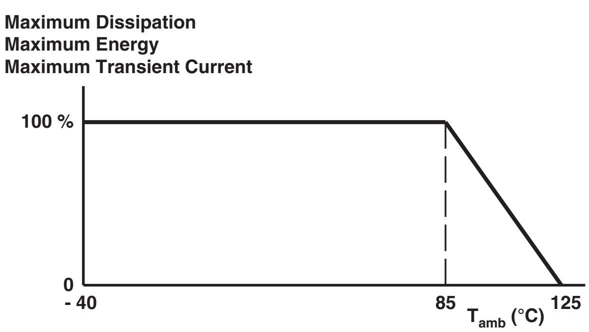
Replace “x” by
- B for bulk type
- T for tape and reel
- A for tape and ammopack

Replace “y” by
- S for straight leads
- F for straight leads with flange (bulk only)
- G for straight leads with flange and H_0 = 16 mm (tape and reel/ammo)
- H for straight leads with flange and H_0 = 18.25 mm (tape and reel/ammo)
- K for kinked leads (bulk only)
- L for kinked leads with H_0 = 16 mm (tape and reel/ammo)
- M for kinked leads with H_0 = 18.25 mm (tape and reel/ammo)

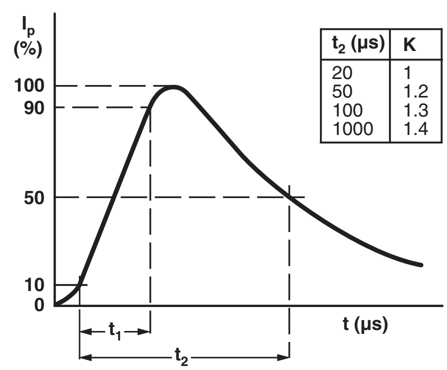
ELECTRICAL CHARACTERISTICS

ELECTRICAL DATA		
PARAMETER	**VALUE**	**UNIT**
Maximum continuous voltage:		
RMS	14 to 680	V
DC	18 to 895	V
Maximum non-repetitive transient current (I_{NRP}) (8 x 20 µs):		
2381 592 ...../VDRS05......E	100 or 400	A
2381 593 ...../VDRS07......E	250 or 1200	A
2381 594 ...../VDRS10......E	500 or 2500	A
2381 595 ...../VDRS14......E	1000 or 4500	A
2381 596 ...../VDRS20......E	2000 or 6500	A
Thermal resistance:		
2381 592 ...../VDRS05......E	≈ 80	K/W
2381 593 ...../VDRS07......E	≈ 70	K/W
2381 594 ...../VDRS10......E	≈ 60	K/W
2381 595 ...../VDRS14......E	≈ 50	K/W
2381 596 ...../VDRS20......E	≈ 40	K/W
Maximum dissipation:		
2381 592 ...../VDRS05......E	100	mW
2381 593 ...../VDRS07......E	250	mW
2381 594 ...../VDRS10......E	400	mW
2381 595 ...../VDRS14......E	600	mW
2381 596 ...../VDRS20......E	1000	mW
Temperature coefficient of voltage at 1 mA maximum	± 0.05	%/K
Voltage proof between interconnected leads and case	2500	V
Storage temperature	- 40 to + 125	°C
Operating temperature	- 40 to + 85	°C

DERATING CURVE



PEAK CURRENT AS A FUNCTION OF PULSE WIDTH



COMPONENT DIMENSIONS (BULK TYPE) in millimeters AND CATALOG NUMBERS

D MAX.	A MAX.	A_0 MAX.	L MIN.	T [(1)] MAX.	E [(1)]	d	F	CATALOG NUMBER
7.0	9.0	11.0	24.0	6.5	0.7 to 3.6	0.6 ± 0.05	5 ± 1.0	2381 592 ...../VDRS05......E
9.0	11.0	13.0	24.0	6.5	0.7 to 3.6	0.6 ± 0.05	5 ± 1.0	2381 593 ...../VDRS07......E
13.5	15.5	18.0	17.0	8	0.9 to 4.5	0.8 ± 0.05	7.5 ± 1.0	2381 594 ...../VDRS10......E
17.0	19.0	23.0	16.0	8	0.9 to 4.5	0.8 ± 0.05	7.5 ± 1.0	2381 595 ...../VDRS14......E
23.0	25.0	28.0	24.0	10	1.1 to 5.8	1.0 ± 0.05	10 ± 1.0	2381 596 ...../VDRS20......E

Note
[(1)] $T_{max.}$ and E values per size and voltage level can be found back in the Electrical Data table

VARISTORS IN BULK

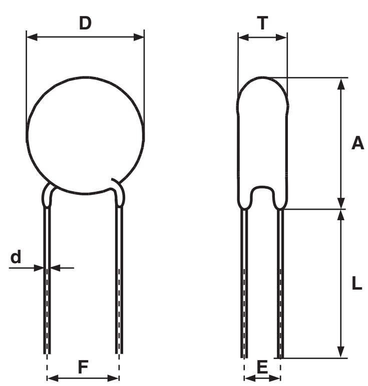
TYPE	2381 592 ..... Ø 5 mm 14 V to 460 V	2381 593 ..... Ø 7 mm 14 V to 460 V	2381 594 ..... Ø 10 mm 14 V to 550 V	2381 595 ..... Ø 14 mm 14 V to 550 V	2381 596 ..... Ø 20 mm 14 V to 680 V
Straight leads; see outline of components with straight leads drawing (1)	5...6	5...6	5...6	5...6	5...6
Straight leads with flange; see outline of components with flanged leads drawing	7...6	7...6	-	-	-
Kinked leads; see outline of components with kinked leads drawing	6...6	6...6	6...6	6...6	6...6
Packaging quantities					
14 V to 95 V	250	250	250	100	50
130 V to 385 V	250	250	250	100	50
420 V to 460 V	250	250	200	100	50
485 V to max. V	-	250	150	100	50

Note

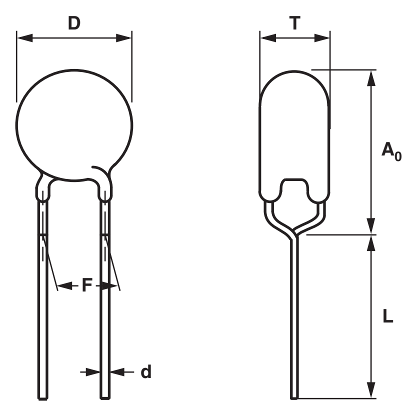
(1) Outline of the Ø 20 mm differs from the other dimensions

DIMENSIONS in millimeters: See Component Dimensions and Electrical Data table

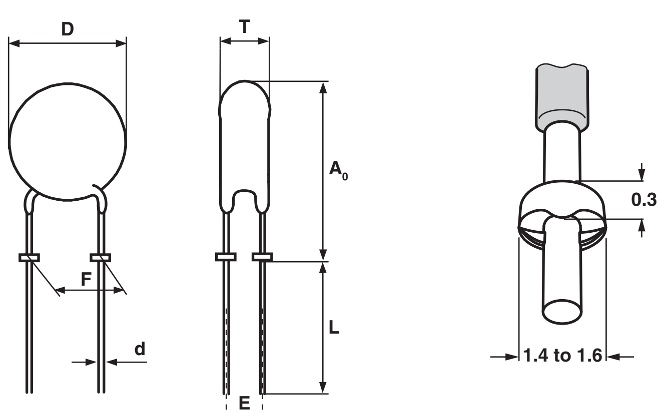
OUTLINE of Component with Straight Leads



OUTLINE of Component with Kinked Leads



OUTLINE of Component with Flanged Leads

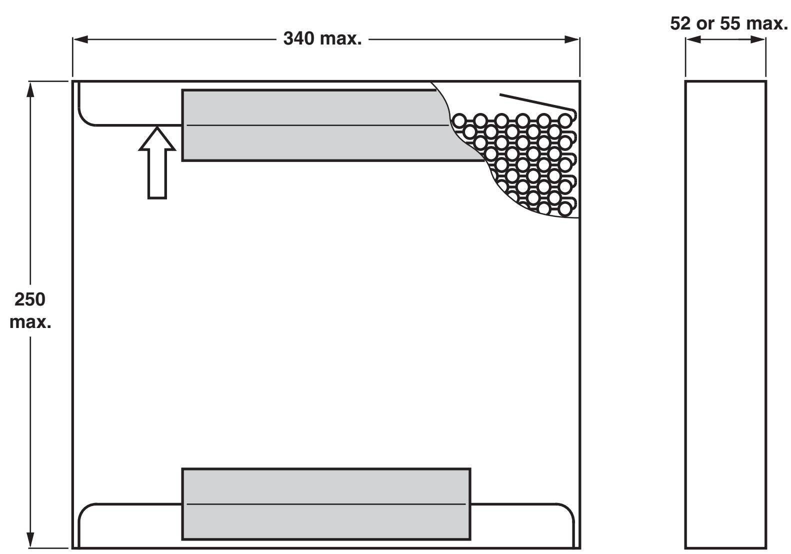


VARISTORS ON TAPE IN AMMOPACK				
TYPE	**2381 592 .....** **Ø 5 mm** **14 V to 460 V**	**2381 593 .....** **Ø 7 mm** **14 V to 460 V**	**2381 594 .....** **Ø 10 mm** **14 V to 550 V**	**2381 595 .....** **Ø 14 mm** **14 V to 550 V**
Straight leads				
H = 18 mm	-	-	0...7	0...7
H = 20 mm	0...7	0...7	-	-
See drawing: Taped version with straight leads				
Straight leads with flange				
H_0 = 16 mm	1...7	1...7	-	-
H_0 = 18.25 mm	2...7	2...7	-	-
See drawing: Taped version with flanged leads				
Kinked leads				
H_0 = 18.25 mm	3...7	3...7	3...7	3...7
H_0 = 16 mm	8...7	8...7	8...7	8...7
See drawing: Taped version with kinked leads				
Packaging quantities				
14 V to 210 V	1500 (1)	1500 (1)	500	500
230 V to max. V	1000	1000	500	500

Note

(1) Except for 35 V and 40 V = 1000 pieces

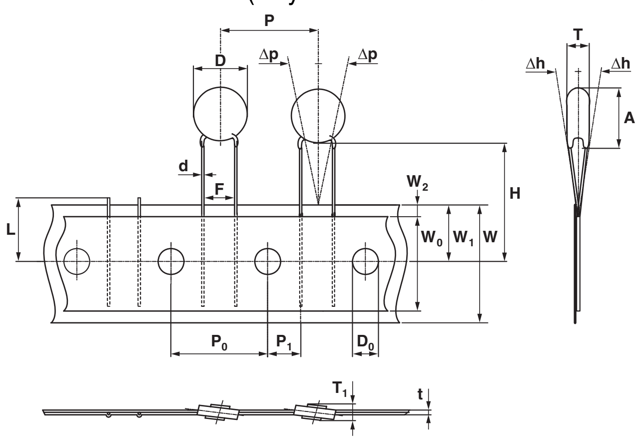
DIMENSIONS OF AMMOPACK in millimeters



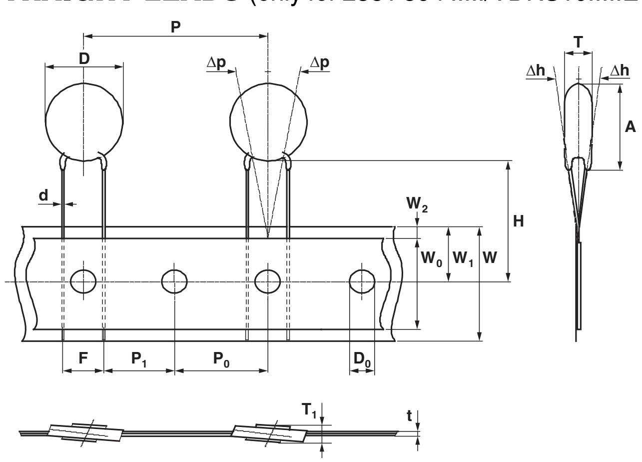
VARISTORS ON TAPE AND REEL				
TYPE	**2381 592 .....** **Ø 5 mm** **14 V to 460 V**	**2381 593 .....** **Ø 7 mm** **14 V to 460 V**	**2381 594 .....** **Ø 10 mm** **14 V to 550 V**	**2381 595 .....** **Ø 14 mm** **14 V to 550 V**
Straight leads H = 18 mm H = 20 mm See drawing: Taped version with straight leads	 - 0...6	 - 0...6	 0...6 -	 0...6 -
Straight leads with flange H_0 = 16 mm H_0 = 18.25 mm See drawing: Taped version with flanged leads	 1...6 2...6	 1...6 2...6	 - -	 - -
Kinked leads H_0 = 18.25 mm H_0 = 16 mm See drawing: Taped version with kinked leads	 3...6 8...6	 3...6 8...6	 3...6 8...6	 3...6 8...6
Packaging quantities				
14 V to 250 V	1500	1500	1000	750
275 V to 300 V	1500	1500	750	750
320 V to 350 V	1000	1000	500	500
385 V to max. V	1000	1000	500	500

PACKAGING

TAPED VERSION WITH STRAIGHT LEADS (only for 2381 592 ...../VDRS05.....E and 2381 593...../VDRS07.....E)

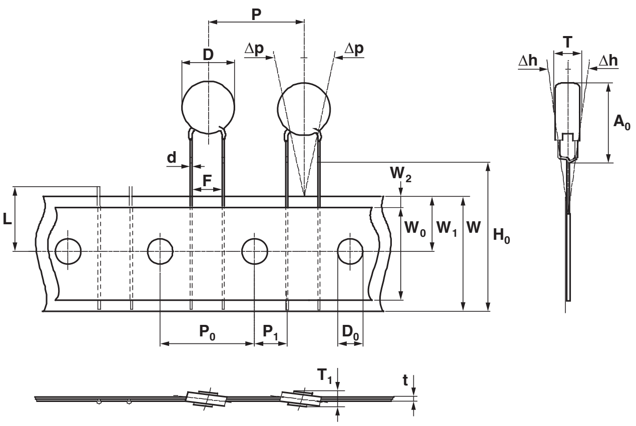


TAPED VERSION WITH STRAIGHT LEADS (only for 2381 594 ...../VDRS10.....E and 2381 595 ...../VDRS14.....E)



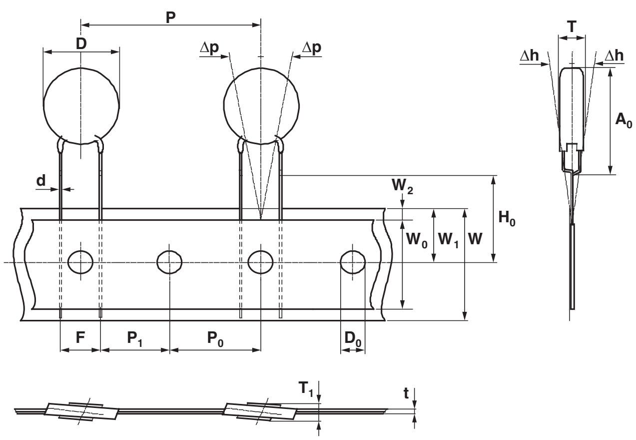
TAPED VERSION WITH KINKED LEADS

(only for 2381 592 ...../VDRS05.....E and 2381 593 ...../VDRS07.....E)



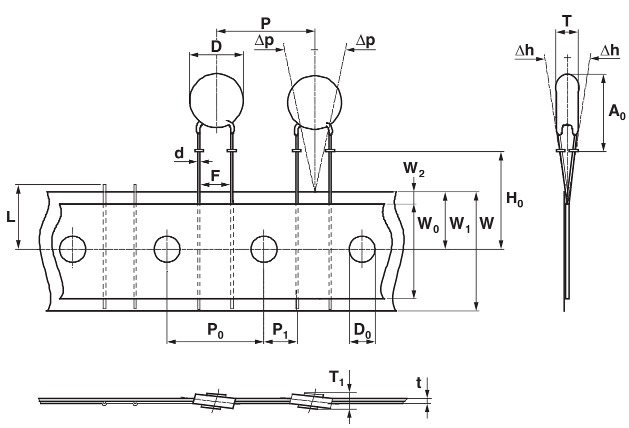
TAPED VERSION WITH KINKED LEADS

(only for 2381 594 ...../VDRS10.....E and 2381 595 ...../VDRS14.....E)



TAPED VERSION WITH FLANGED LEADS

(only for 2381 592 ...../VDRS05.....E and 2381 593 ...../VDRS07.....E)



TAPING DATA (based on IEC 60286-2)					
SYMBOL	**PARAMETER**	**DIMENSIONS/TOLERANCE**			
		592	**593**	**594**	**595**
A	Mounting height	9.0 max.	11.0 max.	15.5 max.	19.0 max.
A_0	Mounting height	11.0 max.	13.0 max.	18.0 max.	23.0 max.
D	Body diameter	7.0 max.	9.0 max.	13.5 max.	17.0 max.
d	Lead wire diameter	0.6 ± 0.05		0.8 ± 0.05	
F	Lead to lead distance (1)	5.0 + 0.8/- 0.2		7.5 ± 0.8	
H	Distance component to tape center (2)	20.0 + 2.0/- 0.0		18.0 + 2.0/- 0.0	
H_0	Lead wire clinch height	16.0 or 18.25 ± 0.5			
P	Pitch of components on tape	12.7 ± 1.0		25.4 ± 1.0	
T	Total thickness	See Electrical Data table			

