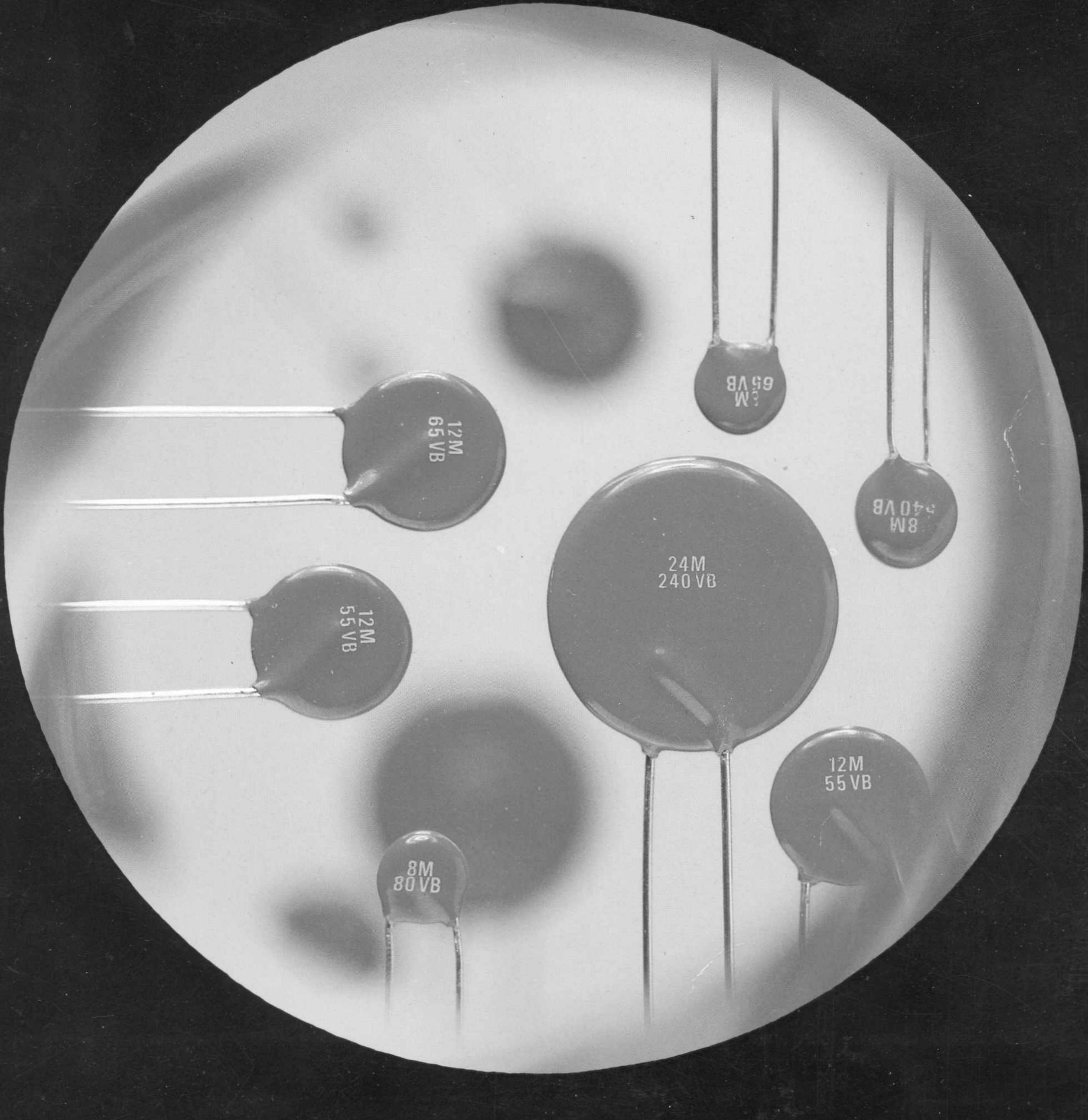
CONRADTY-
CONOX®
METAL OXIDE VARISTORS



C. CONRADTY
NÜRNBERG GmbH & Co. KG

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Post Box 1752
D-8500 Nürnberg
Telephone (09 11) 598-1
Telegrams Ceconradty Nürnberg
Telex 622 391 ccnbg d

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1. General

Conradty - metal oxide - varistors CONOX®

CONOX® varistors are voltage-dependent resistors with symmetrical voltage and current characteristics which are therefore suitable for both DC and AC voltage applications.

