Varistors (MOVs) for photovoltaic systems

VARSI

VARSI - solution provider with a personal touch

How it started?

The beginnings of the company date back to the early seventies – the company used to be a part of the former world-wide known ISKRA Group - TOZD Keramika in DO ISKRA IEZE Ljubljana, reputed producer of technical and high frequency ceramics.

General company data and its strategy

Varsi, d.o.o. decided to carry on with the program of varistors, couplings and temperature probes, which had been a part of the production program also in the former Iskra TOZD Keramika since 1983. Varsi, d.o.o. therefore continues the tradition and on the base of its own knowledge and research upgrades the past experiences in the production of high technology ceramics.
The company has dedicated itself to total customer satisfaction. Market research - product development - purchase - production - testing & control - sales - environmental protection - these are all the activities incorporated into the company managing.

Varsi, d.o.o. strives for perfection in all levels of its activity. The company is present in all major world markets, daily facing the strong competition. It is therefore important to offer high quality products at reasonable costs.

The company has been successful, because:
- It has been able to satisfy and respect customers' expectations and requirements
- It has been balancing the internal costs properly in correlation with the care for good realization of processes
- It has been able to evaluate its efficiency
- It constantly monitors its performance and eliminates the reasons for any possible mistakes
- It creates sufficient new value (added value)
- It takes care for qualifications of the employees, stressing the importance of each single employee being a relevant part of the chain
- It confirms its accomplishments by international standards: UL (3rd Edition), ISO 9001:2000 (process adopted already to the new standard ISO 9001:2008), RoHS Certificate, REACH Compliance.

Company research and development activities

VARSI, d.o.o. works on the base of its own knowledge and research. Its R&D activity is regulated within the company R&D Department.

In May 1999 Varsi, d.o.o. established its own, independent research & development group named ISVAR all with the purpose to upgrade the link between the existing production and research spheres. The research group ISVAR was registered at Slovenian Research Agency (ARRS), Reg. No. 6464-001.
The activity well generates the link between the basic and application research, which enables the optimization of the single technological parameters in the varistor manufacturing process.
The group works closely together with the Institute Jožef Stefan, Technological Centre SEMTO, National Institute of Chemistry, all located in Ljubljana, Slovenia, Laboratory Centre Iskraemeco, Kranj, Slovenia, University Paul Sabatier, Toulouse, France, and with other research centres worldwide.

Why varsi?

- top quality products
- custom tailored solutions
- flexibility
- fast response time
- attractive lead times
- challenging prices
- short design-in period (from samples to the serial production)
- top skilled engineering & application specialists
- manufacturing facility in Europe

We're small, but not fragile,
we're flexible and simple, but highly skilled and experienced,
we offer fast and efficient customer service with a personal touch.
Choosing Varsi means being one step ahead of the general development.
Together we're winners! Give us a chance!

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Photovoltaics is known as a method for generating electric power by using solar cells packaged in photovoltaic modules, often electrically connected in multiples as solar photovoltaic arrays to convert energy from the sun into electricity.

Photovoltaic modules are in majority intended as a complementary energy source to the AC low voltage power supply network. Because solar cells in the photovoltaic modules produce direct electrical current from sun light an additional inverter is required to convert the DC energy to AC energy.

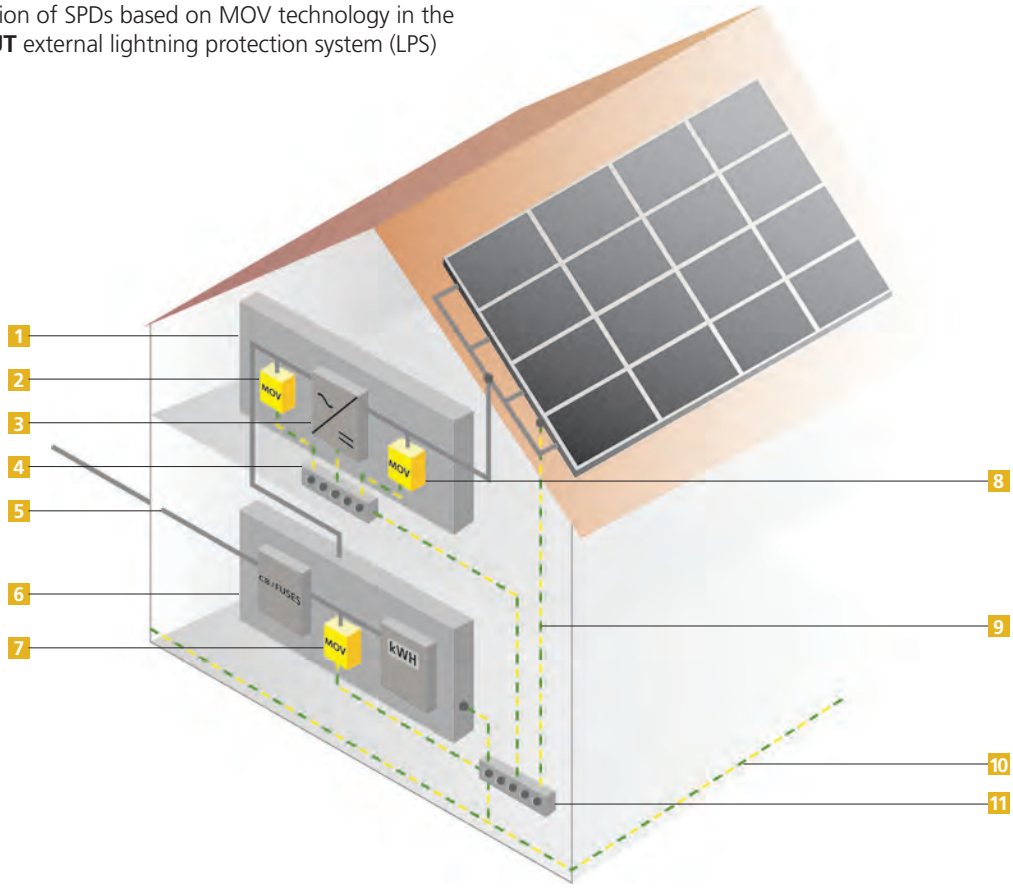
The whole DC power system as photovoltaic modules (arrays), DC/AC inverter, cables and all connections to the AC main electrical network forms so called photovoltaic (PV) installation. Because of photovoltaic modules location and their connection to the main AC network the whole PV installations are exposed to the same overvoltages as expected in the AC systems. Due to the nature of DC/AC inverter and consequently the presence of additional DC power source in the whole power network certain specific precautions have to be considered in the SPD construction and their connection into the DC PV installation loop.