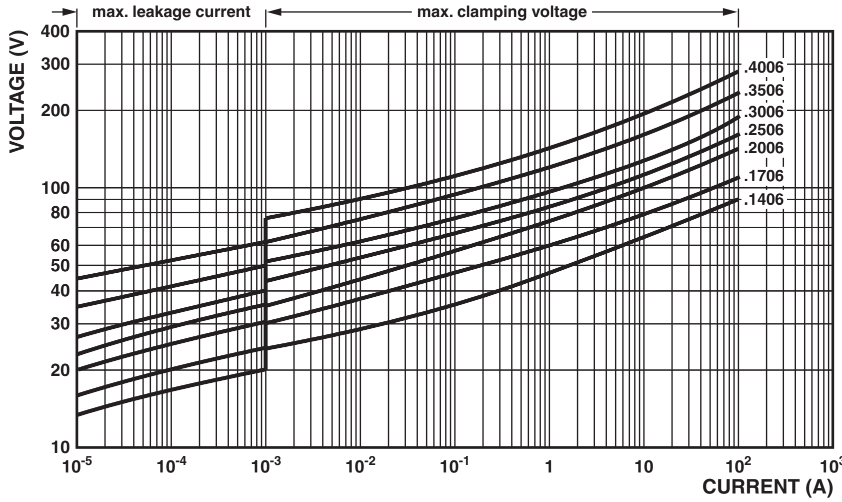
Notes

(1) Guaranteed between component and tape

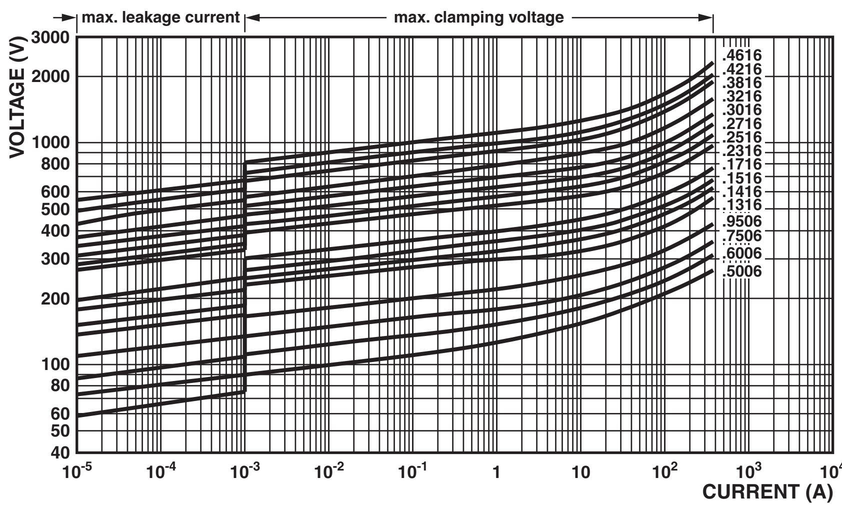
(2) For 2381 595 0511y and 2381 595 0551y: H = 20 mm ± 1 mm

V/I CHARACTERISTICS

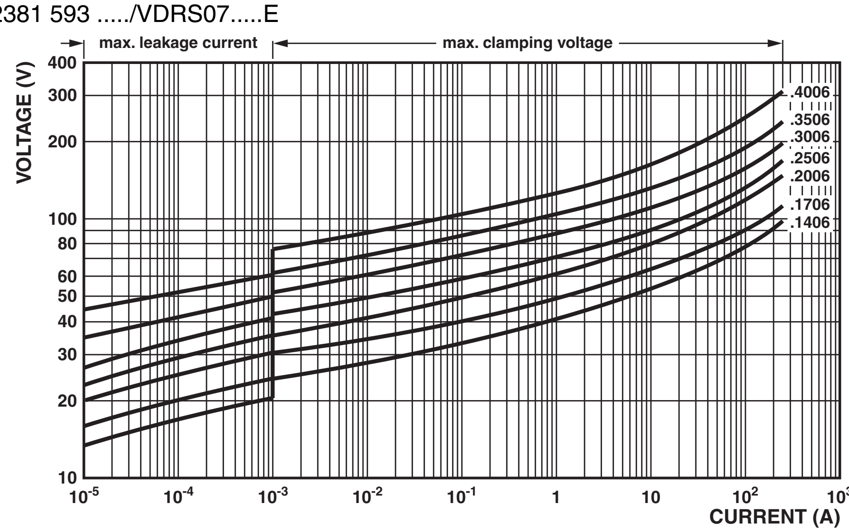
14 V_{RMS} to 40 V_{RMS}; 2381 592 ...../VDRS05.....E



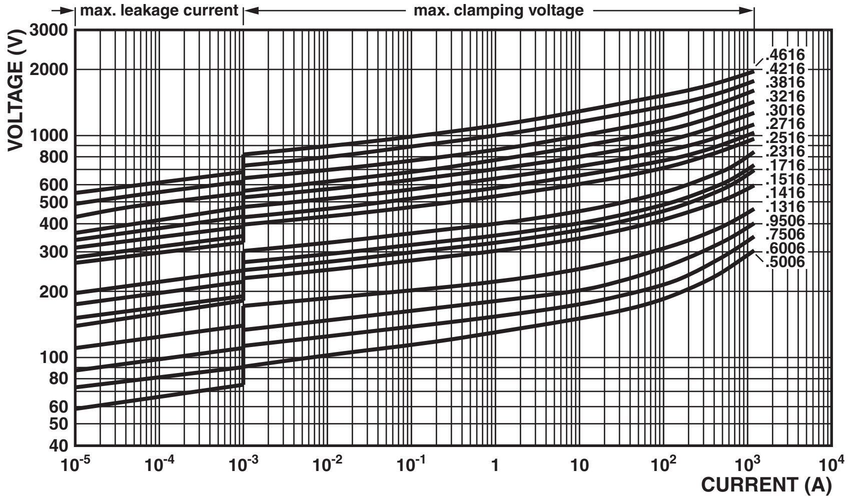
50 V_{RMS} to 460 V_{RMS}; 2381 592 ...../VDRS05.....E



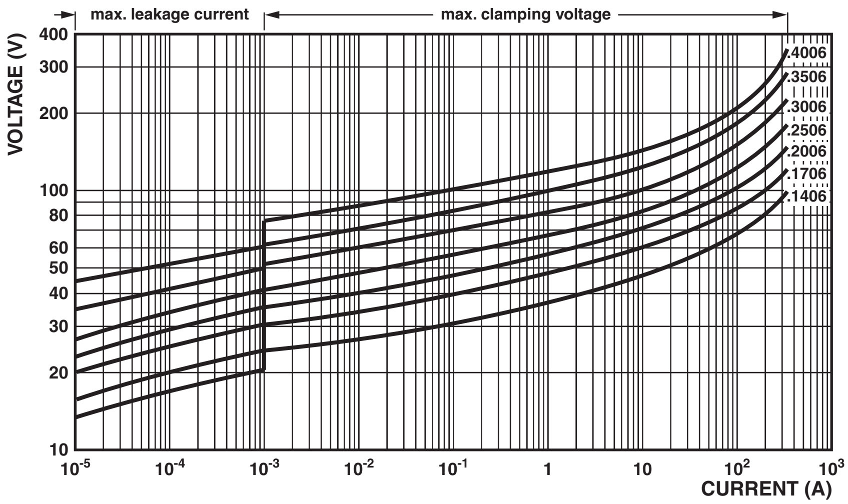
14 V_{RMS} to 40 V_{RMS}; 2381 593 ...../VDRS07.....E



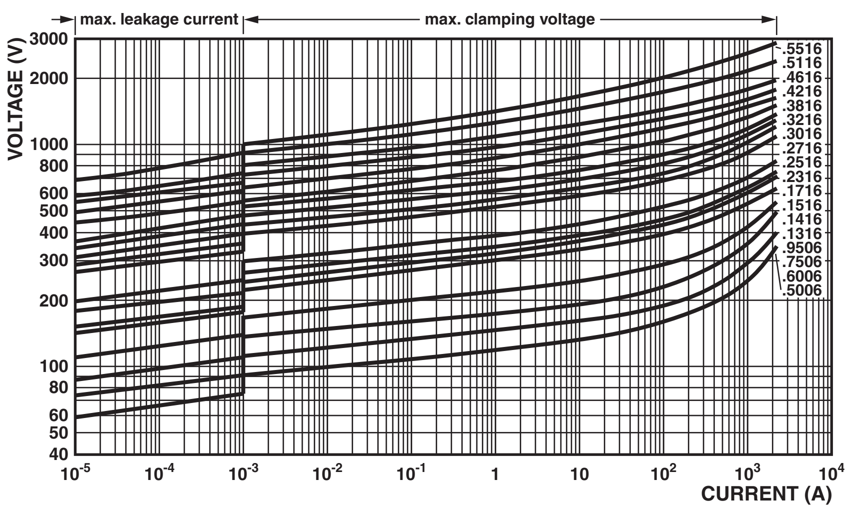
50 V_{RMS} to 460 V_{RMS}; 2381 593 ...../VDRS07.....E



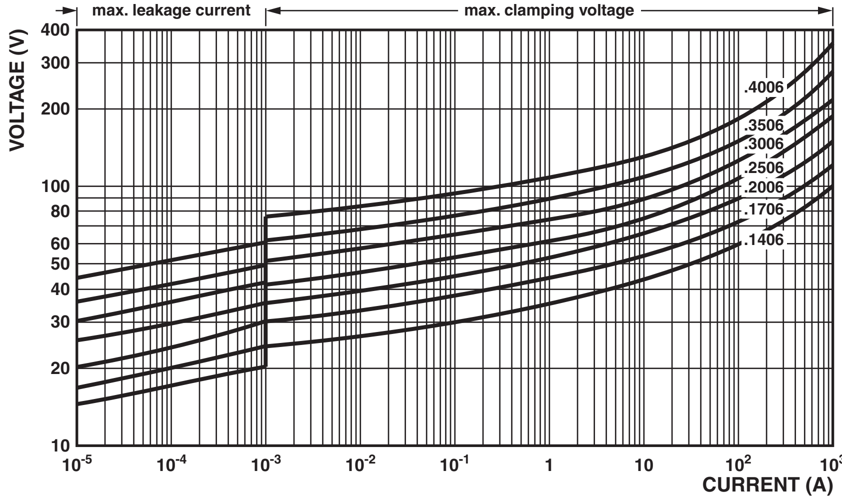
14 V_{RMS} to 40 V_{RMS}; 2381 594 ...../VDRS10.....E



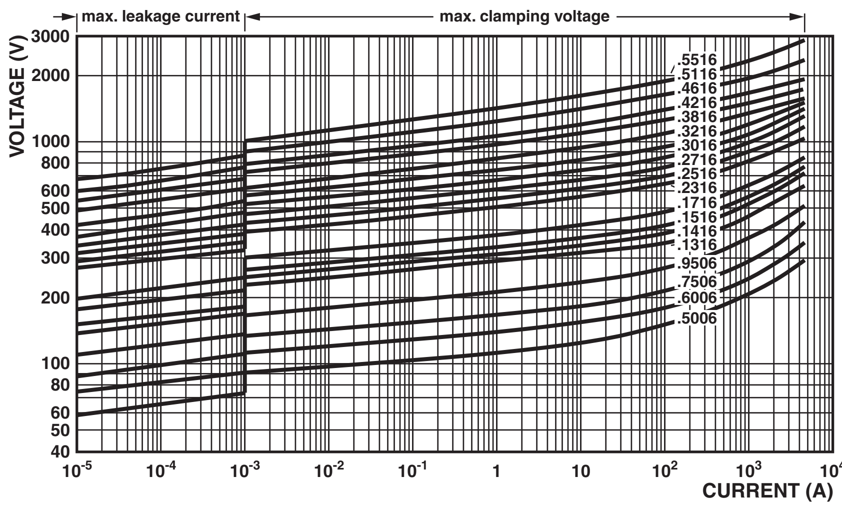
50 V_{RMS} to 550 V_{RMS}; 2381 594 ...../VDRS10.....E



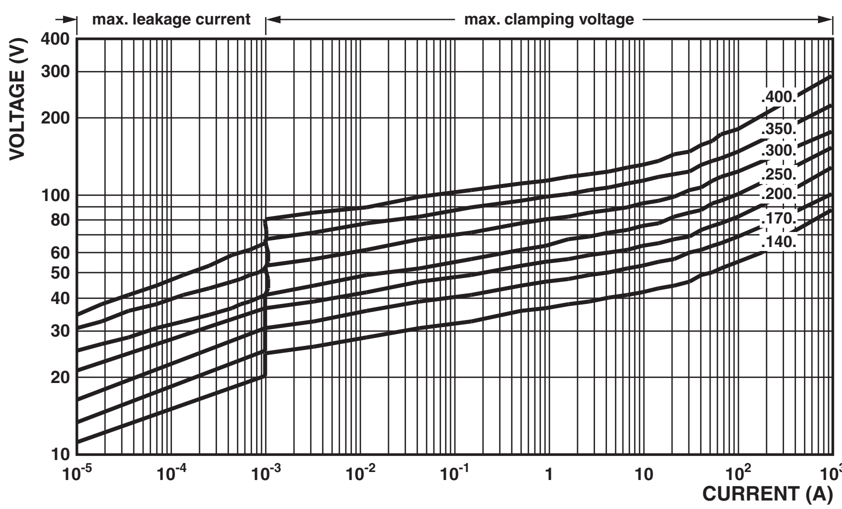
14 V_{RMS} to 40 V_{RMS}; 2381 595 ...../VDRS14.....E



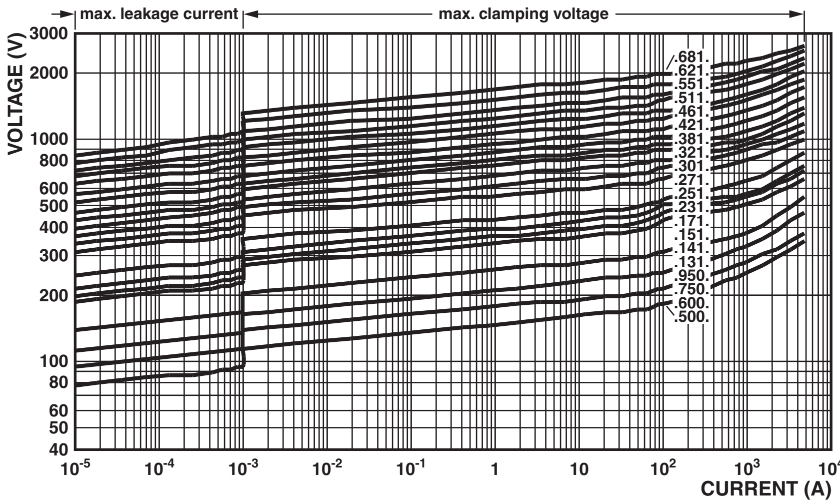
50 V_{RMS} to 550 V_{RMS}; 2381 595 ...../VDRS14.....E



14 V_{RMS} to 40 V_{RMS}; 2381 596 ...../VDRS20.....E

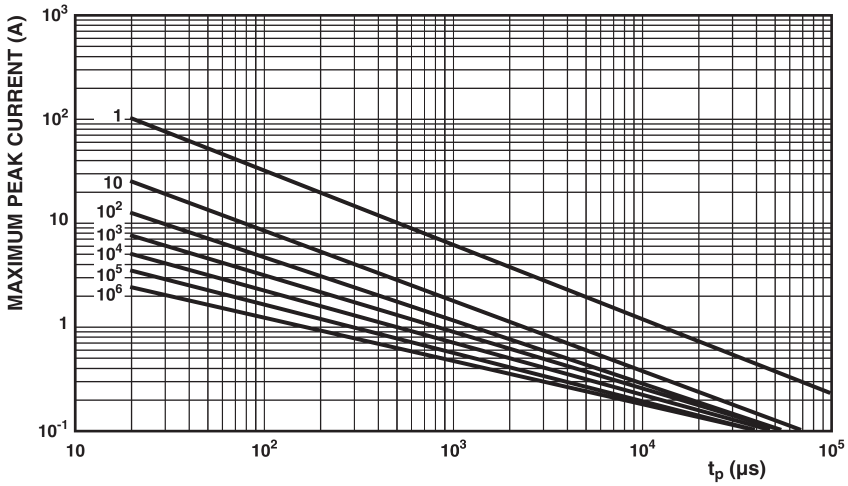


50 V_{RMS} to 680 V_{RMS}; 2381 596 ...../VDRS20.....E

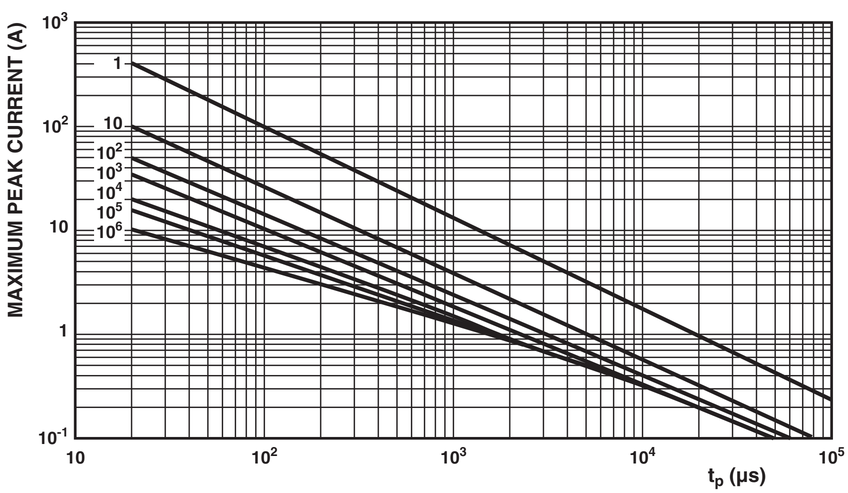


MAXIMUM APPLICABLE TRANSIENT CURRENT AS A FUNCTION OF PULSE DURATION

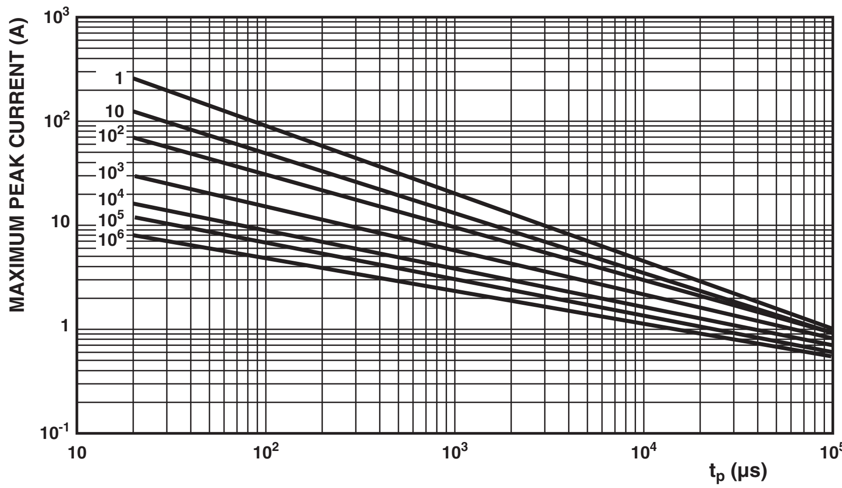
14 V_{RMS} to 40 V_{RMS}; 2381 592 ...../VDRS05.....E