These VDR (voltage-dependent) resistors are distinguished by a high voltage dependence; that is to say, the resistance decreases rapidly as the voltage rises.

This voltage dependence is represented by the nonlinearity exponent. The following relationship between the current I and voltage U applies for the ideal varistor:

$$U = B \cdot I^{1/n}$$

B is the voltage at 1 A and n is the so-called exponent. If, as is usual, the varistor characteristic is entered into a double logarithmic U/I characteristic field, 1/n is the steepness of the characteristic. n = 1 applies to a voltage-independent, ohmic resistance. The voltage dependence increases as the value n increases. The exponent can be determined from two value pairs (U,I).

$$n = \frac{\lg (I_1/I_2)}{\lg (U_1/U_2)}$$

The values $I_1 = 10$ mA and $I_2 = 1$ mA are mostly chosen in practice. These result in

$$n = \frac{1}{\lg (U\ (10\ \text{mA})\ /\ U\ (1\ \text{mA}))}$$

In the case of silicon carbide varistors (OCELIT®), the exponent is approximately 3 to 7 and, in the case of metal oxide varistors (CONOX®) it has been possible to increase this value to more than 25.

As the result of this, CONOX® varistors achieve the response steepness of Zener diodes, but with far higher energy absorption, surge current load and power dissipation values.

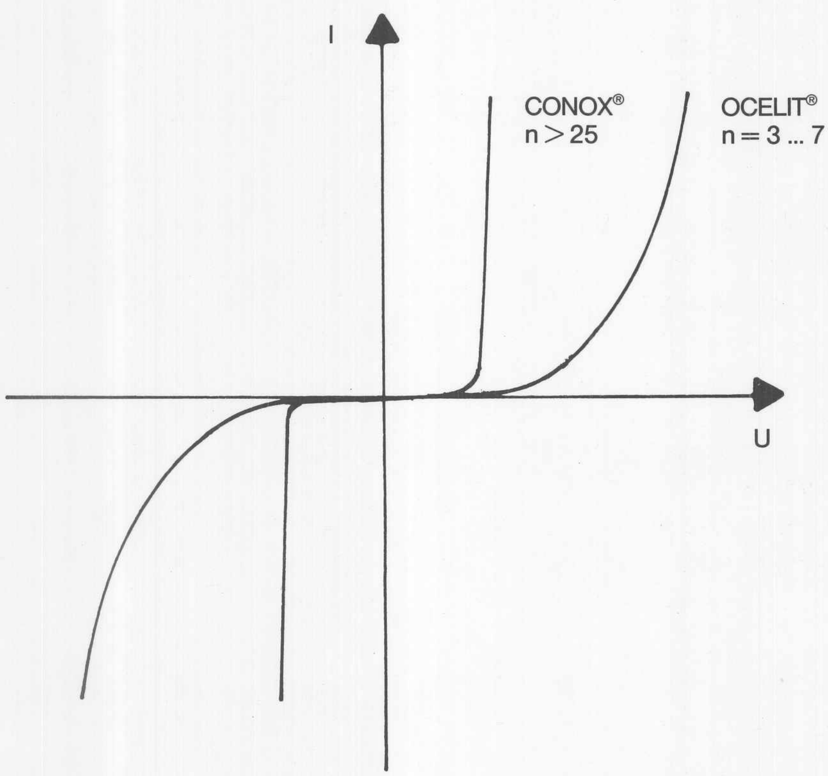


Figure 1: U/I characteristic of OCELIT®/ CONOX® varistors

In conjunction with the short response time of < 25 ns and the low leakage current of < 30 µA, these characteristics make the CONOX® varistor an ideal component for protecting electrical circuits against excess voltages.

Many years of experience in the development and production of our VDRs, i.e.:

- silicon carbide varistors (OCELIT®) since 1953
- metal oxide varistors (CONOX®) since 1974

manufactured in Germany in accordance with our own patents, guarantee optimum overvoltage protection and high reliability.

Our comprehensive standard range of products contains the optimum varistor for your applications.

Please ask for our other type lists for passive components:

VDR-OCELIT® varistors
(Voltage dependant resistors on a silicon carbide basis)

OCELIT® resistors
(Low-induction composite carbon resistors, voltage dependant, for high and low voltage applications)

SILICO® resistors
(Low-induction composite carbon resistors for high loads)

For special applications, and if corresponding quantities are ordered, we also develop and manufacture varistors in accordance with customers' requirements.

Our applications laboratory will be pleased to help you to select the correct varistor type for your circuits.