Overvoltages in a PV installation can occur under several conditions. They may be caused by:

- direct strikes to the external lightning protection system (LPS)
- lightning flashes nearby the PV installations
- direct strikes and consequently induced currents distributed into the electrical network
- faults in the distribution AC low voltage power supply network
- faults in the complementary DC power supply network (new and relatively unknown area)
- switching manipulations in the low voltage power supply network and PV installations.

Basic principles and connections of surge protective devices (SPDs) based on the metal oxide varistors (MOVs) are presented in *Figure 1* and *Figure 2*.

Figure 1 | Possible connection of SPDs based on MOV technology in the case of a building **WITHOUT** external lightning protection system (LPS)



1 SUBDISTRIBUTION BOX
2 MOV TYPE 1* OR TYPE 2
3 DC/AC INVERTER
4 EQUIPOTENTIAL BONDING BAR
5 3 PHASE LOW VOLTAGE POWER LINE ENTRANCE
6 MDB (MAIN DISTRIBUTION BOX)
7 MOV TYPE 1 (230 / 400 V_{AC})
8 MOV TYPE 1
9 ADDITIONAL EARTHING CONNECTION
10 EARTH TERMINATION SYSTEM
11 MAIN EARTHING BAR
12 DOWN CONDUCTOR
13 AIR TERMINATION SYSTEM
14 SEPARATION DISTANCE

* Type 1 when separation distance is not kept

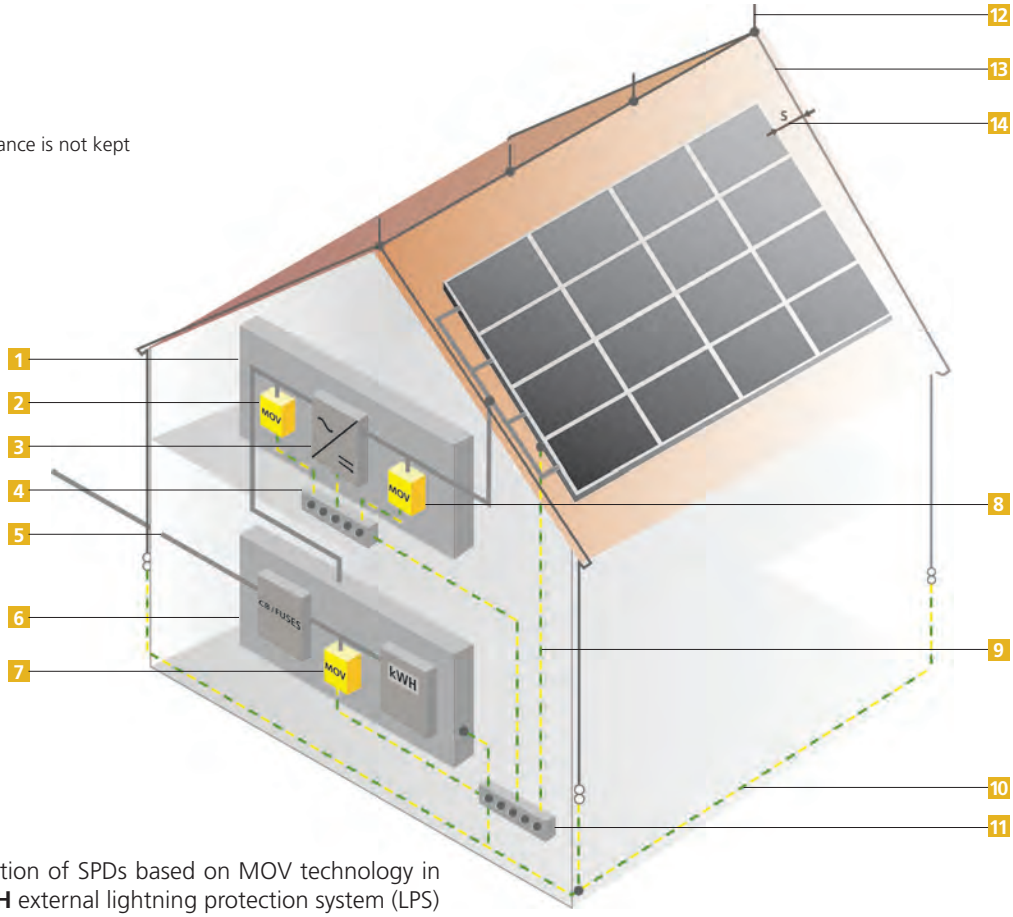


Figure 2 | Possible connection of SPDs based on MOV technology in the case of a building **WITH** external lightning protection system (LPS)

Selection of appropriate MOVs according to the proposed connection

1. Determination of the current value of I_{imp} on the **AC** side of PV installation

	I_{imp} [kA]; (10/350 µs)	I_{max} [kA]; (8/20 µs)	I_n [kA]; (8/20 µs)	U_c [V]
Type 1 / Class I	12,5 kA for LPL* 3 or 4	50 kA	25 kA	230 V / 400 V
Type 2 / Class II		50 kA	20 kA	230 V / 400 V

I_{imp} impulse current acc. to IEC 61643-1; EN 61643-11
I_n nominal discharge current acc. to IEC 61643-1; EN 61643-11
I_{max} maximum discharge current for class II (type 2) acc. to IEC 61643-1; EN 61643-11
U_c maximum continuous operation voltage acc. to IEC 61643-1; EN 61643-11
* LPL lightning protection level (level of risk) according to IEC 62305-2

LPL 1: I_{imp} = 200 kA
LPL 2: I_{imp} = 150 kA
LPL 3 and 4: I_{imp} = 100 kA

A simplified and common approach is used for determination of the current value of I_{imp}. Such SPDs (MOVs) in the PV installation shall be able to withstand 50% of the maximum expected surge current I_{imp} of designed LPS system. The rest of 50% of total surge current is transferred directly into the earthing system of LPS of the building.