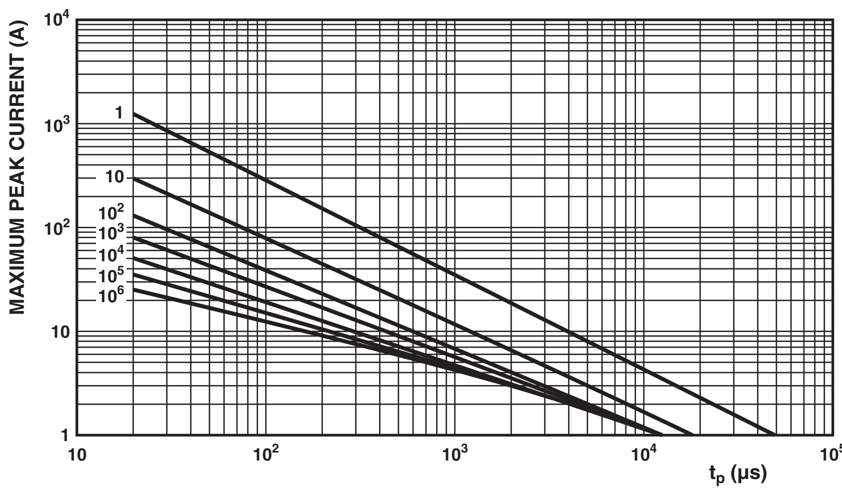
50 V_{RMS} to 460 V_{RMS}; 2381 592 ...../VDRS05.....E



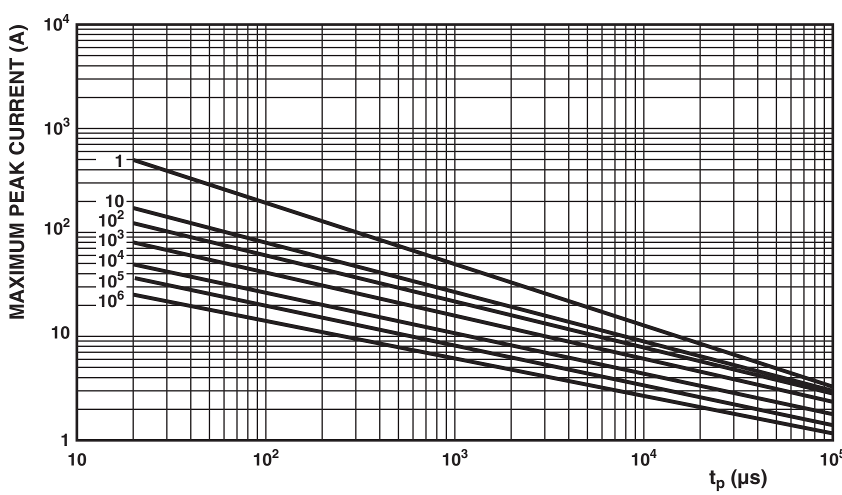
14 V_{RMS} to 40 V_{RMS}; 2381 593 ...../VDRS07.....E



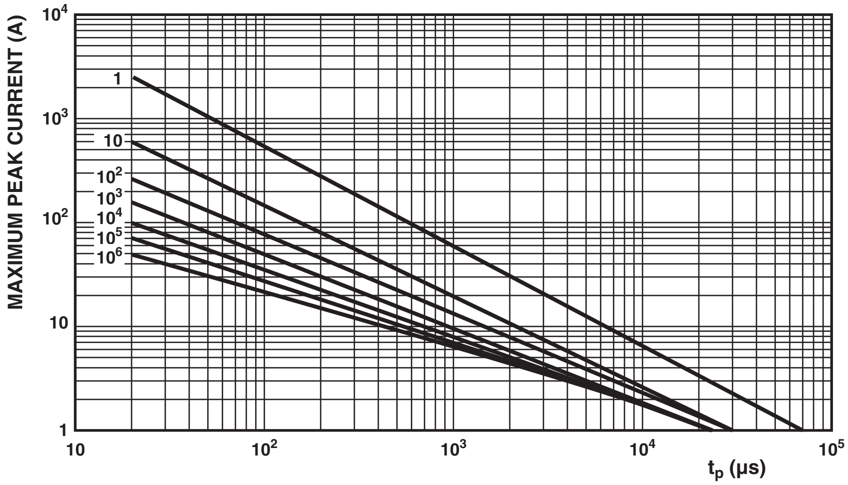
50 V_{RMS} to 460 V_{RMS}; 2381 593 ...../VDRS07.....E



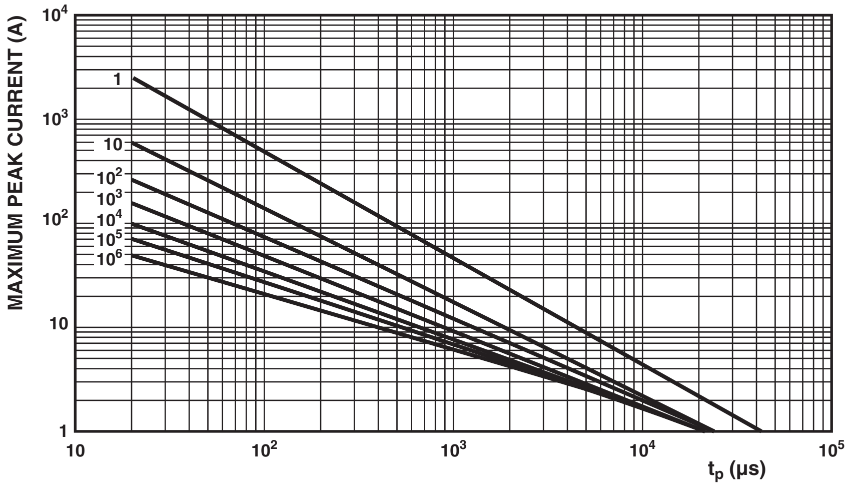
14 V_{RMS} to 40 V_{RMS}; 2381 594 ...../VDRS10.....E



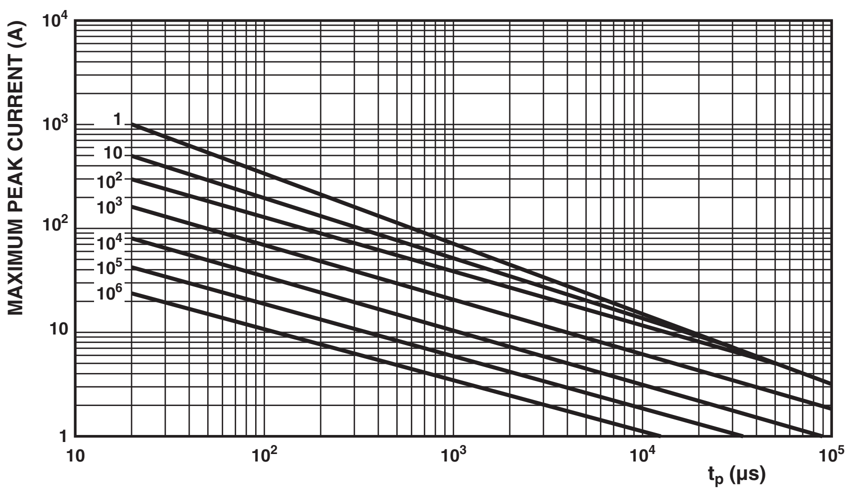
50 V_{RMS} to 320 V_{RMS}; 2381 594 ...../VDRS10.....E



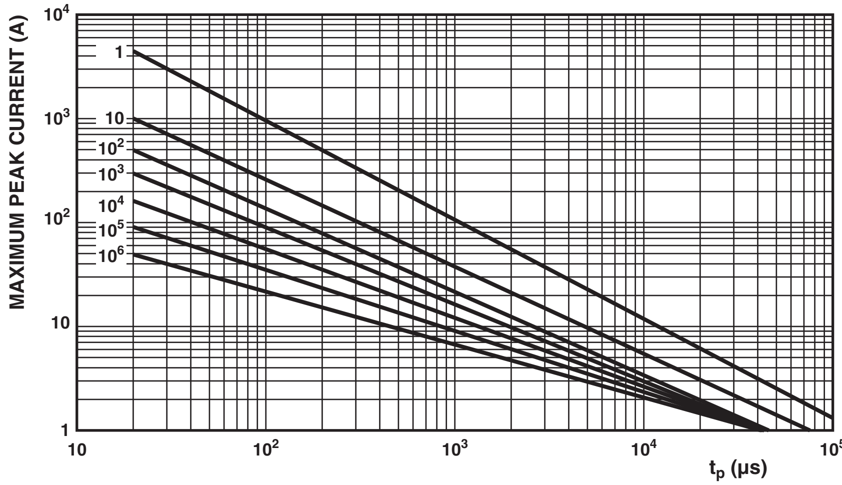
385 V_{RMS} to 550 V_{RMS}; 2381 594 ...../VDRS10.....E



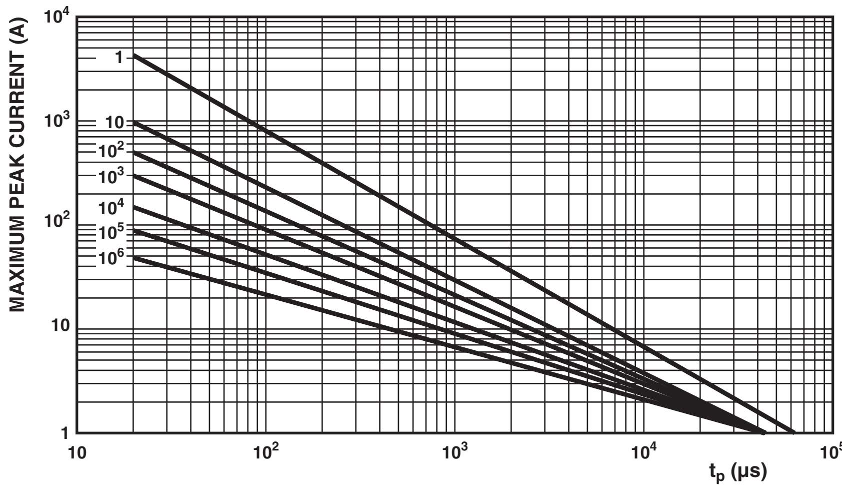
14 V_{RMS} to 40 V_{RMS}; 2381 595 ...../VDRS14.....E



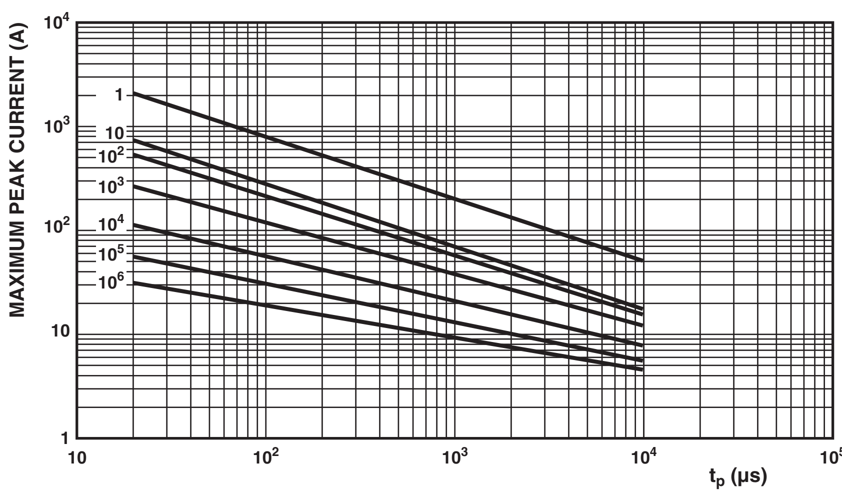
50 V_{RMS} to 320 V_{RMS}; 2381 595 ...../VDRS14.....E



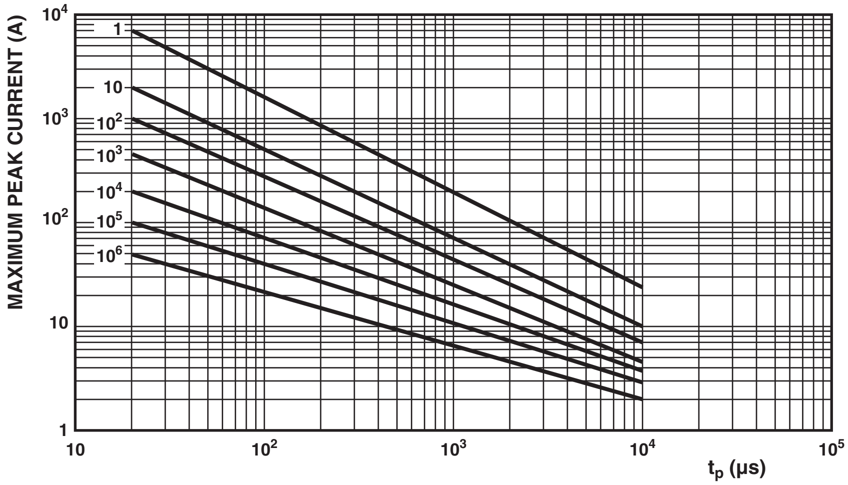
385 V_{RMS} to 550 V_{RMS}; 2381 595 ...../VDRS14.....E



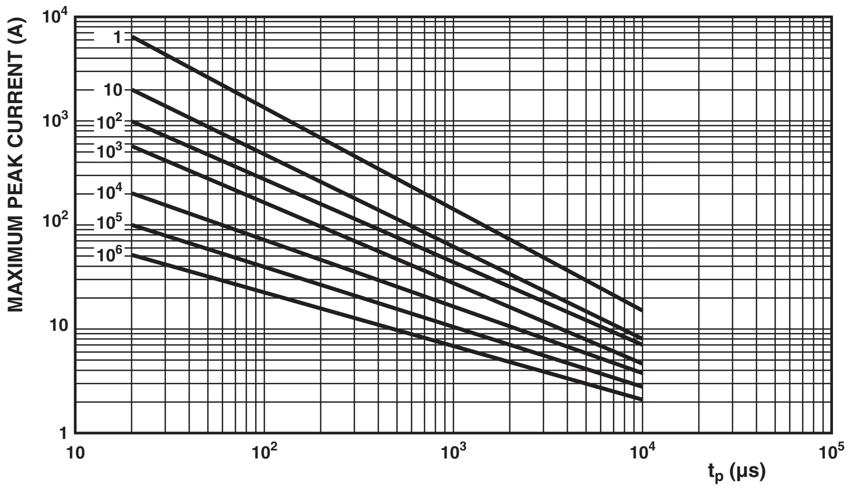
14 V_{RMS} to 40 V_{RMS}; 2381 596 ...../VDRS20.....E



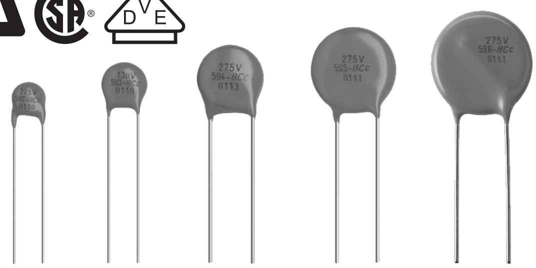
60 V_{RMS} to 300 V_{RMS}; 2381 596 ...../VDRS20.....E



320 V_{RMS} to 680 V_{RMS}; 2381 596 ...../VDRS20.....E



VDR Metal Oxide Varistors High Surge



FEATURES

- Zinc oxide disc, epoxy coated
- Straight or kinked leads
- Higher current surge/size ratio capability up to 10 kA for H20 types
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC
- Certified according to UL 1449 edition 3, VDE/IEC 61051-1/2 and CSA

RoHS
COMPLIANT

QUICK REFERENCE DATA		
PARAMETER	**VALUE**	**UNIT**
Maximum continuous voltage in operating temperature range:		
RMS	11 to 680	V
DC	14 to 895	V
Maximum non-repetitive transient current I_{NRP} (8 x 20 µs)	250 to 10 000	A
Detailed specification	Based on IEC 61051-1 IEC 61051-2 IEC 61051-2-2	
Storage temperature	- 40 to + 150	°C
Operating temperature	- 40 to + 125	°C

ORDERING INFORMATION

The varistors are available in a number of packaging options:

- Bulk
- On tape on reel
- On tape in ammopack

The basic ordering code for each option is given in tables titled Varistors on Tape on Reel, Varistors on Tape in Ammopack and Varistors in Bulk. To complete the catalog number and to determine the required operating parameters, see Electrical Data and Ordering Information table.

APPLICATION

- Overvoltage and transient voltage protection

DESCRIPTION

The varistors consist of a disc of low-ß ceramic material with two tinned solid copper leads. They are coated with a layer of ochre colored epoxy, which provides electrical, mechanical and climatic protection. The encapsulation is resistant to all cleaning solvents in accordance with IEC 60068-2-45.