2. Design

CONOX® varistors are metal oxide varistors and consist of approximately 90 % zinc oxide as a ceramic base material and 10 % filler material for grain growth of the zinc oxide and formation of the junction between the ZnO grains.

Due to sintering of this mass, junctions comparable to those of Zener diodes are formed around the highly conductive ZnO grains. The response voltage of each ZnO grain is approximately 4 V. The varistor voltage is obtained by series connecting all ZnO grains in the current paths.

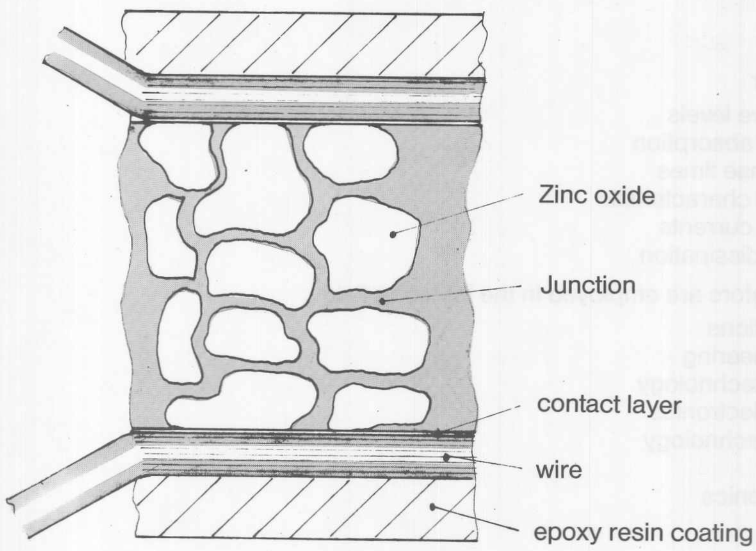


Figure 2: Design of the CONOX® varistor

In simplified terms, the following can be said about the metal oxide varistor:
- The thickness of the disk (with an identical grain size) is a measure of the varistor voltage.
- The diameter of the disk is a measure of the permissible surge current
- Both criteria together (thickness and diameter of the disk) are a measure of the energy absorption and power dissipation.

3. Applications

Overvoltage pulses are particularly dangerous to electronic circuits with semiconductor components. Overvoltages can destroy such components or can impair their functions. In electronic controllers, incorrect command sequences can result in grave consequences.

CONOX® varistors are a reliable and economical means of providing protection against internal overvoltages (that is to say, those which occur within the unit itself) and external overvoltages (that is to say, those which reach the unit from the outside).

CONOX® varistors are used for protection against:
- overvoltages in supply lines caused by lightning or stray inductive or capacitive interference.
- overvoltages in electrical components such as ICs, diodes, transistors, thyristors and triacs.
- burn off in the case of switching contacts with inductive loads.
- excessive switching-off voltages in the case of transformers, magnetic coils, motor and generator windings.

4. Scopes of application

Thanks of their
- low protective levels
- high energy absorption
- short response times
- symmetrical characteristic
- low leakage currents
- high power dissipation

CONOX® varistors are employed in the following fields:
- communications
- power engineering
- automation technology
- consumer electronics
- measuring technology
- telemetry
- office electronics

5. Type selection

CONOX® varistors are classified as follows:

example: CONOX® 12M 220 VB

CONOX®	= **Con**radty metal **ox**ide varistor
12	= nominal diameter in mm Disk types 6, 8, 12, 17 and 24 mm nominal diameter Due to the epoxy resin coating, the installation diameter is greater than the nominal diameter.
M	= disk type with radial wire connections and epoxy resin coating. Wire diameter 6 and 8M = 0.6 mm, 12, 17 and 24M = 0.8 mm.
220	= operating voltage 220 V_{rms}
V	= varistor
B	= varistor voltage tolerance class B = ± 10 % Other tolerance ranges are possible if corresponding quantities are ordered.