According to this simplified rule the maximum current I_{impMOV} per each protected pole that MOV for Class I (IEC) / Type 1 (EN) shall withstand, can be calculated according to the proposed formula:

$$I_{impMOV} = I_{impLPL} / (2n)$$

where:
I_{impMOV} is maximum current per each protected pole (conductor)
I_{impLPL} is total expected current according to LPL (risk assessment)
n is the number of poles (conductors) of the power network

Examples

- 3 phase system (n = 4; four conductors)
  LPL = 3 or 4; I_{impLPL} = 100 kA
  Result: $I_{impMOV} = I_{impLPL} / (2n) = 100 / (2 \times 4) = 12,5$ kA

- 1 phase system (n = 2; two conductors)
  LPL = 3 or 4; I_{impLPL} = 100 kA
  Result: $I_{impMOV} = I_{impLPL} / (2n) = 100 / (2 \times 2) = 25$ kA

2. Determination of the current value of I_{imp} on the **DC** side of PV installation

	I_{imp} [kA]; (10/350 µs)		I_{max} [kA]; (8/20 µs)	I_n [kA]; (8/20 µs)	U_c [V]
Type 1	25 kA for LPL 3 or 4	with LPS system		50 kA	400V÷1200V
	12,5 kA for LPL 3 or 4	without LPS system		25 kA	
Type 2			50 kA	20 kA	400V÷1200V

High Energy Varistor Discs PV1 Series

Description

High Energy Varistor Discs PV1 Series are heavy duty metal oxide varistors, designed for special applications, where unique contacts are required. They offer an excellent surge protection according to IEC61643-1 Class I / (EN 61643-11, Type 1) for use in the surge protective devices (SPDs) for renewable energy sources or anywhere else where lightning protection level (level of risk) according to IEC 62305-2 requires high I_{imp} (10/350 µs) current levels.

The advantages of the PV1 Series are: good solderability (Ag), passivation with glass (on request), excellent performance on DC operating voltages, high I_{imp} (10/350 µs) values in comparison to standard series.

Main Features

Wide Operating Voltage Range V_{AC} ($V_{M\,(AC)}$)* ____ 60 V – 1100 V
Wide Operating Voltage Range V_{DC} ($V_{M\,(DC)}$)* ____ 85 V – 1465 V
High Energy Absorption Capability W_{max} (W_{TM})* (10/350 µs) ____ 600 J – 35000 J
High Maximum Discharge Current Capability I_{max} (I_{TM})* (8/20 µs) ____ up to 100000 A
High Peak Impulse Current Capability I_{imp} (10/350 µs) ____ up to 25000 A
High Nominal Discharge Current Capability I_n (I_{TSM})* (8/20 µs) ____ up to 35000 A
Rating according to IEC 61643-1 modified for DC applications

* designation according to IEC 61643-331

General Technical Data

Climatic Category LCT UCT Damp Heat, Steady state (93% r.h., 40 °C)	40 / 85 / 56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 ... + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 ... + 110 °C	
Response time	< 25 ns	

Type designation

V 275 D 40 S P M (PV1)

V | **V**ARSI Metal Oxide Varistor
275 | Max. AC operating voltage
D | Varistor Design (**D** round, S square, P rectangular)
40 | Rated Diameter of Varistor Disc (40, 50, 60, 80)
S | Ag (**s**ilver) Electrodes
P | **P**assivation Collar
M | **M**atched version
PV1 | **P**hotovoltaic application Class **1**

Table of Standard Values

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (10/350 µs)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (10/350 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\,(AC)}$ * [V]	V_{DC} $V_{M\,(DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I_{peak} [A]	C C_V * [pF]
V60S40	60	85	1.4	40000	600	100	±10	290	20000	220	7000	15000
V60D40	60	85	1.4	40000	600	100	±10	290	20000	220	7000	15000
V75D40	75	100	1.4	40000	720	120	±10	350	20000	264	7000	13000
V75S40	75	100	1.4	40000	720	120	±10	350	20000	264	7000	13000
V95D40	95	125	1.4	40000	900	150	±10	440	20000	330	7000	11000
V95S40	95	125	1.4	40000	900	150	±10	440	20000	330	7000	11000
V115S40	115	150	1.4	40000	1080	180	±10	530	20000	390	7000	8000
V115D40	115	150	1.4	40000	1080	180	±10	530	20000	390	7000	8000
V130S40	130	170	1.4	40000	1230	205	±10	600	20000	450	7000	5800
V130D40	130	170	1.4	40000	1230	205	±10	600	20000	450	7000	5800
V130P50	130	170	1.6	50000	1540	205	±10	600	20000	450	9000	7300
V130D60	130	170	1.6	70000	2500	205	±10	600	25000	450	15000	15000
V130D80	130	170	2.0	100000	4050	205	±10	600	35000	450	25000	28000
V140S40	140	180	1.4	40000	1320	220	±10	650	20000	480	7000	5400
V140D40	140	180	1.4	40000	1320	220	±10	650	20000	480	7000	5400
V140P50	140	180	1.4	50000	1650	220	±10	650	20000	480	9000	6750
V140D60	140	180	1.6	70000	2680	220	±10	650	25000	480	15000	12500
V140D80	140	180	2.0	100000	4340	220	±10	650	35000	480	25000	26000
V150S40	150	200	1.4	40000	1440	240	±10	710	20000	530	7000	5000
V150D40	150	200	1.4	40000	1440	240	±10	710	20000	530	7000	5000
V150P50	150	200	1.4	50000	1800	240	±10	710	20000	530	9000	6250
V150D60	150	200	1.6	70000	2930	240	±10	710	25000	530	15000	11500
V150D80	150	200	2.0	100000	4740	240	±10	710	35000	530	25000	23000
V175D40	175	225	1.4	40000	1620	270	±10	800	20000	590	7000	4200
V175S40	175	225	1.4	40000	1620	270	±10	800	20000	590	7000	4200
V175P50	175	225	1.5	50000	2030	270	±10	800	20000	590	9000	5250
V175D60	175	225	1.6	70000	3290	270	±10	800	25000	590	15000	9800
V175D80	175	225	2.0	100000	5330	270	±10	800	35000	590	25000	20000