MOUNTING

The varistors are suitable for processing on automatic insertion and cutting and bending equipment.

Typical Soldering

235 °C, duration: 5 s (Pb-bearing)
245 °C, duration: 5 s (lead (Pb)-free)

Resistance to soldering heat

260 °C; duration: 10 s max.

MARKING

The varistors are marked with the following information:

- Maximum continuous RMS voltage
- Series number (582, 583, 584, 585 or 586)
- Manufacturer logo
- Date of manufacture (YYWW)

INFLAMMABILITY

The varistors are non-flammable. The encapsulation is made of flammable-resistant epoxy lacquer in accordance with UL 94 V-0.

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE (3) at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY (4) (10 x 1000 μs)	MAXIMUM NON-REP. TRANSIENT CURRENT (5) I_{NRP} (8 x 20 μs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS (1)	
RMS (2) (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC (6)	SAP (7)
11	14	18	40	1.0	0.7	250	1600	3.4	0.5 ± 0.3	2381 582 x110y	VDRH05B011xyE
			36	2.5	1.5	500	3600	3.4	0.5 ± 0.3	2381 583 x110y	VDRH07D011xyE
			36	5.0	2.6	1000	8000	3.8	0.7 ± 0.3	2381 584 x110y	VDRH10G011xyE
			36	10.0	5.2	2000	20 000	3.8	0.7 ± 0.3	2381 585 x110y	VDRH14M011xyE
			36	20.0	13.0	3000	40 000	4.2	0.9 ± 0.3	2381 586 x110y	VDRH20R011ByE
14	18	22	48	1.0	0.8	250	1300	3.4	0.7 ± 0.3	2381 582 x140y	VDRH05B014xyE
			43	2.5	1.7	500	2800	3.4	0.7 ± 0.3	2381 583 x140y	VDRH07D014xyE
			43	5.0	3.2	1000	6000	3.8	0.9 ± 0.3	2381 584 x140y	VDRH10G014xyE
			43	10.0	6.3	2000	15 000	3.8	0.9 ± 0.3	2381 585 x140y	VDRH14M014xyE
			43	20.0	16.0	3000	30 000	4.2	1.1 ± 0.3	2381 586 x140y	VDRH20R014ByE
17	22	27	60	1.0	1.1	250	1050	3.7	0.8 ± 0.3	2381 582 x170y	VDRH05B017xyE
			53	2.5	2.1	500	2000	3.7	0.8 ± 0.3	2381 583 x170y	VDRH07D017xyE
			53	5.0	3.9	1000	4000	4.1	1.0 ± 0.3	2381 584 x170y	VDRH10G017xyE
			53	10.0	7.8	2000	10 000	4.1	1.0 ± 0.3	2381 585 x170y	VDRH14M017xyE
			53	20.0	19.0	3000	20 000	4.5	1.2 ± 0.3	2381 586 x170y	VDRH20R017ByE
20	26	33	73	1.0	1.3	250	900	3.9	1.0 ± 0.3	2381 582 x200y	VDRH05B020xyE
			65	2.5	2.8	500	1500	3.9	1.0 ± 0.3	2381 583 x200y	VDRH07D020xyE
			65	5.0	4.8	1000	3000	4.3	1.2 ± 0.3	2381 584 x200y	VDRH10G020xyE
			65	10.0	9.5	2000	7500	4.3	1.2 ± 0.3	2381 585 x200y	VDRH14M020xyE
			65	20.0	24.0	3000	15 000	4.7	1.4 ± 0.3	2381 586 x200y	VDRH20R020ByE
25	31	39	86	1.0	1.5	250	500	4.2	1.2 ± 0.3	2381 582 x250y	VDRH05B025xyE
			77	2.5	3.0	500	1350	4.2	1.2 ± 0.3	2381 583 x250y	VDRH07D025xyE
			77	5.0	5.6	1000	2600	4.6	1.4 ± 0.3	2381 584 x250y	VDRH10G025xyE
			77	10.0	11.0	2000	6500	4.6	1.4 ± 0.3	2381 585 x250y	VDRH14M025xyE
			77	20.0	28.0	3000	13 000	5.0	1.6 ± 0.3	2381 586 x250y	VDRH20R025ByE
30	38	47	104	1.0	1.8	250	700	4.4	1.4 ± 0.5	2381 582 x300y	VDRH05B030xyE
			93	2.5	3.8	500	1600	4.4	1.4 ± 0.5	2381 583 x300y	VDRH07D030xyE
			93	5.0	6.8	1000	2700	4.8	1.6 ± 0.5	2381 584 x300y	VDRH10G030xyE
			93	10.0	14.0	2000	6000	4.8	1.6 ± 0.5	2381 585 x300y	VDRH14M030xyE
			93	20.0	34.0	3000	12 000	5.2	1.8 ± 0.5	2381 586 x300y	VDRH20R030ByE
35	45	56	123	1.0	2.2	250	560	4.8	1.7 ± 0.5	2381 582 x350y	VDRH05B035xyE
			110	2.5	4.4	500	1300	4.8	1.7 ± 0.5	2381 583 x350y	VDRH07D035xyE
			110	5.0	8.1	1000	2200	5.2	1.9 ± 0.5	2381 584 x350y	VDRH10G035xyE
			110	10.0	16.0	2000	4800	5.2	1.9 ± 0.5	2381 585 x350y	VDRH14M035xyE
			110	20.0	41.0	3000	9600	5.6	2.1 ± 0.5	2381 586 x350y	VDRH20R035ByE
40	56	68	150	1.0	2.6	250	460	5.1	2.1 ± 0.5	2381 582 x400y	VDRH05B040xyE
			135	2.5	5.4	500	1000	5.1	2.1 ± 0.5	2381 583 x400y	VDRH07D040xyE
			135	5.0	9.8	1000	1800	5.5	2.3 ± 0.5	2381 584 x400y	VDRH10G040xyE
			135	10.0	20.0	2000	3800	5.5	2.3 ± 0.5	2381 585 x400y	VDRH14M040xyE
			135	20.0	49.0	3000	7600	5.9	2.5 ± 0.5	2381 586 x400y	VDRH20R040ByE
50	65	82	145	5.0	3.5	800	370	3.5	0.6 ± 0.3	2381 582 x500y	VDRH05E050xyE
			135	10.0	7.0	1750	900	3.5	0.6 ± 0.3	2381 583 x500y	VDRH07K050xyE
			135	25.0	14.0	3500	1500	3.9	0.8 ± 0.3	2381 584 x500y	VDRH10S050xyE
			135	50.0	28.0	6000	3100	3.9	0.8 ± 0.3	2381 585 x500y	VDRH14V050xyE

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE [3] at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY [4] (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT [5] I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS [1]	
RMS [2] (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC [6]	SAP [7]
60	85	100	175	5.0	4.5	800	290	3.7	0.7 ± 0.3	2381 582 x600y	VDRH05E060xyE
			165	10.0	9.0	1750	700	3.7	0.7 ± 0.3	2381 583 x600y	VDRH07K060xyE
			165	25.0	18.0	3500	1200	4.1	0.9 ± 0.3	2381 584 x600y	VDRH10S060xyE
			165	50.0	36.0	6000	2300	4.1	0.9 ± 0.3	2381 585 x600y	VDRH14V060xyE
			165	100.0	72.0	10 000	4600	4.5	1.1 ± 0.3	2381 586 x600y	VDRH20X060ByE
75	100	120	210	5.0	5.5	800	240	4.0	0.9 ± 0.3	2381 582 x750y	VDRH05E075xyE
			200	10.0	11.0	1750	530	4.0	0.9 ± 0.3	2381 583 x750y	VDRH07K075xyE
			200	25.0	22.0	3500	1000	4.4	1.1 ± 0.3	2381 584 x750y	VDRH10S075xyE
			200	50.0	44.0	6000	1900	4.4	1.1 ± 0.3	2381 585 x750y	VDRH14V075xyE
			200	100.0	88.0	10 000	3800	4.8	1.3 ± 0.3	2381 586 x750y	VDRH20X075ByE
95	125	150	260	5.0	6.5	800	180	4.2	1.1 ± 0.3	2381 582 x950y	VDRH05E095xyE
			250	10.0	13.0	1750	450	4.2	1.1 ± 0.3	2381 583 x950y	VDRH07K095xyE
			250	25.0	25.0	3500	800	4.6	1.3 ± 0.3	2381 584 x950y	VDRH10S095xyE
			250	50.0	53.0	6000	1500	4.6	1.3 ± 0.3	2381 585 x950y	VDRH14V095xyE
			250	100.0	106.0	10 000	3000	5.0	1.5 ± 0.3	2381 586 x950y	VDRH20X095ByE
115	150	180	320	5.0	8.0	800	150	3.6	0.9 ± 0.3	2381 582 x111y	VDRH05E115xyE
			300	10.0	16.0	1750	390	3.6	0.9 ± 0.3	2381 583 x111y	VDRH07K115xyE
			300	25.0	32.0	3500	680	4.0	1.1 ± 0.3	2381 584 x111y	VDRH10S115xyE
			300	50.0	65.0	6000	1320	4.0	1.1 ± 0.3	2381 585 x111y	VDRH14V115xyE
			300	100.0	130.0	10 000	2640	4.4	1.3 ± 0.3	2381 586 x111y	VDRH20X115ByE
130	170	205	355	5.0	8.5	800	130	3.8	1.0 ± 0.3	2381 582 x131y	VDRH05E130xyE
			340	10.0	17.5	1750	320	3.8	1.0 ± 0.3	2381 583 x131y	VDRH07K130xyE
			340	25.0	35.0	3500	580	4.3	1.2 ± 0.3	2381 584 x131y	VDRH10S130xyE
			340	50.0	70.0	6000	1050	4.3	1.2 ± 0.3	2381 585 x131y	VDRH14V130xyE
			340	100.0	140.0	10 000	2100	4.8	1.4 ± 0.3	2381 586 x131y	VDRH20X130ByE
140	180	220	380	5.0	9.0	800	120	3.9	1.0 ± 0.3	2381 582 x141y	VDRH05E140xyE
			360	10.0	19.0	1750	290	3.9	1.0 ± 0.3	2381 583 x141y	VDRH07K140xyE
			360	25.0	39.0	3500	540	4.3	1.2 ± 0.3	2381 584 x141y	VDRH10S140xyE
			360	50.0	78.0	6000	950	4.3	1.2 ± 0.3	2381 585 x141y	VDRH14V140xyE
			360	100.0	155.0	10 000	1900	4.8	1.5 ± 0.3	2381 586 x141y	VDRH20X140ByE
150	200	240	415	5.0	10.5	800	110	4.1	1.1 ± 0.3	2381 582 x151y	VDRH05E150xyE
			395	10.0	21.0	1750	270	4.1	1.1 ± 0.3	2381 583 x151y	VDRH07K150xyE
			395	25.0	42.0	3500	490	4.3	1.3 ± 0.3	2381 584 x151y	VDRH10S150xyE
			395	50.0	84.0	6000	850	4.3	1.3 ± 0.3	2381 585 x151y	VDRH14V150xyE
			395	100.0	168.0	10 000	1700	4.8	1.5 ± 0.3	2381 586 x151y	VDRH20X150ByE
175	225	275	475	5.0	11.0	800	90	4.1	1.3 ± 0.3	2381 582 x171y	VDRH05E175xyE
			455	10.0	24.0	1750	230	4.1	1.3 ± 0.3	2381 583 x171y	VDRH07K175xyE
			455	25.0	49.0	3500	430	4.5	1.5 ± 0.3	2381 584 x171y	VDRH10S175xyE
			455	50.0	99.0	6000	750	4.5	1.5 ± 0.3	2381 585 x171y	VDRH14V175xyE
			455	100.0	190.0	10 000	1500	4.9	1.7 ± 0.3	2381 586 x171y	VDRH20X175ByE
195	250	300	525	5.0	12.0	800	80	4.3	1.4 ± 0.8	2381 582 x191y	VDRH05E195xyE
			455	10.0	26.0	1750	210	4.3	1.4 ± 0.8	2381 583 x191y	VDRH07K195xyE
			455	25.0	52.0	3500	380	4.8	1.6 ± 0.8	2381 584 x191y	VDRH10S195xyE
			455	50.0	105.0	6000	690	4.8	1.6 ± 0.8	2381 585 x191y	VDRH14V195xyE
			455	100.0	210.0	10 000	1350	5.1	1.9 ± 0.8	2381 586 x191y	VDRH20X195ByE

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE [3] at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY [4] (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT [5] I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS [1]	
RMS [2] (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC [6]	SAP [7]
210	275	330	575	5.0	13.0	800	75	4.4	1.6 ± 0.8	2381 582 x211y	VDRH05E210xyE
			505	10.0	28.0	1750	190	4.4	1.6 ± 0.8	2381 583 x211y	VDRH07K210xyE
			505	25.0	58.0	3500	350	4.8	1.8 ± 0.8	2381 584 x211y	VDRH10S210xyE
			505	50.0	115.0	6000	610	4.8	1.8 ± 0.8	2381 585 x211y	VDRH14V210xyE
			505	100.0	228.0	10 000	1250	5.3	2.0 ± 0.8	2381 586 x211y	VDRH20X210ByE
230	300	360	620	5.0	16.0	800	70	4.6	1.7 ± 0.8	2381 582 x231y	VDRH05E230xyE
			595	10.0	32.0	1750	170	4.6	1.7 ± 0.8	2381 583 x231y	VDRH07K230xyE
			595	25.0	65.0	3500	320	5.1	1.9 ± 0.8	2381 584 x231y	VDRH10S230xyE
			595	50.0	130.0	6000	540	5.1	1.9 ± 0.8	2381 585 x231y	VDRH14V230xyE
			595	100.0	255.0	10 000	1100	5.4	2.2 ± 0.8	2381 586 x231y	VDRH20X230ByE
250	320	390	675	5.0	17.0	800	60	4.8	1.9 ± 0.8	2381 582 x251y	VDRH05E250xyE
			650	10.0	35.0	1750	160	4.8	1.9 ± 0.8	2381 583 x251y	VDRH07K250xyE
			650	25.0	70.0	3500	300	5.1	2.1 ± 0.8	2381 584 x251y	VDRH10S250xyE
			650	50.0	140.0	6000	480	5.1	2.1 ± 0.8	2381 585 x251y	VDRH14V250xyE
			650	100.0	275.0	10 000	960	5.5	2.3 ± 0.8	2381 586 x251y	VDRH20X250ByE
275	350	430	745	5.0	20.0	800	55	4.9	2.0 ± 0.8	2381 582 x271y	VDRH05E275xyE
			710	10.0	40.0	1750	140	4.9	2.0 ± 0.8	2381 583 x271y	VDRH07K275xyE
			710	25.0	80.0	3500	270	5.3	2.2 ± 0.8	2381 584 x271y	VDRH10S275xyE
			710	50.0	155.0	6000	440	5.3	2.2 ± 0.8	2381 585 x271y	VDRH14V275xyE
			710	100.0	303.0	10 000	900	5.8	2.5 ± 0.8	2381 586 x271y	VDRH20X275ByE
300	385	470	810	5.0	21.0	800	50	5.1	2.2 ± 0.8	2381 582 x301y	VDRH05E300xyE
			775	10.0	42.0	1750	130	5.1	2.2 ± 0.8	2381 583 x301y	VDRH07K300xyE
			775	25.0	85.0	3500	240	5.5	2.4 ± 0.8	2381 584 x301y	VDRH10S300xyE
			775	50.0	175.0	6000	400	5.5	2.4 ± 0.8	2381 585 x301y	VDRH14V300xyE
			775	100.0	350.0	10 000	810	5.9	2.7 ± 0.8	2381 586 x301y	VDRH20X300ByE
320	420	510	880	5.0	22.0	800	45	5.5	2.4 ± 0.8	2381 582 x321y	VDRH05E320xyE
			842	10.0	45.0	1750	120	5.5	2.4 ± 0.8	2381 583 x321y	VDRH07K320xyE
			842	25.0	92.0	3500	220	6.0	2.6 ± 0.8	2381 584 x321y	VDRH10S320xyE
			842	50.0	190.0	6000	370	6.0	2.6 ± 0.8	2381 585 x321y	VDRH14V320xyE
			842	100.0	382.0	10 000	750	6.3	2.9 ± 0.8	2381 586 x321y	VDRH20X320ByE
350	460	560	940	5.0	25.0	800	42	5.8	2.7 ± 0.8	2381 582 x351y	VDRH05E350xyE
			920	10.0	51.0	1750	110	5.8	2.7 ± 0.8	2381 583 x351y	VDRH07K350xyE
			920	25.0	102.0	3500	200	6.1	2.9 ± 0.8	2381 584 x351y	VDRH10S350xyE
			920	50.0	205.0	6000	320	6.1	2.9 ± 0.8	2381 585 x351y	VDRH14V350xyE
			920	100.0	410.0	10 000	650	6.5	3.2 ± 0.8	2381 586 x351y	VDRH20X350ByE
385	505	620	1050	5.0	27.0	800	40	6.0	3.0 ± 0.8	2381 582 x381y	VDRH05E385xyE
			1025	10.0	54.0	1750	95	6.0	3.0 ± 0.8	2381 583 x381y	VDRH07K385xyE
			1025	25.0	107.0	3500	180	6.5	3.2 ± 0.8	2381 584 x381y	VDRH10S385xyE
			1025	50.0	215.0	6000	280	6.5	3.2 ± 0.8	2381 585 x381y	VDRH14V385xyE
			1025	100.0	420.0	10 000	570	6.8	3.5 ± 0.8	2381 586 x381y	VDRH20X385ByE
420	560	680	1150	5.0	28.0	800	35	6.3	3.2 ± 0.8	2381 582 x421y	VDRH05E420xyE
			1120	10.0	56.0	1750	85	6.3	3.2 ± 0.8	2381 583 x421y	VDRH07K420xyE
			1120	25.0	112.0	3500	165	6.7	3.4 ± 0.8	2381 584 x421y	VDRH10S420xyE
			1120	50.0	225.0	6000	250	6.7	3.4 ± 0.8	2381 585 x421y	VDRH14V420xyE
			1120	100.0	430.0	10 000	510	7.1	3.7 ± 0.8	2381 586 x421y	VDRH20X420ByE