5.1 Brief description of the standard product range

– Operating voltage	35 to 540 V_{rms}
– Installation diameter	7 to 25 mm
– Exponent	> 25
– Surge currents	up to 4000 A
– Energy absorption	up to 200 J
– Continuous power dissipation	up to 0.8 W
– Response time	≦ 50 ns
– Operating temperature at zero load	-25 to +115°C
– Operating temperature at full load	-25 to + 70°C
– Temperature coefficient at 1 mA between +25° and +85°C	-0.05 %/K
– Capacitance	80 to 3000 pF
– Standard range	90 types

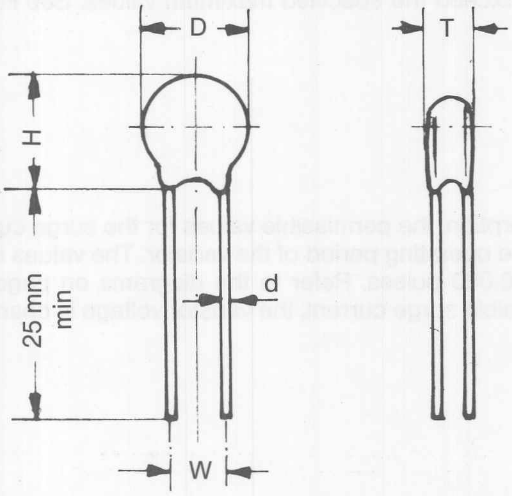


Figure 3: Mechanical dimensions

5.2 Selection criteria

The varistor types are listed in the following tables according to operating voltages. Several types (up to 5) are available for each operating voltage and these differ with respect to their sizes and capabilities.

In order to select the best varistor for a specific application, it is best to proceed on the basis of the operating voltage continuously applied to the varistor. The operating voltage recommended for each varistor is listed in the table for AC voltages. The maximally permissible AC voltage is also listed. Under no circumstances may this be exceeded. The specified maximum DC voltage value applies to a voltage without an AC voltage component ("hum"). If an AC voltage component is present, this value must be reduced accordingly.

Corresponding to the intended application, a class of varistor is selected in such a manner that the maximally possible operating voltage lies below the maximum value of the table. On the other hand, the chosen varistor should have as low a voltage as possible in order to achieve good limiting of overvoltage pulses.

Of the types available for one operating voltage, further selection is based on the following criteria:

- pulse current
- pulse energy
- power dissipation

The pulse current, pulse energy and power dissipation must lie within the threshold values specified in the table. The maximum current and energy pulses depend on the number of pulses during the entire operating time of the varistor and on the pulse waveform. The values specified in the table apply to a standard wave 8/20 μs. For other pulse lengths, refer to the diagrams on pages 11 to 19 for the maximally permissible current.

For pulses with the energy E in the time interval t the power dissipation is calculated as follows:

$$P = \frac{E}{t}$$

5.2.1 Operating voltage

The operating voltage U_{rms} is part of the varistor designation. The maximally permissible rms operating voltage is approximately 10 % higher. Under no circumstances may this be exceeded. The maximally permissible DC voltage value ($U_{=max} \approx 1.3 \times U_{rms\ max}$) applies to a voltage with no hum. If the voltage has a hum component, this value must be reduced accordingly, as well as at ambient temperatures above + 70°C (see Figure 4).

5.2.2 Energy absorption

The permissible energy absorption values depend on the length and number of pulses during the entire operating period of the varistor as well as on the ambient temperature.

The values for the standard wave 8/20 µs are given in the table. The permissible energy value must be determined from the diagrams on pages 11 to 19 if the pulse length differs. The permissible energy decreases as the pulse duration increases. The values for 1, 100 and 10.000 pulses are given in the table. Refer to the diagrams on pages 11 to 19 for further values. The energy E is given by $E = U \cdot I \cdot t$. The change in the varistor voltage is less than 10 % at loads which should not exceed the specified maximum values. See Figure 4 for ambient temperatures above +70°C.

5.2.3 Surge current

As in the case of the energy absorption, the permissible values for the surge current I depend on the length and number of pulses during the entire operating period of the varistor. The values in the table apply to the standard wave 8/20 µs and 1, 100 and 10.000 pulses. Refer to the diagrams on pages 11 to 19 for further values. If loaded with the maximally permissible surge current, the varistor voltage is changed by less than 10 %.

5.2.4 Protective level

The protective level is the maximally permissible voltage at a specific current, in this case, at the maximum current for 10.000 pulses. Refer to the characteristic curves for further voltage values.

5.2.5 Varistor voltage

The varistor voltage is measured with an impressed current of 1 mA and serves to characterize each varistor type. CONOX® varistors are usually delivered with a varistor voltage tolerance of ± 10 %.

5.2.6 Capacitance

Only typical values are specified for the capacitance. These apply to a frequency of 1 kHz. The capacitance drops somewhat at higher frequencies.

5.2.7 Power dissipation

The power dissipation value applies for a temperature range of -25°C to +70°C. Refer to Figure 4 for ambient temperatures which do not lie within this range.