* designation according to IEC 61643-331

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (10/350 µs)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (10/350 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I_{peak} [A]	C C_V * [pF]
V230D40	230	300	1.4	40000	2050	360	±10	1060	20000	790	7000	3400
V230S40	230	300	1.4	40000	1990	360	±10	1060	20000	790	7000	3400
V230P50	230	300	1.5	50000	2710	360	±10	1060	20000	790	9000	4250
V230D60	230	300	1.6	70000	4390	360	±10	1060	25000	790	15000	8000
V230D80	230	300	2.0	100000	7110	360	±10	1060	35000	790	25000	16000
V250D40	250	320	1.4	40000	2340	390	±10	1150	20000	850	7000	3100
V250S40	250	320	1.4	40000	2340	390	±10	1150	20000	850	7000	3100
V250P50	250	320	1.5	50000	2930	390	±10	1150	20000	850	9000	3900
V250D60	250	320	1.6	70000	4760	390	±10	1150	25000	850	15000	7200
V250D80	250	320	2.0	100000	7700	390	±10	1150	35000	850	25000	14100
V275D40	275	350	1.4	40000	2580	430	±10	1270	20000	940	7000	2900
V275S40	275	350	1.4	40000	2580	430	±10	1270	20000	940	7000	2900
V275P50	275	350	1.5	50000	3230	430	±10	1270	20000	940	9000	3600
V275D60	275	350	1.6	70000	5250	430	±10	1270	25000	940	15000	6800
V275D80	275	350	2.0	100000	8500	430	±10	1270	35000	940	25000	13000
V300S40	300	385	1.4	40000	2820	470	±10	1390	20000	1030	7000	2700
V300D40	300	385	1.4	40000	2820	470	±10	1390	20000	1030	7000	2700
V300P50	300	385	1.5	50000	3530	470	±10	1390	20000	1030	9000	3400
V300D60	300	385	1.6	70000	5730	470	±10	1390	25000	1030	15000	6300
V300D80	300	385	2.0	100000	9290	470	±10	1390	35000	1030	25000	12000
V320S40	320	420	1.4	40000	3060	510	±10	1510	20000	1120	7000	2400
V320D40	320	420	1.4	40000	3060	510	±10	1510	20000	1120	7000	2400
V320P50	320	420	1.5	50000	3830	510	±10	1510	20000	1120	9000	3000
V320D60	320	420	1.6	70000	6220	510	±10	1510	25000	1120	15000	5800
V320D80	320	420	2.0	100000	10080	510	±10	1510	35000	1120	25000	11000

* designation according to IEC 61643-331

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (10/350 µs)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (10/350 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I_{peak} [A]	C C_V * [pF]
V385S40	385	505	1.4	40000	3720	620	±10	1840	20000	1360	7000	2000
V385D40	385	505	1.4	40000	3720	620	±10	1840	20000	1360	7000	2000
V385P50	385	505	1.5	50000	4660	620	±10	1840	20000	1360	9000	2500
V385D60	385	505	1.6	70000	7570	620	±10	1840	25000	1360	15000	4800
V385D80	385	505	2.0	100000	12250	620	±10	1840	35000	1360	25000	9000
V420S40	420	560	1.4	40000	4080	680	±10	2020	20000	1490	7000	1900
V420D40	420	560	1.4	40000	4080	680	±10	2020	20000	1490	7000	1900
V420P50	420	560	1.5	50000	5110	680	±10	2020	20000	1490	9000	2350
V420D60	420	560	1.6	70000	8300	680	±10	2020	25000	1490	15000	4500
V420D80	420	560	2.0	100000	13440	680	±10	2020	35000	1490	25000	8600
V440S40	440	585	1.4	40000	4290	715	±10	2120	20000	1570	7000	1800
V440D40	440	585	1.4	40000	4290	715	±10	2120	20000	1570	7000	1800
V440P50	440	585	1.5	50000	5380	715	±10	2120	20000	1570	9000	2200
V440D60	440	585	1.6	70000	8730	715	±10	2120	25000	1570	15000	4300
V440D80	440	585	2.0	100000	14130	715	±10	2120	35000	1570	25000	8200
V460D40	460	615	1.4	40000	4500	750	±10	2220	20000	1650	7000	1700
V460S40	460	615	1.4	40000	4500	750	±10	2220	20000	1650	7000	1700
V460P50	460	615	1.5	50000	5640	750	±10	2220	20000	1650	9000	2100
V460D60	460	615	1.6	70000	9150	750	±10	2220	25000	1650	15000	4100
V460D80	460	615	2.0	100000	14820	750	±10	2220	35000	1650	25000	7800
V510S40	510	670	1.4	40000	4920	820	±10	2430	20000	1800	7000	1600
V510D40	510	670	1.4	40000	4920	820	±10	2430	20000	1800	7000	1600
V510P50	510	670	1.5	50000	6170	820	±10	2430	20000	1800	9000	2000
V510D60	510	670	1.6	70000	10010	820	±10	2430	25000	1800	15000	4800
V510D80	510	670	2.0	100000	16209	820	±10	2430	35000	1800	25000	7000

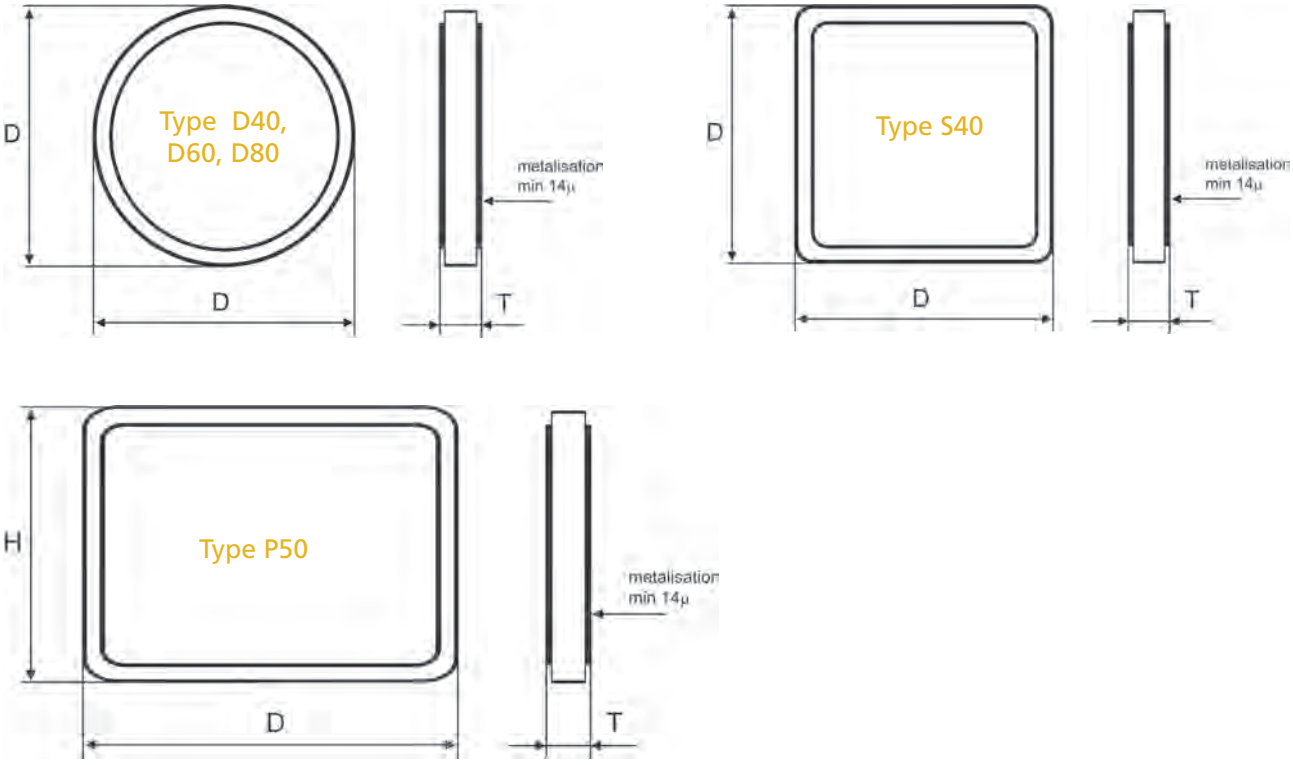
* designation according to IEC 61643-331