ELECTRICAL DATA AND ORDERING INFORMATION

MAXIMUM CONTINUOUS VOLTAGE		VOLTAGE [3] at 1 mA	MAXIMUM VOLTAGE at STATED CURRENT		MAXIMUM ENERGY [4] (10 x 1000 µs)	MAXIMUM NON-REP. TRANSIENT CURRENT [5] I_{NRP} (8 x 20 µs)	TYPICAL CAPACITANCE at 1 kHz	T (max.)	E	CATALOG NUMBERS [1]	
RMS [2] (V)	DC (V)	(V)	V (V)	I (A)	(J)	(A)	(pF)	(mm)	(mm)	12NC [6]	SAP [7]
460	615	750	1290	5.0	29.0	800	30	6.6	3.6 ± 0.8	2381 582 x461y	VDRH05E460xyE
			1240	10.0	58.0	1750	75	6.6	3.6 ± 0.8	2381 583 x461y	VDRH07K460xyE
			1240	25.0	115.0	3500	150	7.0	3.8 ± 0.8	2381 584 x461y	VDRH10S460xyE
			1240	50.0	230.0	6000	225	7.0	3.8 ± 0.8	2381 585 x461y	VDRH14V460xyE
			1240	100.0	440.0	10 000	450	7.5	4.1 ± 0.8	2381 586 x461y	VDRH20X460ByE
485	640	780	1290	10.0	59.0	1750	65	6.8	3.7 ± 0.8	2381 583 x481y	VDRH07K485xyE
			1290	25.0	116.0	3500	145	7.3	3.9 ± 0.8	2381 584 x481y	VDRH10S485xyE
			1290	50.0	233.0	6000	220	7.3	3.9 ± 0.8	2381 585 x481y	VDRH14V485xyE
			1290	100.0	450.0	10 000	400	7.6	4.2 ± 0.8	2381 586 x481y	VDRH20X485ByE
510	670	820	1355	10.0	60.0	1750	62	7.0	3.9 ± 0.8	2381 583 x511y	VDRH07K510xyE
			1355	25.0	118.0	3500	135	7.5	4.1 ± 0.8	2381 584 x511y	VDRH10S510xyE
			1355	50.0	235.0	6000	220	7.5	4.1 ± 0.8	2381 585 x511y	VDRH14V510xyE
			1355	100.0	460.0	10 000	400	7.9	4.4 ± 0.8	2381 586 x511y	VDRH20X510ByE
550	745	910	1500	25.0	127.0	3500	120	7.9	4.5 ± 0.8	2381 584 x551y	VDRH10S550xyE
			1500	50.0	255.0	6000	180	7.9	4.5 ± 0.8	2381 585 x551y	VDRH14V550xyE
			1500	100.0	510.0	10 000	320	8.3	4.9 ± 0.8	2381 586 x551y	VDRH20X550ByE
625	825	1000	1650	25.0	140.0	3500	105	8.4	5.0 ± 0.8	2381 584 x6216	VDRH10S625ByE
			1650	50.0	283.0	6000	165	8.4	5.0 ± 0.8	2381 585 x6216	VDRH14V625ByE
			1650	100.0	566.0	10 000	280	8.8	5.3 ± 0.8	2381 586 x6216	VDRH20X625ByE
680	895	1100	1815	25.0	155.0	3500	80	9.8	5.4 ± 0.8	2381 584 x6816	VDRH10S680ByE
			1815	50.0	310.0	6000	150	9.8	5.4 ± 0.8	2381 585 x6816	VDRH14V680ByE
			1815	100.0	620.0	10 000	250	10.2	5.8 ± 0.8	2381 586 x6816	VDRH20X680ByE

Notes

(1) The products are certified according to (c)UL (E332800), VDE (40013495) and CSA (219883)

(2) The sinusoidal voltage is assumed as the normal operating condition. If a non-sinusoidal voltage is present, type selection should be based on multiplying the peak voltage by a factor of 0.707.

(3) The voltage measured at 1 mA meets the requirements of IEC 61051.
The tolerance on the voltage at 1 mA is ± 10 %.

(4) High energy surges are generally of longer duration. The maximum energy for one pulse of 10 x 1000 µs is given as a reference for longer duration pulses. This pulse can be characterised by peak current (I_p) and pulse width t_2 (virtual time of half I_p value, following *"IEC 60060-2, section 6"*). If V_p is the clamping voltage corresponding to I_p, the energy absorbed in the varistor is determined by the formula:
$E = K \times V_p \times I_p \times t_2$
where:
a) K is dependant on the value of t2 when the value of t1 is between 8 µs and 10 µs; see Peak Current as a Function of Pulse Width drawing.

(5) A current wave of 8 x 20 µs is used as a standard for pulse current and clamping voltage ratings. The maximum non-repetitive transient current is given for one pulse applied during the life of the component.

(6) For composition of the 12NC part number replace "x" and "y" by figures from the sections "Varistors in Bulk", "Varistors on Tape in Ammopack" and "Varistors on "Tape on Reel"

(7) For composition of the SAP part number:

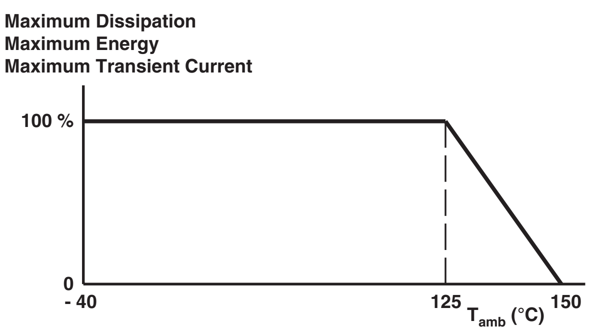
Replace "x" by
- B for bulk type
- T for tape and reel
- A for tape and ammopack

Replace "y" by
- S for straight leads
- K for kinked leads (bulk only)
- L for kinked leads with H_0 = 16 mm (tape and reel/ammo)
- M for kinked leads with H_0 = 18.25 mm (tape and reel/ammo)

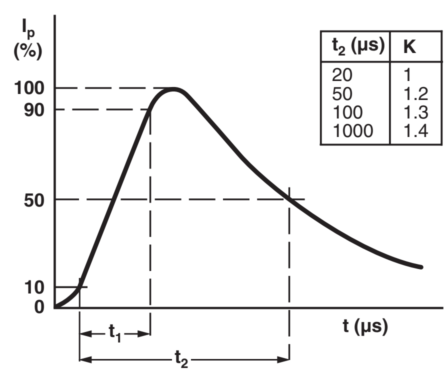
ELECTRICAL CHARACTERISTICS

ELECTRICAL DATA		
PARAMETER	VALUE	UNIT
Maximum continuous voltage: RMS DC	 11 to 680 14 to 895	 V V
Maximum non-repetitive transient current (I_{NRP}) (8 x 20 µs): 2381 582 ...../VDRH05......E 2381 583 ...../VDRH07......E 2381 584 ...../VDRH10......E 2381 585 ...../VDRH14......E 2381 586 ...../VDRH20......E	 250 or 800 500 or 1750 1000 or 3500 2000 or 6000 3000 or 10 000	 A A A A A
Thermal resistance: 2381 582 ...../VDRH05......E 2381 583 ...../VDRH07......E 2381 584 ...../VDRH10......E 2381 585 ...../VDRH14......E 2381 586 ...../VDRH20......E	 ≈ 80 ≈ 70 ≈ 60 ≈ 50 ≈ 40	 K/W K/W K/W K/W K/W
Maximum dissipation: 2381 582 ...../VDRH05......E 2381 583 ...../VDRH07......E 2381 584 ...../VDRH10......E 2381 585 ...../VDRH14......E 2381 586 ...../VDRH20......E	 100 250 400 600 1000	 mW mW mW mW mW
Temperature coefficient of voltage at 1 mA maximum	± 0.05	%/K
Voltage proof between interconnected leads and case	2500	V
Storage temperature Operating temperature	- 40 to + 150 - 40 to + 125	°C °C

DERATING CURVE



PEAK CURRENT AS A FUNCTION OF PULSE WIDTH



t_2 (µs)	K
20	1
50	1.2
100	1.3
1000	1.4

COMPONENT DIMENSIONS (BULK TYPE) in millimeters **AND CATALOG NUMBERS**								
D MAX.	A MAX.	A_0 MAX.	L MIN.	T (1) MAX.	E (1)	d	F	CATALOG NUMBER
7.0	9.0	11.0	24.0	6.5	0.7 to 3.6	0.6 ± 0.05	5 ± 1.0	2381 582 ...../VDRH05.....E
9.0	11.0	13.0	24.0	6.5	0.7 to 3.6	0.6 ± 0.05	5 ± 1.0	2381 583 ...../VDRH07.....E
13.5	15.5	18.0	17.0	8	0.9 to 4.5	0.8 ± 0.05	7.5 ± 1.0	2381 584 ...../VDRH10.....E
17.0	19.0	23.0	16.0	8	0.9 to 4.5	0.8 ± 0.05	7.5 ± 1.0	2381 585 ...../VDRH14.....E
23.0	25.0	28.0	24.0	10	1.1 to 5.8	1.0 ± 0.05	10 ± 1.0	2381 586 ...../VDRH20.....E

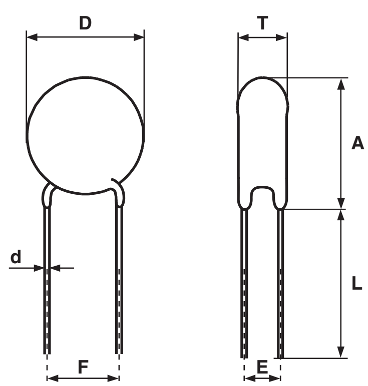
Note

(1) $T_{max.}$ and E values per size and voltage level can be found back in the Electrical Data table

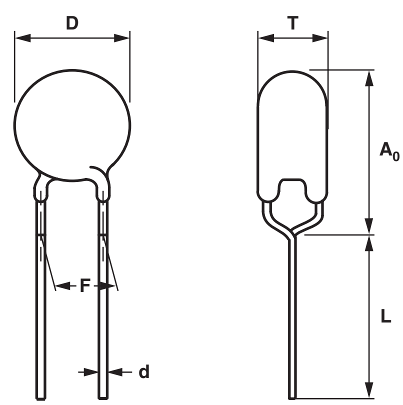
VARISTORS IN BULK					
TYPE	**2381 582 ..... Ø 5 mm 11 V to 460 V**	**2381 583 ..... Ø 7 mm 11 V to 510 V**	**2381 584 ..... Ø 10 mm 11 V to 680 V**	**2381 585 ..... Ø 14 mm 11 V to 680 V**	**2381 586 ..... Ø 20 mm 11 V to 680 V**
Straight leads; see outline of components with straight leads drawing	5...6	5...6	5...6	5...6	5...6
Kinked leads; see outline of components with kinked leads drawing	6...6	6...6	6...6	6...6	6...6
Packaging quantities					
14 V to 95 V	250	250	250	100	50
130 V to 385 V	250	250	250	100	50
420 V to 460 V	250	250	200	100	50
485 V to max. V	-	250	150	100	50

DIMENSIONS in millimeters: See Component Dimensions and Electrical Data table

OUTLINE of Component with Straight Leads



OUTLINE of Component with Kinked Leads

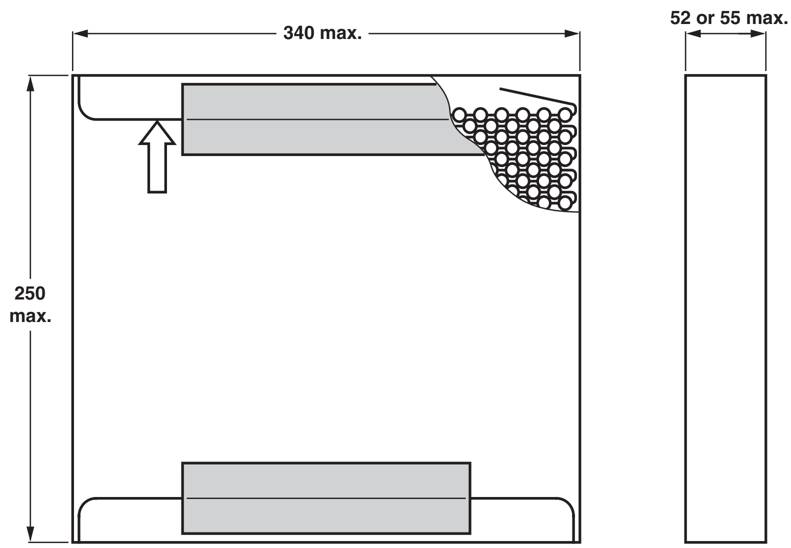


VARISTORS ON TAPE IN AMMOPACK				
TYPE	**2381 582 ..... Ø 5 mm 11 V to 460 V**	**2381 583 ..... Ø 7 mm 11 V to 510 V**	**2381 584 ..... Ø 10 mm 11 V to 550 V**	**2381 585 ..... Ø 14 mm 11 V to 550 V**
Straight leads				
H = 18 mm	-	-	0...7	0...7
H = 20 mm	0...7	0...7	-	-
See drawing: Taped version with straight leads				
Kinked leads				
H_0 = 18.25 mm	3...7	3...7	3...7	3...7
H_0 = 16 mm	8...7	8...7	8...7	8...7
See drawing: Taped version with kinked leads				
Packaging quantities				
14 V to 210 V	1500 (1)	1500 (1)	500	500
230 V to max. V	1000	1000	500	500

Note

(1) Except for 35 V and 40 V = 1000 pieces

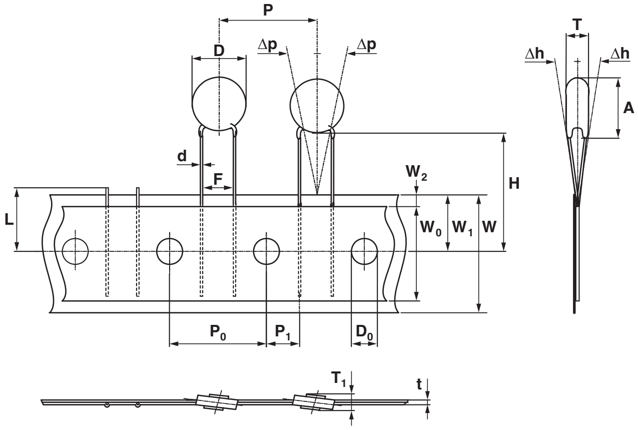
DIMENSIONS OF AMMOPACK in millimeters



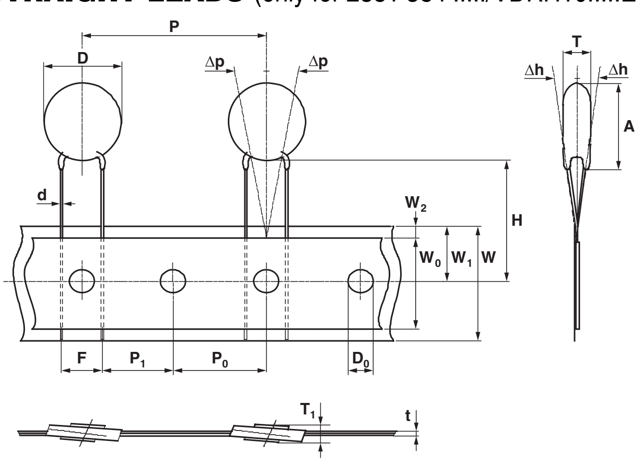
VARISTORS ON TAPE AND REEL				
TYPE	**2381 582 ..... Ø 5 mm 11 V to 460 V**	**2381 583 ..... Ø 7 mm 11 V to 510 V**	**2381 584 ..... Ø 10 mm 11 V to 550 V**	**2381 585 ..... Ø 14 mm 11 V to 550 V**
Straight leads H = 18 mm H = 20 mm See drawing: Taped version with straight leads	 - 0...6	 - 0...6	 0...6 -	 0...6 -
Kinked leads H_0 = 18.25 mm H_0 = 16 mm See drawing: Taped version with kinked leads	 3...6 8...6	 3...6 8...6	 3...6 8...6	 3...6 8...6
Packaging quantities				
14 V to 250 V	1500	1500	1000	750
275 V to 300 V	1500	1500	750	750
320 V to 350 V	1000	1000	500	500
385 V to max. V	1000	1000	500	500

PACKAGING

TAPED VERSION WITH STRAIGHT LEADS (only for 2381 582 ...../VDRH05.....E and 2381 583 ...../VDRH07.....E)

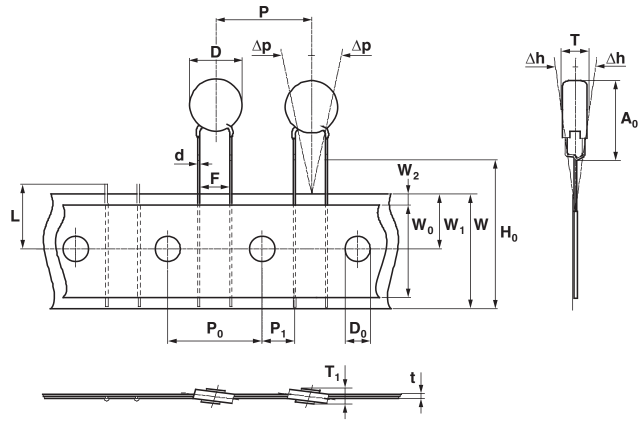


TAPED VERSION WITH STRAIGHT LEADS (only for 2381 584 ...../VDRH10.....E and 2381 585 ...../VDRH14.....E)