5.2.8 Operating temperature range

The specified energy absorption, power dissipation and operating voltage values apply to a range of -25°C to +70°C. At higher temperatures the values must be reduced in accordance with the curve.

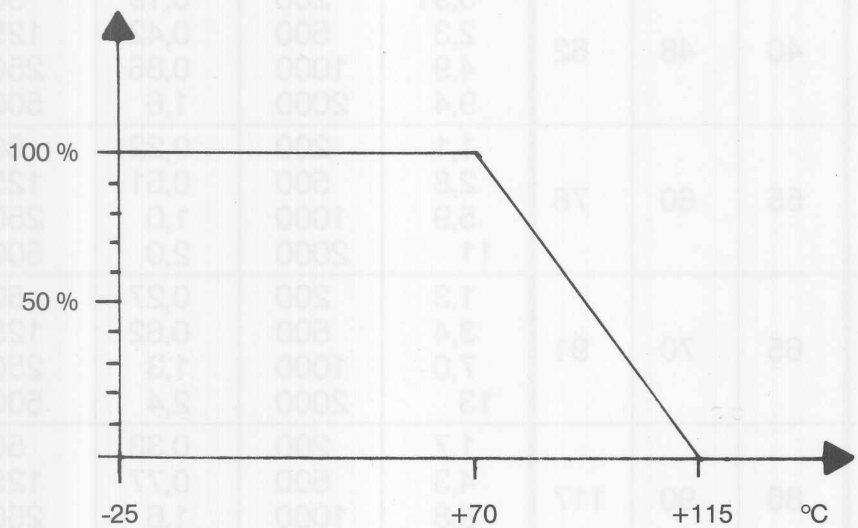


Figure 4: Dependence of the permissible power dissipation, energy and operating voltage on the ambient temperature

5.2.9 Response time

The response time of the varistor is essentially defined by the connection inductance. In order to achieve a short response time (≦ 50 ns), the varistor must be installed with short connections for low inductance.

6. Technical data

The maximum values given in the following tables are absolute threshold values.
The maximally permissible load of a varistor has been reached when one of the specified maximum values is exceeded, even if the other threshold values have not yet been reached.

6.1 CONOX® varistors 35 to 170 VB

Type	Operating voltage			One surge 8/20 µs max.		10^2 surges 8/20 µs max.		10^4 surg
	U_{rms} V	max. U_{rms} V	max. U= V	energy J	current A	energy J	current A	energy J
6M 35VB	35	42	54	0,75	200	0,16	50	0,05
8M 35VB				1,9	500	0,35	125	0,13
12M 35VB				4,0	1000	0,71	250	0,23
17M 35VB				7,9	2000	1,3	500	0,36
6M 40VB	40	48	62	0,91	200	0,19	50	0,06
8M 40VB				2,3	500	0,42	125	0,15
12M 40VB				4,9	1000	0,86	250	0,29
17M 40VB				9,4	2000	1,6	500	0,44
6M 55VB	55	60	78	1,1	200	0,22	50	0,07
8M 55VB				2,8	500	0,51	125	0,19
12M 55VB				5,9	1000	1,0	250	0,36
17M 55VB				11	2000	2,0	500	0,54
6M 65VB	65	70	91	1,3	200	0,27	50	0,09
8M 65VB				3,4	500	0,62	125	0,22
12M 65VB				7,0	1000	1,3	250	0,43
17M 65VB				13	2000	2,4	500	0,64
6M 80VB	80	90	117	1,7	200	0,33	50	0,11
8M 80VB				4,3	500	0,77	125	0,28
12M 80VB				8,8	1000	1,6	250	0,55
17M 80VB				17	2000	3,1	500	0,80
6M 90VB	90	105	137	2,0	200	0,39	50	0,13
8M 90VB				5,2	500	0,93	125	0,33
12M 90VB				10	1000	1,9	250	0,66
17M 90VB				20	2000	3,7	500	0,97
24M 90VB				39	4000	7,6	1000	1,2
6M 110VB	110	130	169	2,4	200	0,48	50	0,16
8M 110VB				6,4	500	1,1	125	0,41
12M 110VB				13	1000	2,3	250	0,81
17M 110VB				24	2000	4,6	500	1,2
24M 110VB				48	4000	9,2	1000	1,5
6M 130VB	130	140	182	2,7	200	0,52	50	0,18
8M 130VB				7,0	500	1,2	125	0,44
12M 130VB				14	1000	2,5	250	0,89
17M 130VB				26	2000	5,0	500	1,3
24M 130VB				53	4000	10	1000	1,6
6M 140VB	140	160	208	3,0	200	0,58	50	0,20
8M 140VB				7,9	500	1,4	125	0,50
12M 140VB				16	1000	2,8	250	1,0
17M 140VB				29	2000	5,7	500	1,5
24M 140VB				60	4000	11	1000	1,8
6M 170VB	170	195	253	3,7	200	0,71	50	0,25
8M 170VB				9,6	500	1,7	125	0,61
12M 170VB				19	1000	3,5	250	1,2
17M 170VB				36	2000	6,9	500	1,8
24M 170VB				75	4000	14	1000	2,2