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (10/350 µs)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (10/350 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I_{peak} [A]	C C_V * [pF]
V550S40	550	745	1.4	40000	5460	910	±10	2700	20000	2000	7000	1500
V550D40	550	745	1.4	40000	5460	910	±10	2700	20000	2000	7000	1500
V550P50	550	745	1.5	50000	6850	910	±10	2700	20000	2000	9000	1850
V550D60	550	745	1.6	70000	11110	910	±10	2700	25000	2000	15000	3500
V550D80	550	745	2.0	100000	17988	910	±10	2700	35000	2000	25000	6600
V625S40	625	825	1.4	40000	6000	1000	±10	2970	20000	2200	7000	1400
V625D40	625	825	1.4	40000	6000	1000	±10	2970	20000	2200	7000	1400
V625P50	625	825	1.5	50000	7520	1000	±10	2970	20000	2200	9000	1750
V625D60	625	825	1.6	70000	12200	1000	±10	2970	25000	2200	15000	3200
V625D80	625	825	2.0	100000	19760	1000	±10	2970	35000	2200	25000	6000
V680S40	680	895	1.4	40000	6600	1100	±10	3260	20000	2420	7000	1200
V680D40	680	895	1.4	40000	6600	1100	±10	3260	20000	2420	7000	1200
V680P50	680	895	1.5	50000	8280	1100	±10	3260	20000	2420	9000	1500
V680D60	680	895	1.6	70000	13430	1100	±10	3260	25000	2420	15000	2800
V680D80	680	895	2.0	100000	21740	1100	±10	3260	35000	2420	25000	5200
V750S40	750	970	1.4	40000	7200	1200	±10	3560	20000	2640	7000	1100
V750D40	750	970	1.4	40000	7200	1200	±10	3560	20000	2640	7000	1100
V750P50	750	970	1.5	50000	9030	1200	±10	3560	20000	2640	9000	1400
V750D60	750	970	1.6	70000	14650	1200	±10	3560	25000	2640	15000	2600
V750D80	750	970	2.0	100000	23720	1200	±10	3560	35000	2640	25000	4900
V1100D40	1100	1465	1.4	40000	10800	1800	±10	5340	20000	3960	7000	800
V1100S40	1100	1465	1.4	40000	10800	1800	±10	5340	20000	3960	7000	800
V1100P50	1100	1465	1.5	50000	13550	1800	±10	5340	20000	3960	9000	1000
V1100D60	1100	1465	1.6	70000	21970	1800	±10	5340	25000	3960	15000	1800
V1100D80	1100	1465	2.0	100000	35580	1800	±10	5340	35000	3960	25000	3300

* designation according to IEC 61643-331

NOTE: **All specified voltages are available also as:**
- **epoxy coated versions with different designs of the terminals (LE, ME, FE, IE, JE or customized)**
- **hard-wired option in black plastic housing (E Series)**
- **discs available as single (7 kA), double (12,5 kA), 2 x double (25 kA), 2 x double + 1 (5 varistors together) or customized matched versions**

Dimension



Dimension		S40	D40	P50		D60	D80
Part Number	T mm (± 1)	D mm (± 1)	D mm (± 1)	D mm (± 1)	H mm (± 1)	D mm (± 1)	D mm (± 1)
V60 D, S, P	1.0	33	40	43	33	60	80
V75 D, S, P	1.2	33	40	43	33	60	80
V95 D, S, P	1.5	33	40	43	33	60	80
V115 D, S, P	1.8	33	40	43	33	60	80
V130 D, S, P	2.1	33	40	43	33	60	80
V140 D, S, P	2.2	33	40	43	33	60	80
V150 D, S, P	2.4	33	40	43	33	60	80
V175 D, S, P	2.7	33	40	43	33	60	80
V230 D, S, P	3.6	33	40	43	33	60	80
V250 D, S, P	3.9	33	40	43	33	60	80
V275 D, S, P	4.3	33	40	43	33	60	80
V300 D, S, P	4.7	33	40	43	33	60	80
V320 D, S, P	5.1	33	40	43	33	60	80
V385 D, S, P	6.2	33	40	43	33	60	80
V420 D, S, P	6.8	33	40	43	33	60	80
V440 D, S, P	7.1	33	40	43	33	60	80
V460 D, S, P	7.5	33	40	43	33	60	80
V510 D, S, P	8.2	33	40	43	33	60	80
V550 D, S, P	9.1	33	40	43	33	60	80
V625 D, S, P	10	33	40	43	33	60	80
V680 D, S, P	11	33	40	43	33	60	80
V750 D, S, P	12	33	40	43	33	60	80
V1100 D, S, P	18	33	40	34	33	60	80

All dimensions are maximum except where noted.
Dimensions **are in millimeters.**

High Energy Varistor Discs PV2 Series

Description

High Energy Varistor Discs PV2 Series are heavy duty metal oxide varistors, designed for special applications, where unique contacts are required. They offer an excellent surge protection according to IEC 61643-1 Class II / (EN 61643-11, Type 2), for use in the surge protective devices (SPDs) for renewable energy sources or anywhere else where lightning protection level (level of risk) according to IEC 62305-2 requires high I_{max} (8/20 µs) current levels.

The advantages of the PV2 Series are: good solderability (Ag), passivation with glass (on request), excellent performance on DC operating voltages, high I_{max} (8/20 µs) values in comparison to standard series.