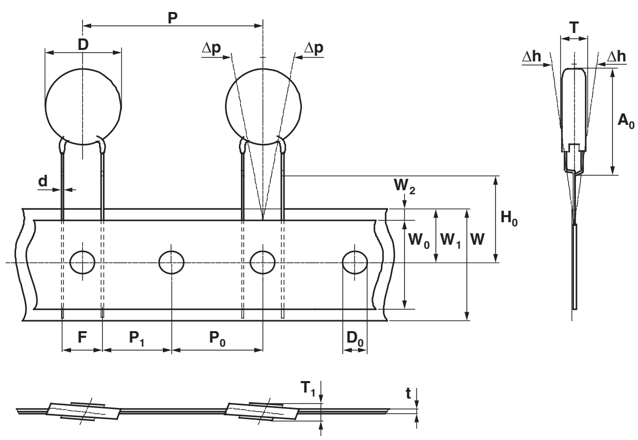
TAPED VERSION WITH KINKED LEADS

(only for 2381 582 ...../VDRH10.....E and 2381 583 ...../VDRH07.....E)



TAPED VERSION WITH KINKED LEADS

(only for 2381 584 ...../VDRH10.....E and 2381 585 ...../VDRH14.....E)



TAPING DATA (based on IEC 60286-2)

SYMBOL	PARAMETER	DIMENSIONS/TOLERANCE			
		582	583	584	585
A	Mounting height	9.0 max.	11.0 max.	15.5 max.	19.0 max.
A_o	Mounting height	11.0 max.	13.0 max.	18.0 max.	23.0 max.
D	Body diameter	7.0 max.	9.0 max.	13.5 max.	17.0 max.
d	Lead wire diameter	0.6 ± 0.05		0.8 ± 0.05	
F	Lead to lead distance (1)	5.0 + 0.8/- 0.2		7.5 ± 0.8	
H	Distance component to tape center (2)	20.0 + 2.0/- 0.0		18.0 + 2.0/- 0.0	
H_0	Lead-wire clinch height	16.0 or 18.25 ± 0.5			
P	Pitch of components on tape	12.7 ± 1.0		25.4 ± 1.0	
T	Total thickness	See Electrical Data table			

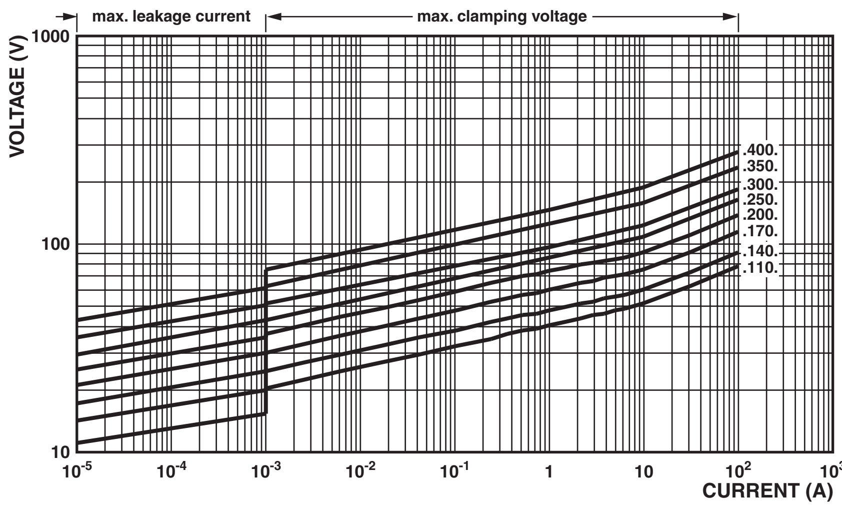
Notes

(1) Guaranteed between component and tape

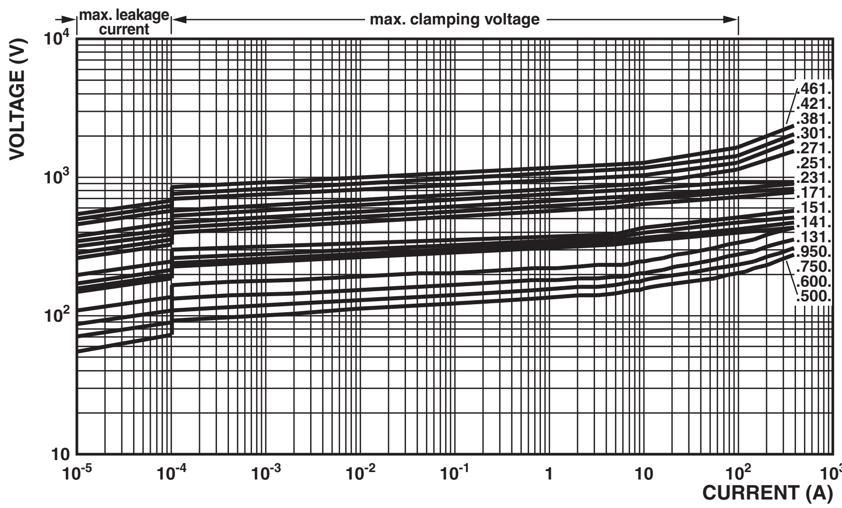
(2) For 2381 585 0511y and 2381 585 0551y: H = 20 mm ± 1 mm

V/I CHARACTERISTICS

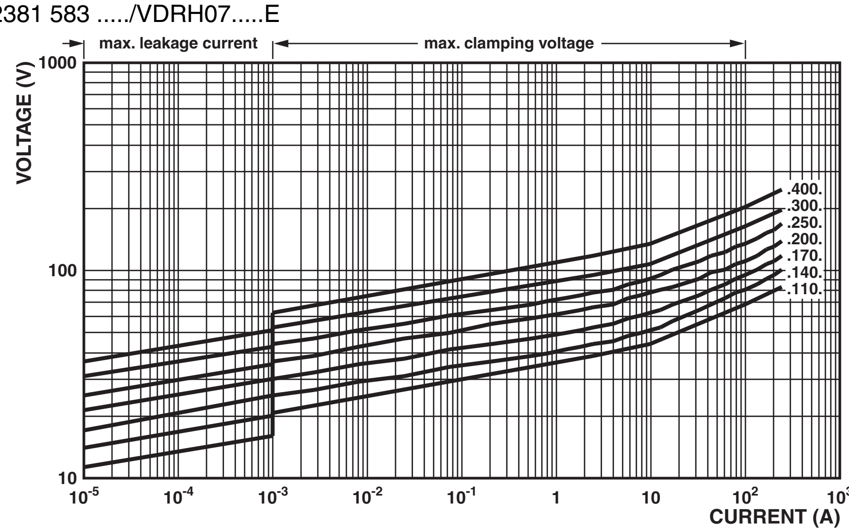
11 V_{RMS} to 40 V_{RMS}; 2381 582 ...../VDRH05.....E



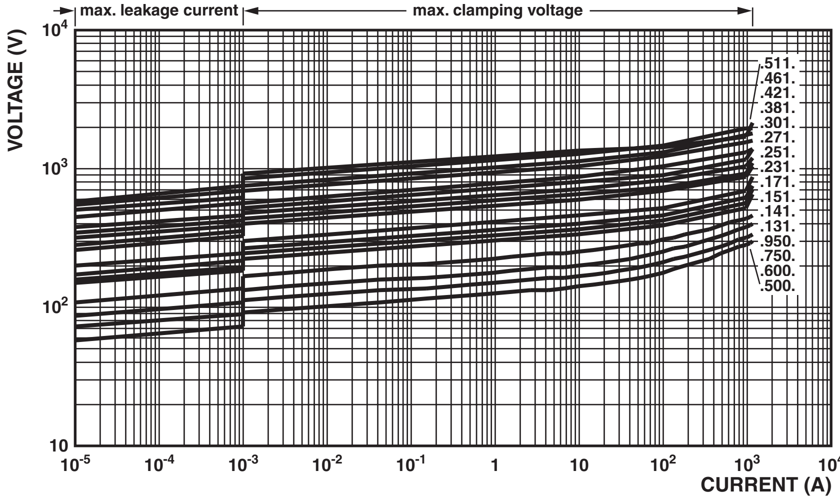
50 V_{RMS} to 460 V_{RMS}; 2381 582 ...../VDRH05.....E



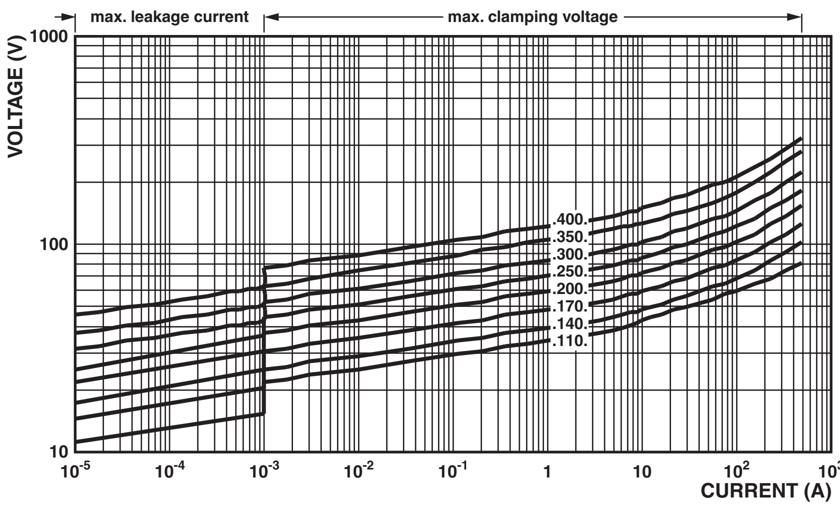
11 V_{RMS} to 40 V_{RMS}; 2381 583 ...../VDRH07.....E



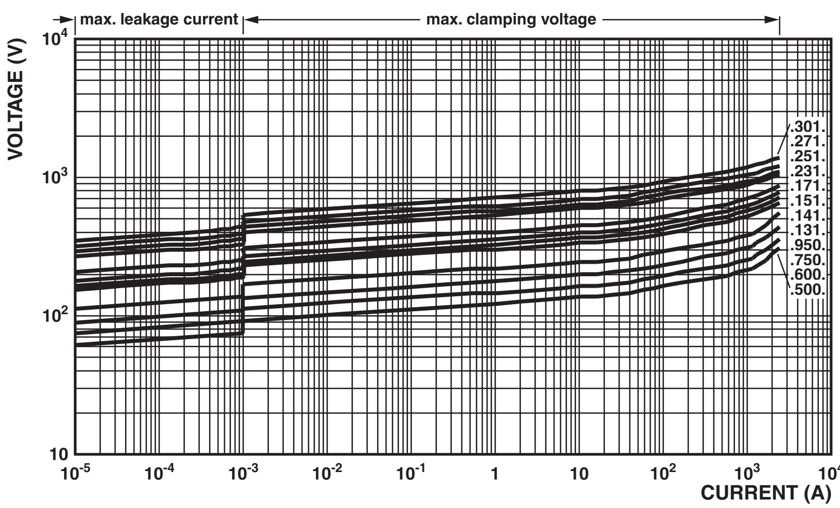
50 V_{RMS} to 510 V_{RMS}; 2381 583 ...../VDRH07.....E



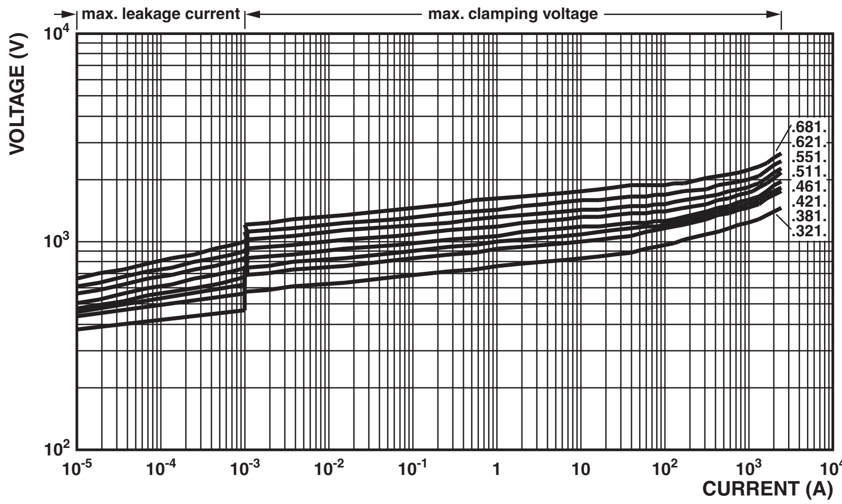
11 V_{RMS} to 40 V_{RMS}; 2381 584 ...../VDRH10.....E



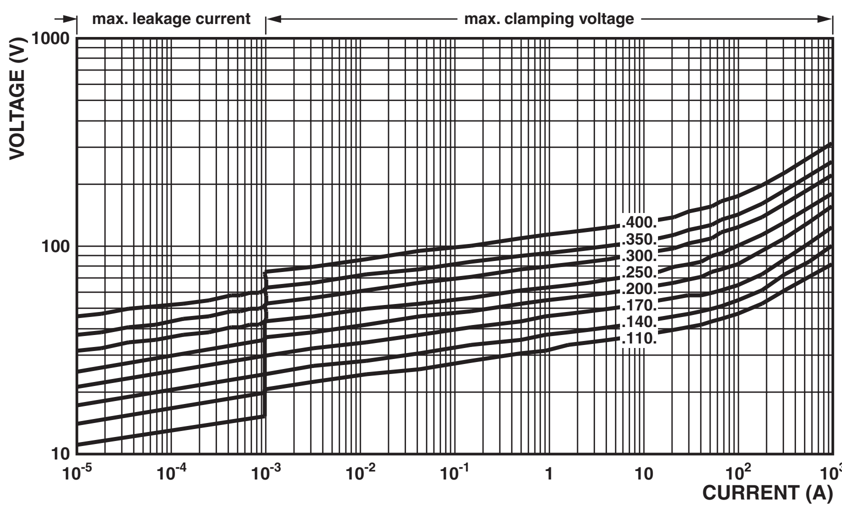
50 V_{RMS} to 300 V_{RMS}; 2381 584 ...../VDRH10.....E



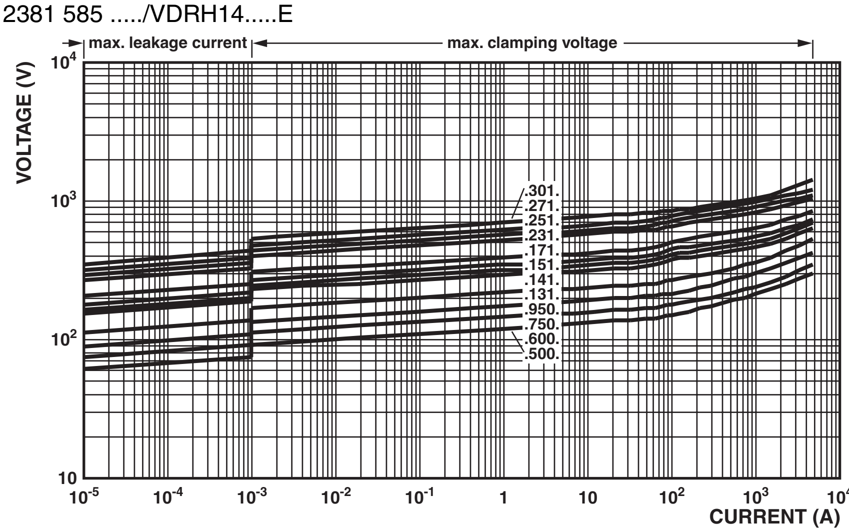
320 V_{RMS} to 680 V_{RMS}; 2381 584 ...../VDRH10.....E



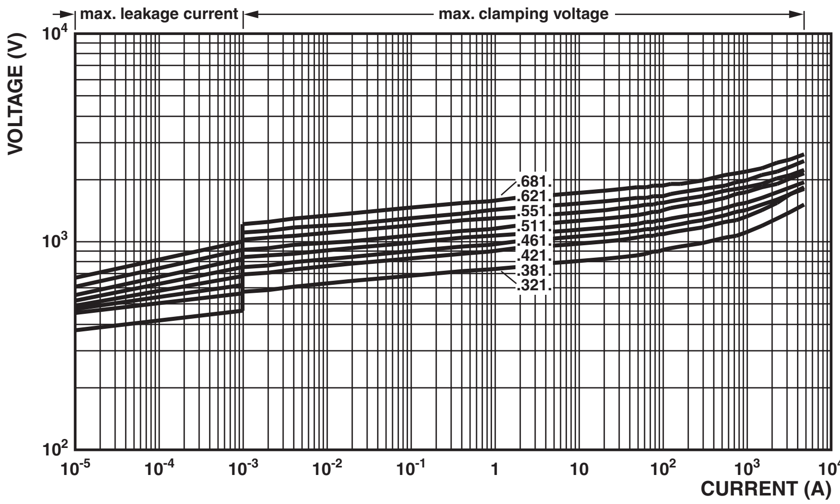
11 V_{RMS} to 40 V_{RMS}; 2381 585 ...../VDRH14.....E