8/20 µs max. current A	Protective level at 10^4 surges V	Varistor voltage at 1 mA ± 10 % V	C typ. pF	Power dissipation W	Dimensions in mm D max.	H max.	T max.	w ±1	d
20	130	68	300	0,1	7	8	3	5	0,6
50	140		740	0,2	9	11	3	5	0,6
100	135		1900	0,4	15	17	4	7,5	0,8
150	135		4700	0,6	18	21	4	7,5	0,8
20	155	82	250	0,1	7	8	3	5	0,6
50	165		620	0,2	9	11	3	5	0,6
100	160		1600	0,4	15	17	4	7,5	0,8
150	160		3900	0,6	18	21	4	7,5	0,8
20	190	100	200	0,1	7	8	3	5	0,6
50	200		510	0,2	9	11	4	5	0,6
100	190		1300	0,4	15	17	4	7,5	0,8
150	190		3200	0,6	18	21	4	7,5	0,8
20	230	120	170	0,1	7	8	4	5	0,6
50	240		430	0,2	9	11	4	5	0,6
100	230		1100	0,4	15	17	4	7,5	0,8
150	230		2600	0,6	18	21	4	7,5	0,8
20	285	150	140	0,1	7	8	4	5	0,6
50	300		350	0,2	9	11	4	5	0,6
100	285		890	0,4	15	17	4	7,5	0,8
150	280		2100	0,6	18	21	4	7,5	0,8
20	340	180	120	0,1	7	8	4	5	0,6
50	360		300	0,2	9	11	4	5	0,6
100	340		740	0,4	15	17	4	7,5	0,8
150	335		1800	0,6	18	21	4	7,5	0,8
200	345		2900	0,8	25	28	4	7,5	0,8
20	380	220	100	0,1	7	8	4	5	0,6
50	400		250	0,2	9	11	4	5	0,6
100	375		610	0,4	15	18	4	7,5	0,8
150	370		1400	0,6	18	21	4	7,5	0,8
200	380		2400	0,8	25	28	4	7,5	0,8
20	455	240	90	0,1	7	8	4	5	0,6
50	480		230	0,2	9	11	4	5	0,6
100	445		560	0,4	15	18	4	7,5	0,8
150	440		1300	0,6	18	21	4	7,5	0,8
200	455		2200	0,8	25	28	4	7,5	0,8
20	510	270	80	0,1	7	8	4	5	0,6
50	540		210	0,2	9	11	4	5	0,6
100	500		500	0,4	15	18	4	7,5	0,8
150	495		1200	0,6	18	21	5	7,5	0,8
200	505		2000	0,8	25	28	5	7,5	0,8
20	625	330	70	0,1	7	8	4	5	0,6
50	660		180	0,2	9	11	4	5	0,6
100	610		410	0,4	15	18	5	7,5	0,8
150	605		910	0,6	18	21	5	7,5	0,8
200	615		1700	0,8	25	28	5	7,5	0,8