Main Features

Wide Operating Voltage Range V_{AC} ($V_{M\,(AC)}$)* ____ 60 V – 1100 V
Wide Operating Voltage Range V_{DC} ($V_{M\,(DC)}$)* ____ 85 V – 1465 V
High Energy Absorption Capability W_{max} (W_{TM})* (2ms) ____ 145 J – 6000 J
High Maximum Discharge Current Capability I_{max} (I_{TM})* (8/20 µs) ____ up to 125000 A
High Nominal Discharge Current Capability I_n (I_{TSM})* (8/20 µs) ____ up to 35000 A
Rating according to IEC 61643-1 modified for DC applications

* designation according to IEC 61643-331

General Technical Data

Climatic Category LCT UCT Damp Heat, Steady state (93% r.h., 40 °C)	40 / 85 / 56 – 40 °C + 85 °C 56 days	in accordance with IEC 68-1 in accordance with IEC 68-2-3
Operating temperature	– 40 ... + 85 °C	in accordance with CECC 42 000
Storage temperature	– 40 ... + 110 °C	
Response time	< 25 ns	

Type designation

V 275 D 40 S P M (PV2)

V | **V**ARSI Metal Oxide Varistor
275 | Max. AC operating voltage
D | Varistor Design (**D** round, S square, P rectangular)
40 | Rated Diameter of Varistor Disc (40, 50, 60, 80)
S | Ag (**s**ilver) Electrodes
P | **P**assivation Collar
M | **M**atched version
PV2 | **P**hotovoltaic application Class **2**

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (2 ms)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (8/20 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I [A]	C C_V * [pF]
V60S40	60	85	1.4	50000	145	100	±10	290	20000	165	300	15000
V60D40	60	85	1.4	50000	145	100	±10	290	20000	165	300	15000
V75D40	75	100	1.4	50000	180	120	±10	350	20000	200	300	13000
V75S40	75	100	1.4	50000	180	120	±10	350	20000	200	300	13000
V95D40	95	125	1.4	50000	220	150	±10	440	20000	250	300	11000
V95S40	95	125	1.4	50000	220	150	±10	440	20000	250	300	11000
V115S40	115	150	1.4	50000	280	180	±10	530	20000	300	300	8000
V115D40	115	150	1.4	50000	280	180	±10	530	20000	300	300	8000
V130S40	130	170	1.4	50000	320	205	±10	600	20000	340	300	5800
V130D40	130	170	1.4	50000	320	205	±10	600	20000	340	300	5800
V130P50	130	170	1.6	60000	370	205	±10	600	20000	340	400	7300
V130D60	130	170	1.6	85000	480	205	±10	600	25000	340	500	15000
V130D80	130	170	2.0	125000	660	205	±10	600	35000	340	800	28000
V140S40	140	180	1.4	50000	340	220	±10	650	20000	360	300	5400
V140D40	140	180	1.4	50000	450	220	±10	650	20000	360	300	5400
V140P50	140	180	1.4	60000	390	220	±10	650	20000	360	400	6750
V140D60	140	180	1.6	85000	510	220	±10	650	25000	360	500	12500
V140D80	140	180	2.0	125000	710	220	±10	650	35000	360	800	26000
V150S40	150	200	1.4	50000	370	240	±10	710	20000	395	300	5000
V150D40	150	200	1.4	50000	370	240	±10	710	20000	395	300	5000
V150P50	150	200	1.4	60000	430	240	±10	710	20000	395	400	6250
V150D60	150	200	1.6	85000	570	240	±10	710	25000	395	500	11500
V150D80	150	200	2.0	125000	800	240	±10	710	35000	395	800	23000
V175D40	175	225	1.4	50000	410	270	±10	800	20000	455	300	4200
V175S40	175	225	1.4	50000	410	270	±10	800	20000	455	300	4200
V175P50	175	225	1.5	60000	470	270	±10	800	20000	455	400	5250
V175D60	175	225	1.6	85000	630	270	±10	800	25000	455	500	9800
V175D80	175	225	2.0	125000	890	270	±10	800	35000	455	800	20000

* designation according to IEC 61643-331

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (2 ms)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (8/20 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I [A]	C C_V * [pF]
V230D40	230	300	1.4	50000	470	360	±10	1060	20000	595	300	3400
V230S40	230	300	1.4	50000	470	360	±10	1060	20000	595	300	3400
V230P50	230	300	1.5	60000	560	360	±10	1060	20000	595	400	4250
V230D60	230	300	1.6	85000	800	360	±10	1060	25000	595	500	8000
V230D80	230	300	2.0	125000	1200	360	±10	1060	35000	595	800	16000
V250D40	250	320	1.4	50000	505	390	±10	1150	20000	650	300	3100
V250S40	250	320	1.4	50000	505	390	±10	1150	20000	650	300	3100
V250P50	250	320	1.5	60000	610	390	±10	1150	20000	650	400	3900
V250D60	250	320	1.6	85000	870	390	±10	1150	25000	650	500	7200
V250D80	250	320	2.0	125000	1300	390	±10	1150	35000	650	800	14100
V275D40	275	350	1.4	50000	565	430	±10	1270	20000	710	300	2900
V275S40	275	350	1.4	50000	565	430	±10	1270	20000	710	300	2900
V275P50	275	350	1.5	60000	670	430	±10	1270	20000	710	400	3600
V275D60	275	350	1.6	85000	940	430	±10	1270	25000	710	500	6800
V275D80	275	350	2.0	125000	1400	430	±10	1270	35000	710	800	13000
V300S40	300	385	1.4	50000	600	470	±10	1390	20000	775	300	2700
V300D40	300	385	1.4	50000	600	470	±10	1390	20000	775	300	2700
V300P50	300	385	1.5	60000	710	470	±10	1390	20000	775	400	3400
V300D60	300	385	1.6	85000	1000	470	±10	1390	25000	775	500	6300
V300D80	300	385	2.0	125000	1500	470	±10	1390	35000	775	800	12000
V320S40	320	420	1.4	50000	655	510	±10	1510	20000	840	300	2400
V320D40	320	420	1.4	50000	655	510	±10	1510	20000	840	300	2400
V320P50	320	420	1.5	60000	770	510	±10	1510	20000	840	400	3000
V320D60	320	420	1.6	85000	1080	510	±10	1510	25000	840	500	5800
V320D80	320	420	2.0	125000	1600	510	±10	1510	35000	840	800	11000