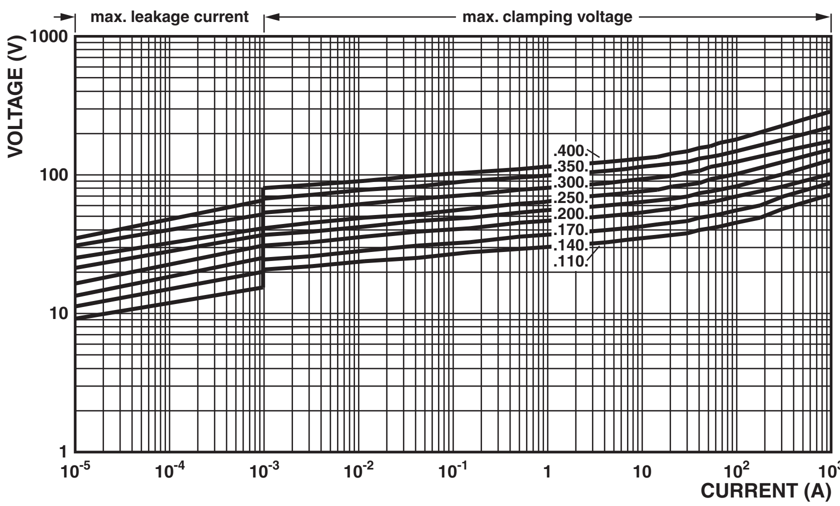
50 V_{RMS} to 300 V_{RMS}; 2381 585 ...../VDRH14.....E



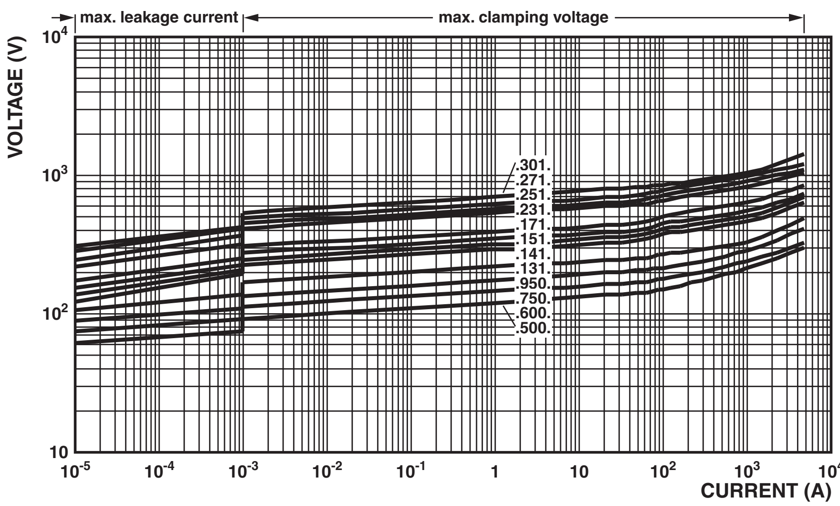
320 V_{RMS} to 680 V_{RMS}; 2381 585 ...../VDRH14.....E



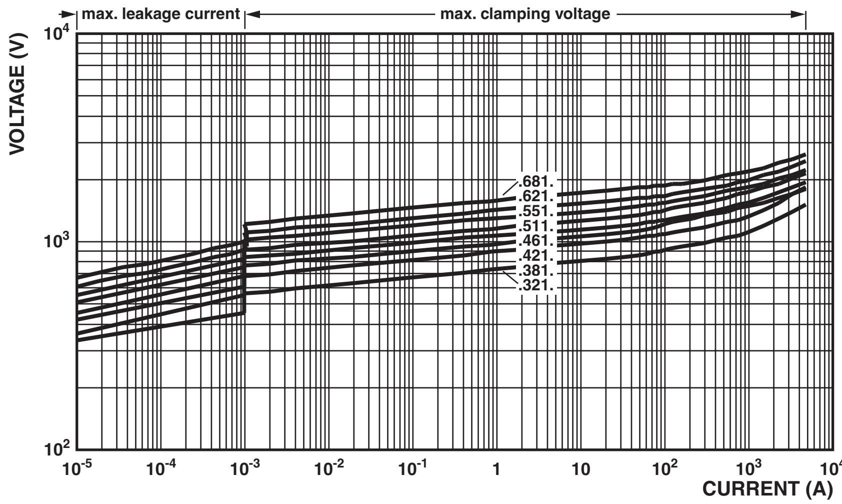
11 V_{RMS} to 40 V_{RMS}; 2381 586 ...../VDRH20.....E



50 V_{RMS} to 300 V_{RMS}; 2381 586 ...../VDRH20.....E

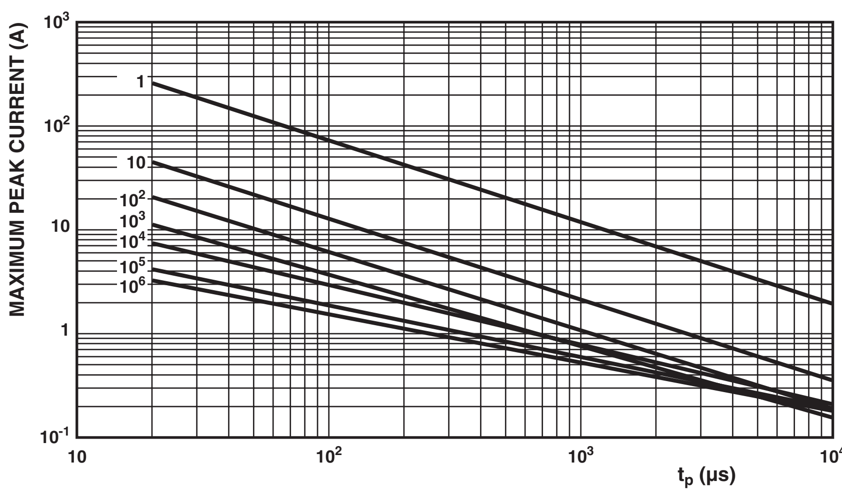


320 V_{RMS} to 680 V_{RMS}; 2381 586 ...../VDRH20.....E

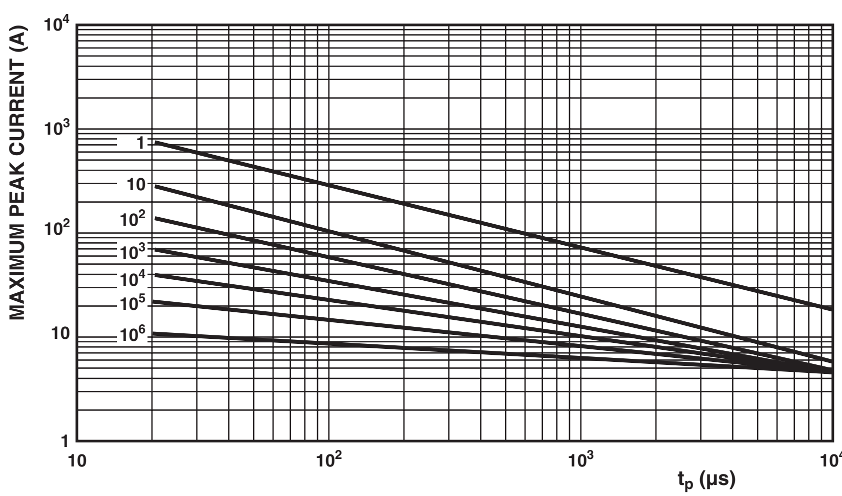


MAXIMUM APPLICABLE TRANSIENT CURRENT AS A FUNCTION OF PULSE DURATION

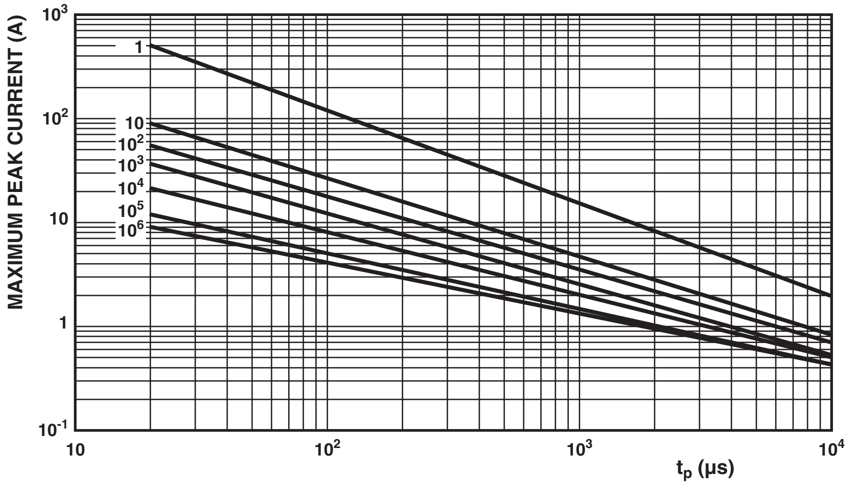
11 V_{RMS} to 40 V_{RMS}; 2381 582 ...../VDRH05.....E



50 V_{RMS} to 300 V_{RMS}; 2381 582 ...../VDRH05.....E



11 V_{RMS} to 40 V_{RMS}; 2381 583 ...../VDRH07.....E



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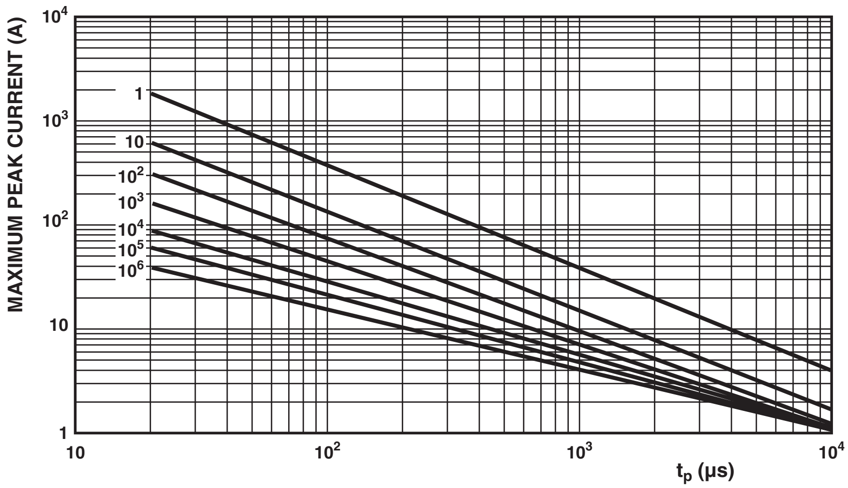

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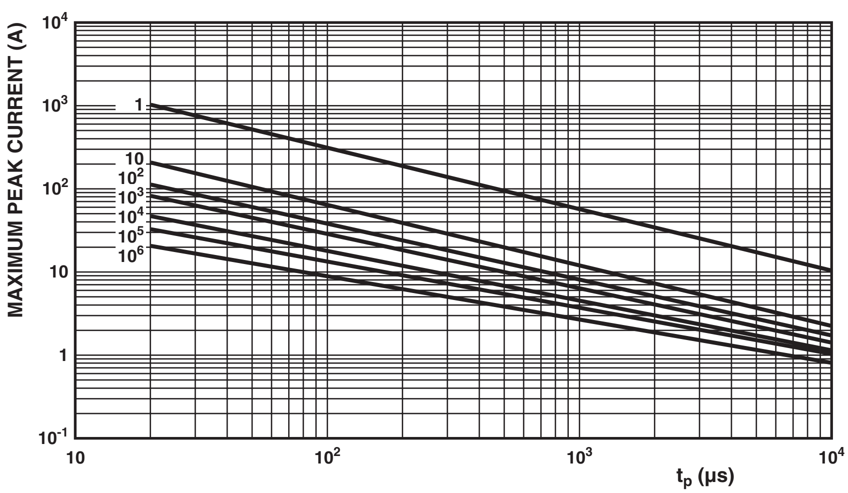

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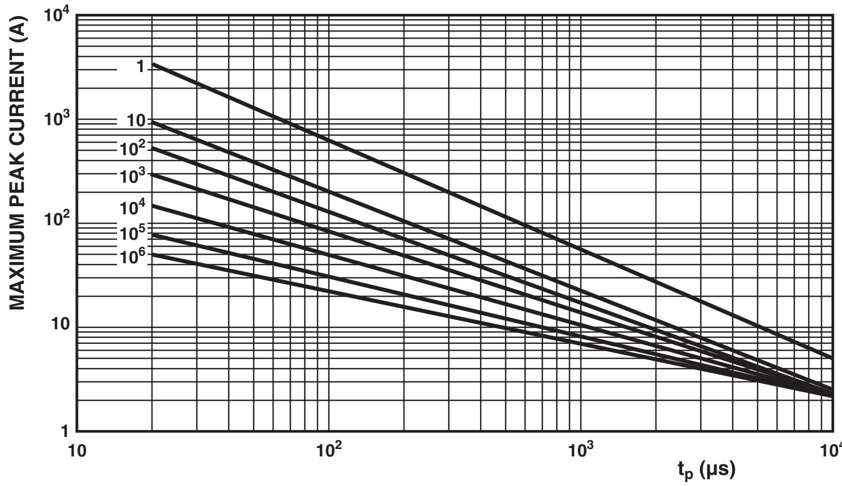
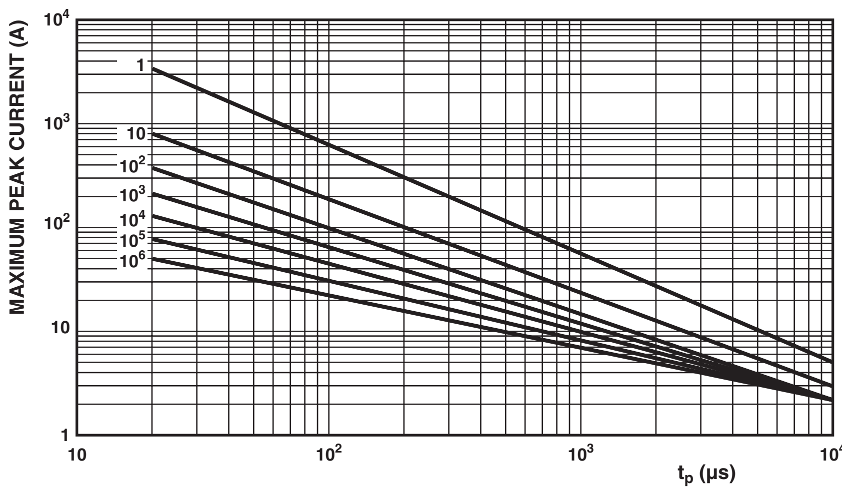
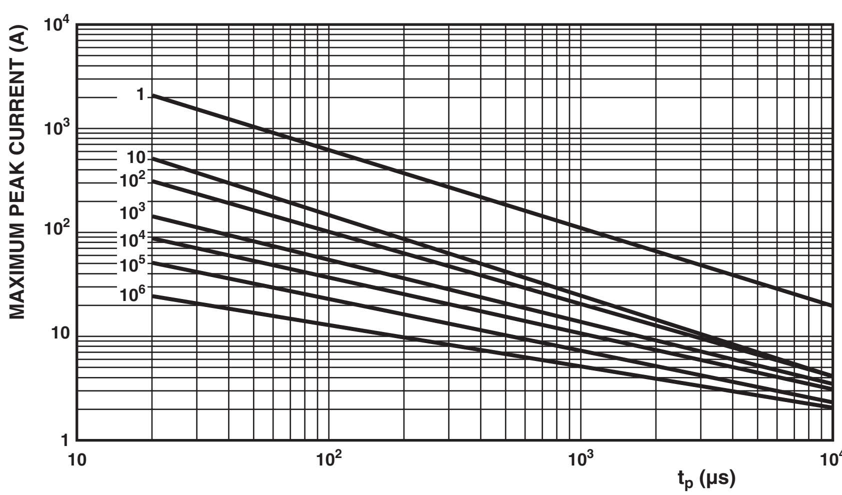


320 V_{RMS} to 680 V_{RMS}; 2381 584 ...../VDRH10.....E



11 V_{RMS} to 40 V_{RMS}; 2381 585 ...../VDRH14.....E



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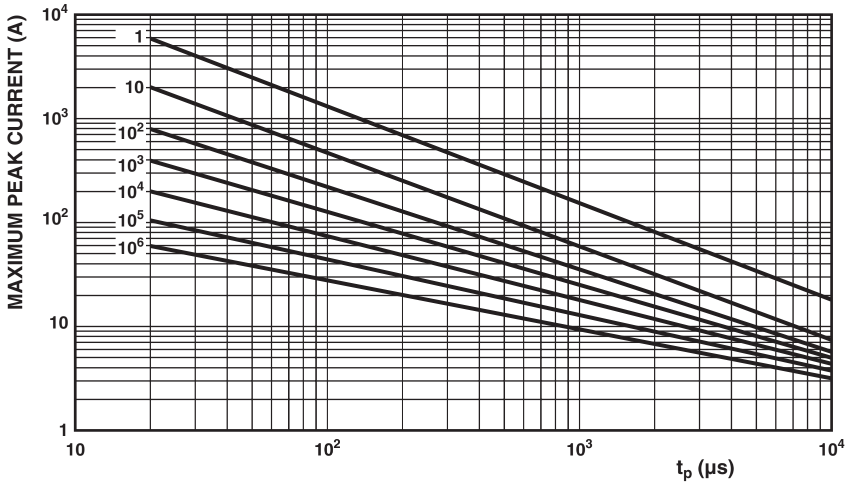

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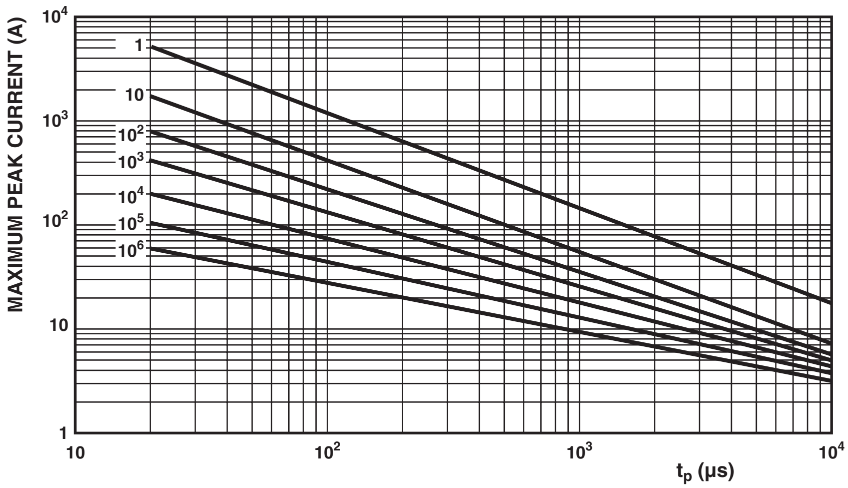