6.2 CONOX® varistors 200 to 540 VB

Type	Operating voltage U_{ms} V	max. U_{rms} V	max. U= V	One surge 8/20 µs max. energy J	current A	10^2 surges 8/20 µs max. energy J	current A	10^4 surg max. energy J
6M 200VB	200	230	300	4,3	200	0,83	50	0,29
8M 200VB				11	500	2,0	125	0,72
12M 200VB				23	1000	4,1	250	1,5
17M 200VB				42	2000	8,2	500	2,1
24M 200VB				89	4000	16	1000	2,6
6M 220VB	220	250	325	4,7	200	0,90	50	0,31
8M 220VB				12	500	2,2	125	0,78
12M 220VB				24	1000	4,4	250	1,6
17M 220VB				45	2000	8,9	500	2,3
24M 220VB				96	4000	18	1000	2,8
6M 240VB	240	265	345	5,0	200	0,96	50	0,34
8M 240VB				13	500	2,3	125	0,83
12M 240VB				26	1000	4,8	250	1,7
17M 240VB				48	2000	9,5	500	2,4
24M 240VB				105	4000	19	1000	3,0
6M 250VB	250	280	364	5,2	200	1,0	50	0,35
8M 250VB				14	500	2,4	125	0,87
12M 250VB				27	1000	5,0	250	1,8
17M 250VB				51	2000	9,9	500	2,5
24M 250VB				110	4000	20	1000	3,2
8M 300VB	300	330	429	16	500	2,9	125	1,0
12M 300VB				32	1000	5,9	250	2,1
17M 300VB				60	2000	12	500	3,0
24M 300VB				130	4000	23	1000	3,8
8M 340VB	340	380	494	19	500	3,3	125	1,2
12M 340VB				37	1000	6,8	250	2,4
17M 340VB				69	2000	14	500	3,4
24M 340VB				150	4000	27	1000	4,3
8M 380VB	380	420	546	21	500	3,7	125	1,3
12M 380VB				41	1000	7,5	250	2,7
17M 380VB				76	2000	15	500	3,8
24M 380VB				165	4000	30	1000	4,8
8M 420VB	420	460	598	23	500	4,0	125	1,4
12M 420VB				45	1000	8,3	250	2,9
17M 420VB				83	2000	17	500	4,2
24M 420VB				180	4000	32	1000	5,3
8M 440VB	440	490	637	24	500	4,2	125	1,5
12M 440VB				47	1000	8,7	250	3,1
17M 440VB				88	2000	17	500	4,4
24M 440VB				190	4000	34	1000	5,6
8M 540VB	540	600	780	29	500	5,2	125	1,8
12M 540VB				58	1000	11	250	3,8
17M 540VB				110	2000	21	500	5,4
24M 540VB				235	4000	42	1000	6,8