* designation according to IEC 61643-331

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (2 ms)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (8/20 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I [A]	C C_V * [pF]
V385S40	385	505	1.4	50000	815	620	±10	1840	20000	1025	300	2000
V385D40	385	505	1.4	50000	815	620	±10	1840	20000	1025	300	2000
V385P50	385	505	1.5	60000	970	620	±10	1840	20000	1025	400	2500
V385D60	385	505	1.6	85000	1360	620	±10	1840	25000	1025	500	4800
V385D80	385	505	2.0	125000	2000	620	±10	1840	35000	1025	800	9000
V420S40	420	560	1.4	50000	930	680	±10	2020	20000	1120	300	1900
V420D40	420	560	1.4	50000	930	680	±10	2020	20000	1120	300	1900
V420P50	420	560	1.5	60000	1100	680	±10	2020	20000	1120	400	2350
V420D60	420	560	1.6	85000	1500	680	±10	2020	25000	1120	500	4500
V420D80	420	560	2.0	125000	2200	680	±10	2020	35000	1120	800	8600
V440S40	440	585	1.4	50000	950	715	±10	2120	20000	1180	300	1800
V440D40	440	585	1.4	50000	950	715	±10	2120	20000	1180	300	1800
V440P50	440	585	1.5	60000	1130	715	±10	2120	20000	1180	400	2200
V440D60	440	585	1.6	85000	1600	715	±10	2120	25000	1180	500	4300
V440D80	440	585	2.0	125000	2350	715	±10	2120	35000	1180	800	8200
V460D40	460	615	1.4	50000	1010	750	±10	2220	20000	1240	300	1700
V460S40	460	615	1.4	50000	1010	750	±10	2220	20000	1240	300	1700
V460P50	460	615	1.5	60000	1210	750	±10	2220	20000	1240	400	2100
V460D60	460	615	1.6	85000	1720	750	±10	2220	25000	1240	500	4100
V460D80	460	615	2.0	125000	2500	750	±10	2220	35000	1240	800	7800
V510S40	510	670	1.4	50000	1040	820	±10	2430	20000	1355	300	1600
V510D40	510	670	1.4	50000	1040	820	±10	2430	20000	1355	300	1600
V510P50	510	670	1.5	60000	1250	820	±10	2430	20000	1355	400	2000
V510D60	510	670	1.6	85000	1760	820	±10	2430	25000	1355	500	4800
V510D80	510	670	2.0	125000	2600	820	±10	2430	35000	1355	800	7000

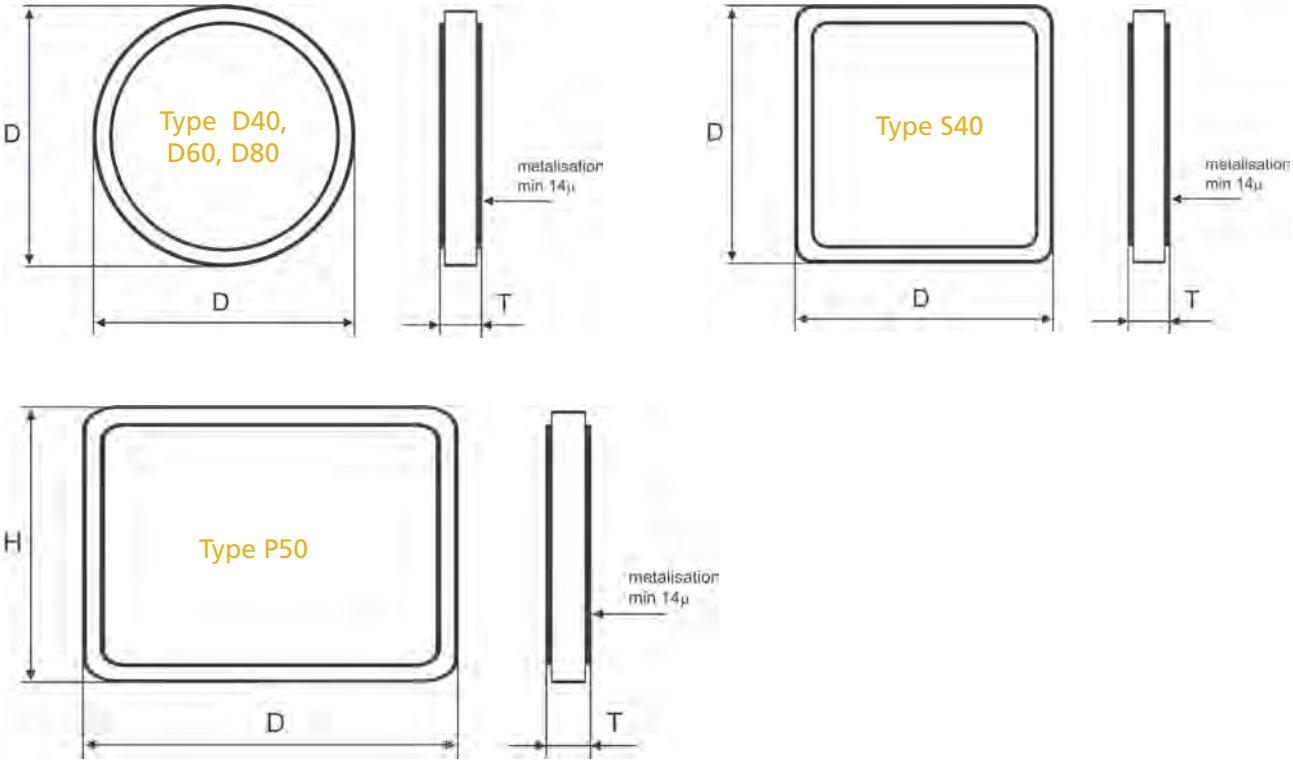
* designation according to IEC 61643-331