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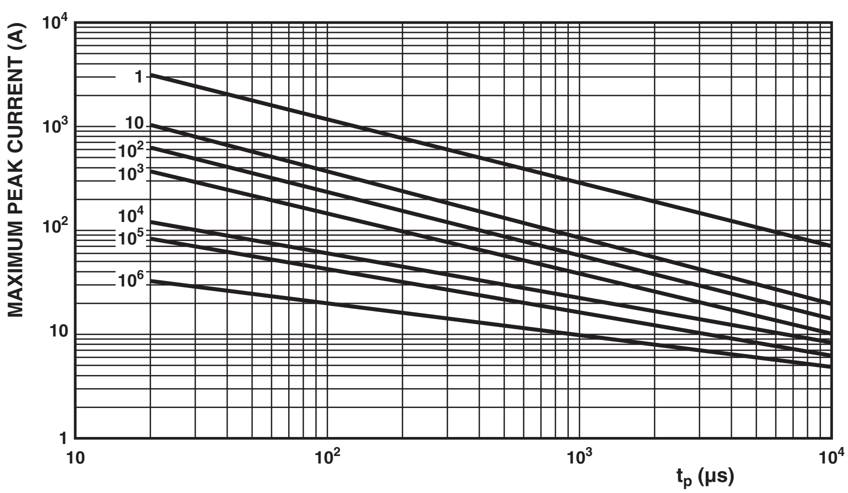
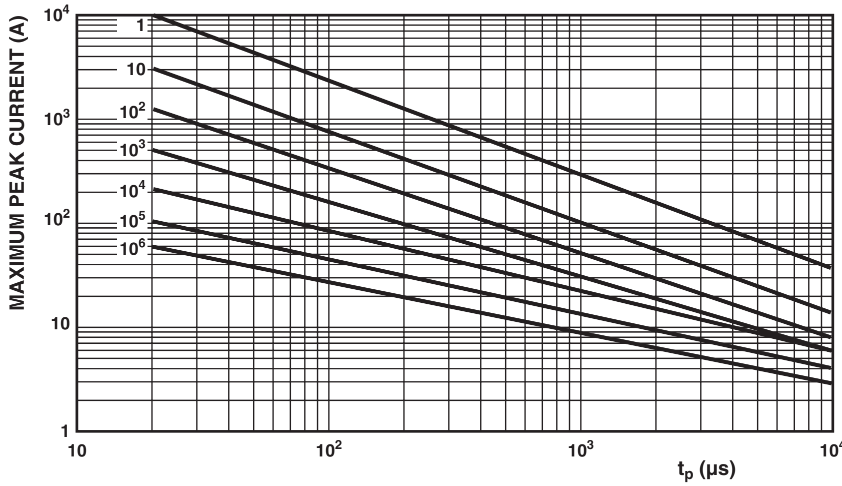
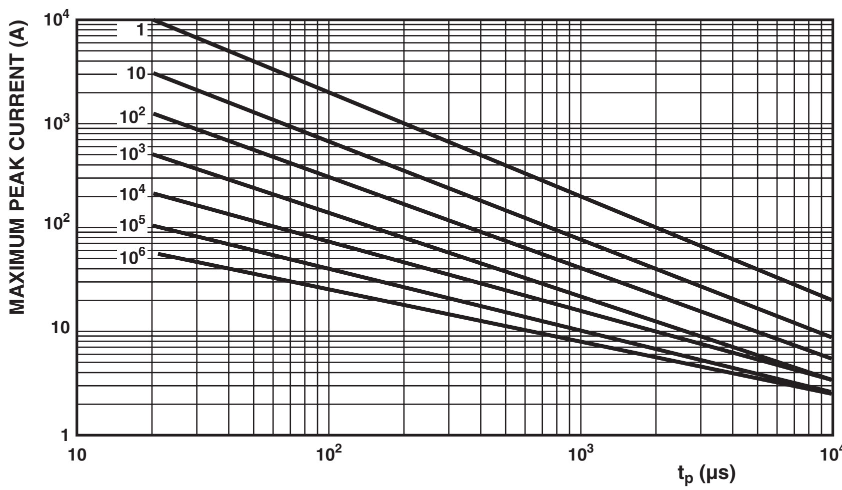


50 V_{RMS} to 300 V_{RMS}; 2381 586 ...../VDRH20.....E



320 V_{RMS} to 680 V_{RMS}; 2381 586 ...../VDRH20.....E



Surface Mount Multilayer Varistors

Contents

SMD 0402 Multilayer Varistor

FEATURES

RoHS COMPLIANT

- Surface mount multilayer surge suppressor
- Inherent bidirectional clamping
- Excellent energy/volume ratio
- Suitable for reflow soldering
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC

QUICK REFERENCE DATA

PARAMETER	VALUE	UNIT
Maximum Continuous Voltage DC AC	 5.6 to 18.0 4.0 to 14.0	V
Maximum Clamping Voltage at 1 A	15.5 to 40	V
Capacitance Range (at 1 MHz)	90 to 360	pF
Maximum Energy (10/1000 µs)	0.05	J
Maximum Peak Current	20	A
Operating Temperature Range	- 55 to 125	°C
Climatic Category	55/125/56	
Weight	± 0.0015	g

APPLICATIONS

Over-voltage and transient voltage protection:

- Data lines and I/O port protection
- Protection against ESD transients
- On-board protection of IC’s and transistors
- Modem protection
- LCD protection

DESCRIPTION

Size 0402 (1005M) multilayer chip varistor with NiSn terminations.

PACKAGING

Available in 8 mm paper tape and reel.

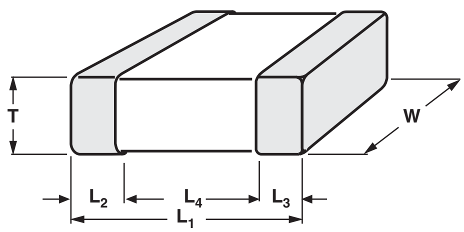
ELECTRICAL DATA AND ORDERING INFORMATION

WORKING VOLTAGE		BREAKDOWN VOLTAGE (1 mA)	MAXIMUM CLAMPING VOLTAGE (1 A)	TYPICAL CAPACITANCE (1 MHz)	PART NUMBER	
V_{RMS}	V_{DC}	V_b	V_C	C	12NC	SAP
V	V	V	V	pF	2381 553	MLV0402E3
4.0	5.6	7.1 to 9.3	15.5	360	20406	0403T
7.0	9.0	11.0 to 14.0	20.0	230	20706	0703T
11.0	14.0	16.0 to 20.0	30.0	120	21106	1103T
14.0	18.0	23.0 to 28.0	40.0	90	21406	1403T

Notes

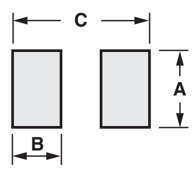
- Sinusoidal voltage assumed as normal operating condition.
  If a non-sinusoidal voltage is present, the crest voltage x 0.707 should be used for type selection.
- Voltage at a current of 1 mA, measured according to 4.3 of CECC 42 000.
- Parts are not recommended for automotive applications.

DIMENSIONS in millimeters



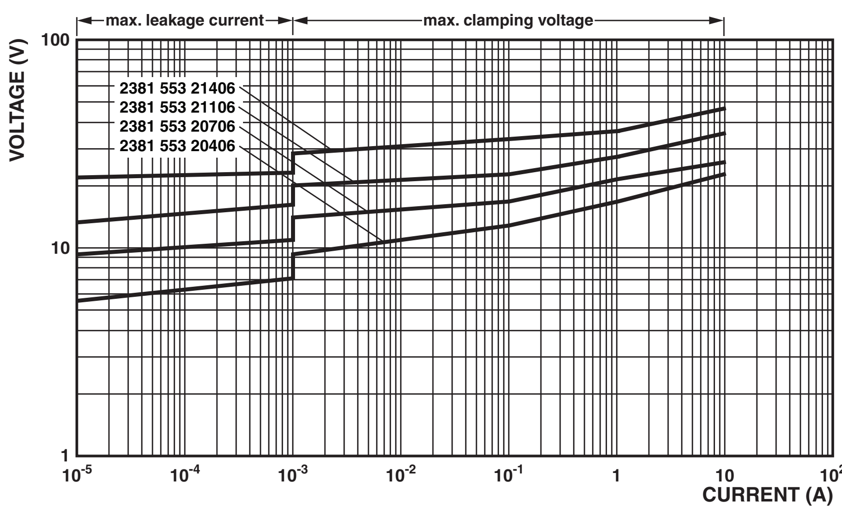
L_1	W	T	L_2 and L_3
1.0 ± 0.1	0.5 ± 0.1	0.6 max.	0.25 ± 0.15

RECOMMENDED FOOTPRINT in millimeters



A	B	C
0.7	0.7	2.0

V/I CHARACTERISTICS



SMD 0603 Multilayer Varistor

FEATURES

- Surface mount multilayer surge suppressor
- Inherent bidirectional clamping
- Excellent energy/volume ratio
- Suitable for reflow soldering
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

QUICK REFERENCE DATA

PARAMETER	VALUE	UNIT
Maximum Continuous Voltage DC AC	 5.6 to 30.0 4.0 to 25.0	V
Maximum Clamping Voltage at 1 A	15.5 to 65	V
Capacitance Range (at 1 MHz)	150 to 825	pF
Maximum Energy (10/1000 µs)	0.1	J
Maximum Peak Current	30	A
Operating Temperature Range	- 55 to 125	°C
Climatic Category	55/125/56	
Weight	± 0.005	g

APPLICATIONS

Over-voltage and transient voltage protection:

- Data lines and I/O port protection
- Protection against ESD transients
- On-board protection of IC's and transistors
- Modem protection
- LCD protection

DESCRIPTION

Size 0603 (1608M) multilayer chip varistor with NiSn terminations.

PACKAGING

Available in 8 mm paper tape and reel.

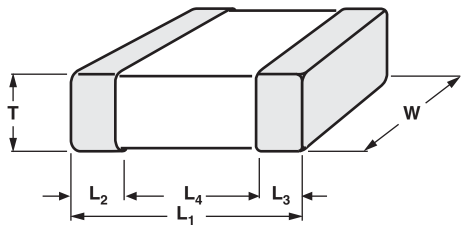
ELECTRICAL DATA AND ORDERING INFORMATION

WORKING VOLTAGE		BREAKDOWN VOLTAGE (1 mA)	MAXIMUM CLAMPING VOLTAGE (1 A)	TYPICAL CAPACITANCE (1 MHz)	PART NUMBER	
V_{RMS}	V_{DC}	V_b	V_C	C	12NC	SAP
V	V	V	V	pF	2381 553	MLV0603E3
4.0	5.6	7.1 to 9.3	15.5	825	30406	0403T
7.0	9.0	11.0 to 14.0	20.0	550	30706	0703T
11.0	14.0	16.0 to 20.0	30.0	425	31106	1103T
14.0	18.0	23.0 to 28.0	40.0	225	31406	1403T
20.0	26.0	31.0 to 38.0	58.0	160	32006	2003T
25.0	30.0	37.0 to 46.0	65.0	150	32506	2503T

Notes

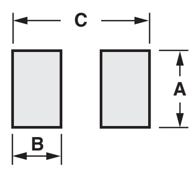
- Sinusoidal voltage assumed as normal operating condition.
  If a non-sinusoidal voltage is present, the crest voltage x 0.707 should be used for type selection.
- Voltage at a current of 1 mA, measured according to 4.3 of CECC 42 000.
- Parts are not recommended for automotive applications.

DIMENSIONS in millimeters



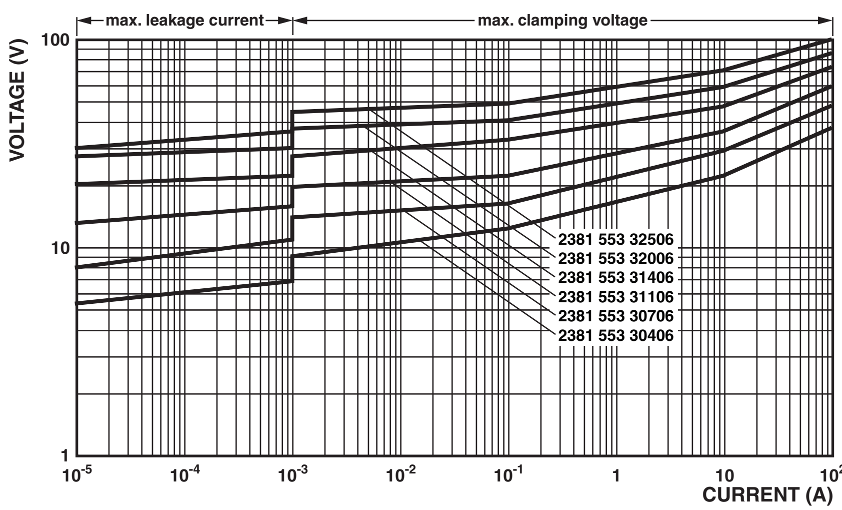
L_1	W	T	L_2 and L_3
1.6 ± 0.15	0.8 ± 0.15	0.9 max.	0.35 ± 0.15

RECOMMENDED FOOTPRINT in millimeters



A	B	C
1.0	1.0	3.0

V/I CHARACTERISTICS



SMD 0805 Multilayer Varistor

FEATURES

- Surface mount multilayer surge suppressor
- Inherent bidirectional clamping
- Excellent energy/volume ratio
- Suitable for reflow soldering
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

QUICK REFERENCE DATA

PARAMETER	VALUE	UNIT
Maximum Continuous Voltage DC AC	 5.6 to 30.0 4.0 to 25.0	V
Maximum Clamping Voltage at 1 A	15.5 to 65	V
Capacitance Range (at 1 MHz)	80 to 860	pF
Maximum Energy (10/1000 µs)	0.1	J
Maximum Peak Current	30 to 40	A
Operating Temperature Range	- 55 to 125	°C
Climatic Category	55/125/56	
Weight	± 0.011	g

APPLICATIONS

Over-voltage and transient voltage protection:

- Data lines and I/O port protection
- Protection against ESD transients
- On-board protection of IC's and transistors
- Modem protection
- LCD protection

DESCRIPTION

Size 0805 (2012M) multilayer chip varistor with NiSn terminations.

PACKAGING

Available in 8 mm paper tape and reel.

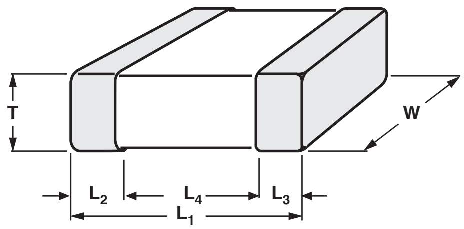
ELECTRICAL DATA AND ORDERING INFORMATION

WORKING VOLTAGE		BREAKDOWN VOLTAGE (1 mA)	MAXIMUM CLAMPING VOLTAGE (1 A)	PEAK CURRENT (8/20 µs)	TYPICAL CAPACITANCE (1 MHz)	PART NUMBER	
V_{RMS}	V_{DC}	V_b	V_C	I_P	C	12NC	SAP
V	V	V	V	A	pF	2381 553	MLV0805E3
4.0	5.6	7.1 to 9.3	15.5	40	860	40406	0403T
7.0	9.0	11.0 to 14.0	20.0	40	585	40706	0703T
11.0	14.0	16.5 to 20.3	30.0	40	280	41106	1103T
25.0	30.0	37.0 to 46.0	65.0	30	80	42506	2503T

Notes

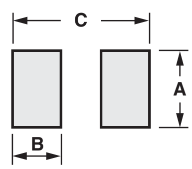
- Sinusoidal voltage assumed as normal operating condition.
  If a non-sinusoidal voltage is present, the crest voltage x 0.707 should be used for type selection.
- Voltage at a current of 1 mA, measured according to 4.3 of CECC 42 000.
- Parts are not recommended for automotive applications.

DIMENSIONS in millimeters



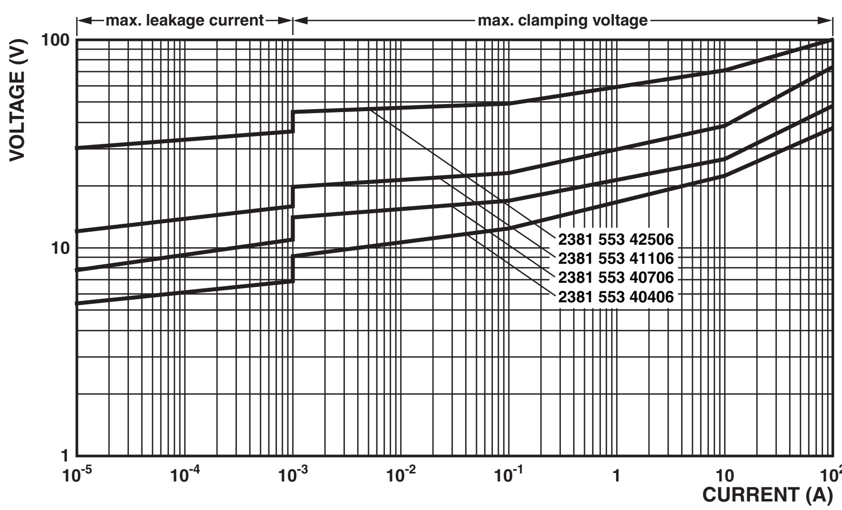
L_1	W	T	L_2 and L_3
2.0 ± 0.2	1.25 ± 0.2	1.0 max.	0.4 ± 0.3

RECOMMENDED FOOTPRINT in millimeters



A	B	C
1.4	1.2	3.4

V/I CHARACTERISTICS



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