Part Number	Maximum Ratings TA = + 85 °C (+ 185 °F)					Characteristics TA = + 25 °C (+ 77 °F)						
	Operating Voltage		Average Power Dissipation	Permissible Peak Current (8/20 µs)	Energy Absorption (2 ms)	Varistor Voltage (1 mA)		Maximum Clamping Voltage at Test Current (8/20 µs)		Maximum Clamping Voltage at Test Current (8/20 µs)		Typical Capacitance f = 1kHz
	RMS Voltage	DC Voltage										
	V_{RMS} $V_{M\ (AC)}$ * [V]	V_{DC} $V_{M\ (DC)}$ * [V]	P_{max} P_M * [W]	I_{max} I_{TM} * [A]	W_{max} W_{TM} * [J]	V_N [V]	ΔV_N [%]	V_C [V]	I_n I_{TSM} * [A]	V_C [V]	I [A]	C C_V * [pF]
V550S40	550	745	1.4	50000	1080	910	±10	2700	20000	1400	300	1500
V550D40	550	745	1.4	50000	1080	910	±10	2700	20000	1400	300	1500
V550P50	550	745	1.5	60000	1340	910	±10	2700	20000	1400	400	1850
V550D60	550	745	1.6	85000	2020	910	±10	2700	25000	1400	500	3500
V550D80	550	745	2.0	125000	3100	910	±10	2700	35000	1400	800	6600
V625S40	625	825	1.4	50000	1100	1000	±10	2970	20000	1650	300	1400
V625D40	625	825	1.4	50000	1100	1000	±10	2970	20000	1650	300	1400
V625P50	625	825	1.5	60000	1400	1000	±10	2970	20000	1650	400	1750
V625D60	625	825	1.6	85000	2150	1000	±10	2970	25000	1650	500	3200
V625D80	625	825	2.0	125000	3300	1000	±10	2970	35000	1650	800	6000
V680S40	680	895	1.4	50000	1130	1100	±10	3260	20000	1815	300	1200
V680D40	680	895	1.4	50000	1130	1100	±10	3260	20000	1815	300	1200
V680P50	680	895	1.5	60000	1450	1100	±10	3260	20000	1815	400	1500
V680D60	680	895	1.6	85000	2280	1100	±10	3260	25000	1815	500	2800
V680D80	680	895	2.0	125000	3600	1100	±10	3260	35000	1815	800	5200
V750S40	750	970	1.4	50000	1230	1200	±10	3560	20000	2000	300	1100
V750D40	750	970	1.4	50000	1230	1200	±10	3560	20000	2000	300	1100
V750P50	750	970	1.5	60000	1600	1200	±10	3560	20000	2000	400	1400
V750D60	750	970	1.6	85000	2500	1200	±10	3560	25000	2000	500	2600
V750D80	750	970	2.0	125000	4000	1200	±10	3560	35000	2000	800	4900
V1100D40	1100	1465	1.4	50000	1850	1800	±10	5340	20000	2970	300	800
V1100S40	1100	1465	1.4	50000	1850	1800	±10	5340	20000	2970	300	800
V1100P50	1100	1465	1.5	60000	2400	1800	±10	5340	20000	2970	400	1000
V1100D60	1100	1465	1.6	85000	3800	1800	±10	5340	25000	2970	500	1800
V1100D80	1100	1465	2.0	125000	6000	1800	±10	5340	35000	2970	800	3300

* designation according to IEC 61643-331

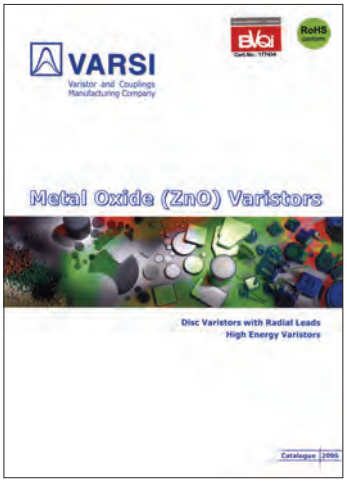
NOTE: **All specified voltages are available also as:**
- **epoxy coated versions with different designs of the terminals (LE, ME, FE, IE, JE or customized)**
- **hard-wired option in black plastic housing (E Series)**
- **discs available as matched versions**

Dimension



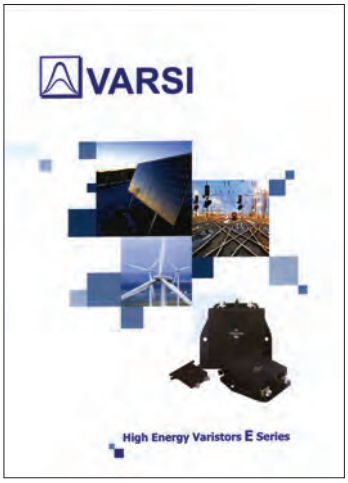
Dimension		S40	D40	P50		D60	D80
Part Number	T mm (± 1)	D mm (± 1)	D mm (± 1)	D mm (± 1)	H mm (± 1)	D mm (± 1)	D mm (± 1)
V60 D, S, P	1.0	33	40	43	33	60	80
V75 D, S, P	1.2	33	40	43	33	60	80
V95 D, S, P	1.5	33	40	43	33	60	80
V115 D, S, P	1.5	33	40	43	33	60	80
V130 D, S, P	1.7	33	40	43	33	60	80
V140 D, S, P	1.8	33	40	43	33	60	80
V150 D, S, P	2.0	33	40	43	33	60	80
V175 D, S, P	2.3	33	40	43	33	60	80
V230 D, S, P	2.2	33	40	43	33	60	80
V250 D, S, P	2.4	33	40	43	33	60	80
V275 D, S, P	2.6	33	40	43	33	60	80
V300 D, S, P	2.9	33	40	43	33	60	80
V320 D, S, P	3.1	33	40	43	33	60	80
V385 D, S, P	3.8	33	40	43	33	60	80
V420 D, S, P	3.8	33	40	43	33	60	80
V440 D, S, P	4.0	33	40	43	33	60	80
V460 D, S, P	4.2	33	40	43	33	60	80
V510 D, S, P	4.6	33	40	43	33	60	80
V550 D, S, P	5.1	33	40	43	33	60	80
V625 D, S, P	5.6	33	40	43	33	60	80
V680 D, S, P	6.2	33	40	43	33	60	80
V750 D, S, P	6.7	33	40	43	33	60	80
V1100 D, S, P	10.0	33	40	34	33	60	80

All dimensions are maximum except where noted.
Dimensions **are in millimeters.**

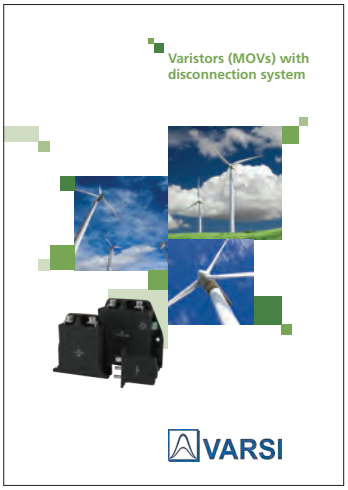


General Catalogue
Standard leaded varistors: K5 - K20, K5 - K20P, K5 - K20E, KS20, K25 K25P;
High energy varistors: bare discs (D, S Series), epoxy coated varistors D32, S40, D60, D80 LE (ME, FE, IE, JE), hard-wired varistors E25, E32, E40, High energy blocks (D40HEB)

Short-form Catalogue
overview of Varsi product range



High energy varistors E Series
(E25, E32, E40, E60, E80) for wind, solar and transportation applications



Varistors with disconnection system (ET40, ET80, ED80, VTDS40)

VARSI, d.o.o.
Varistor and Couplings Manufacturing Company
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E commercial@varsi.si; technical@varsi.si
W www.varsi.si

ISO 9001 BUREAU VERITAS Certification

RoHS Compliant

Edition 1 – June 2009