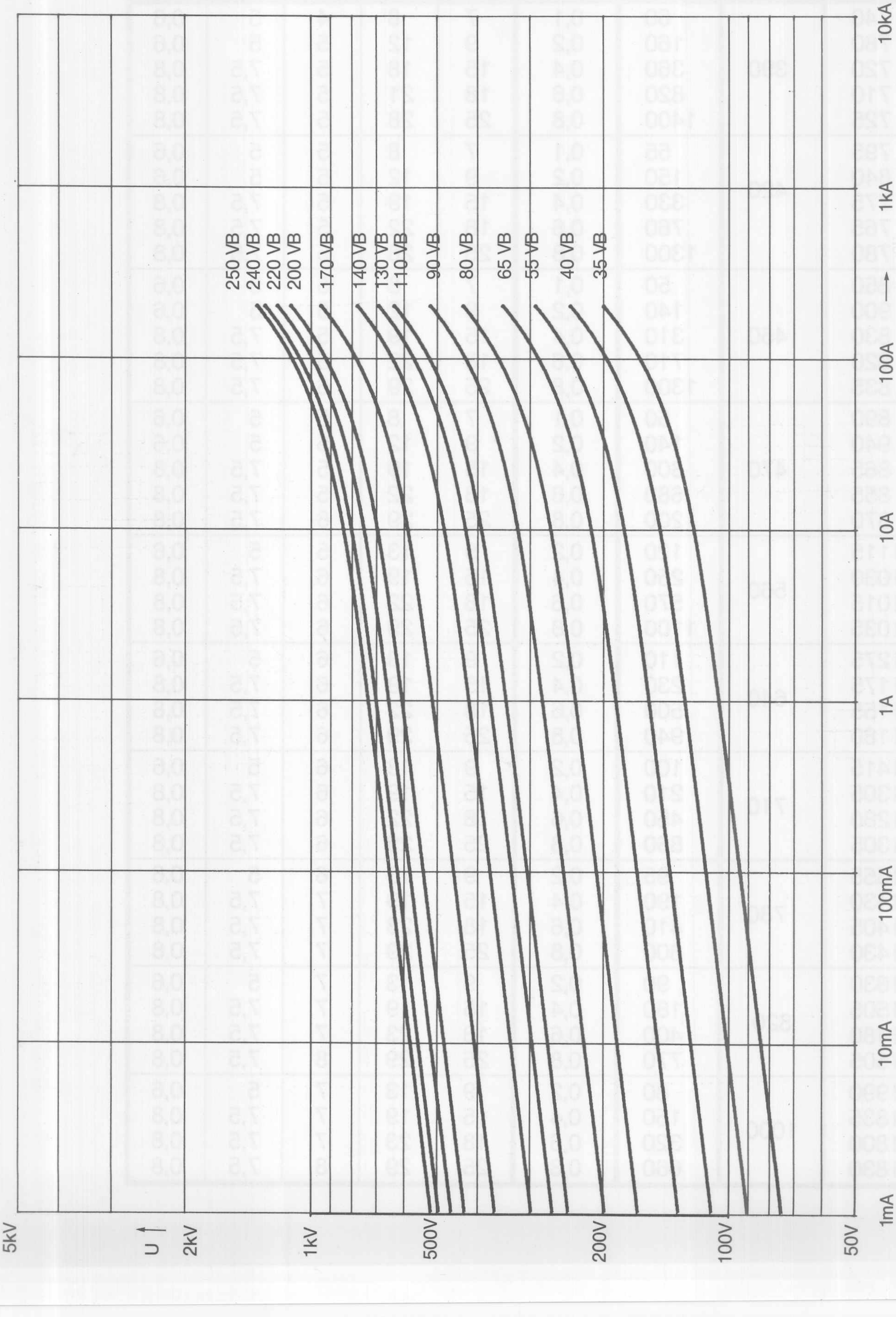
/20 µs max. current A	Protective level at 10^4 surges V	Varistor voltage at 1 mA ± 10 % V	C typ. pF	Power dissipation W	Dimensions in mm D max.	H max.	T max.	w ±1	d
20	740	390	60	0,1	7	8	4	5	0,6
50	780		160	0,2	9	12	5	5	0,6
100	720		360	0,4	15	18	5	7,5	0,8
150	710		820	0,6	18	21	5	7,5	0,8
200	725		1400	0,8	25	28	5	7,5	0,8
20	795	420	55	0,1	7	8	5	5	0,6
50	840		150	0,2	9	12	5	5	0,6
100	775		330	0,4	15	19	5	7,5	0,8
150	765		760	0,6	18	22	5	7,5	0,8
200	780		1300	0,8	25	28	5	7,5	0,8
20	850	450	50	0,1	7	8	5	5	0,6
50	900		140	0,2	9	12	5	5	0,6
100	830		310	0,4	15	19	5	7,5	0,8
150	820		710	0,6	18	22	5	7,5	0,8
200	835		1300	0,8	25	29	6	7,5	0,8
20	890	470	50	0,1	7	8	5	5	0,6
50	940		140	0,2	9	12	5	5	0,6
100	865		300	0,4	15	19	5	7,5	0,8
150	855		680	0,6	18	22	5	7,5	0,8
200	870		1200	0,8	25	29	6	7,5	0,8
50	1115	560	120	0,2	9	13	5	5	0,6
100	1030		250	0,4	15	19	6	7,5	0,8
150	1015		570	0,6	18	22	6	7,5	0,8
200	1035		1100	0,8	25	29	6	7,5	0,8
50	1275	640	110	0,2	9	13	6	5	0,6
100	1175		230	0,4	15	19	6	7,5	0,8
150	1155		500	0,6	18	22	6	7,5	0,8
200	1180		940	0,8	25	29	6	7,5	0,8
50	1415	710	100	0,2	9	13	6	5	0,6
100	1305		210	0,4	15	19	6	7,5	0,8
150	1280		450	0,6	18	22	6	7,5	0,8
200	1305		860	0,8	25	29	6	7,5	0,8
50	1555	780	95	0,2	9	13	6	5	0,6
100	1430		190	0,4	15	19	7	7,5	0,8
150	1405		410	0,6	18	23	7	7,5	0,8
200	1430		800	0,8	25	29	7	7,5	0,8
50	1630	820	90	0,2	9	13	7	5	0,6
100	1505		180	0,4	15	19	7	7,5	0,8
150	1480		400	0,6	18	23	7	7,5	0,8
200	1505		770	0,8	25	29	8	7,5	0,8
50	1990	1000	80	0,2	9	13	7	5	0,6
100	1835		150	0,4	15	19	7	7,5	0,8
150	1800		320	0,6	18	23	7	7,5	0,8
200	1830		660	0,8	25	29	8	7,5	0,8

7. Characteristic curves and diagrams for CONOX® varistors

Characteristics:
The characteristic curves 1 to 5 show the maximum possible voltage at a specific current. The typical voltage values thus lie below this.

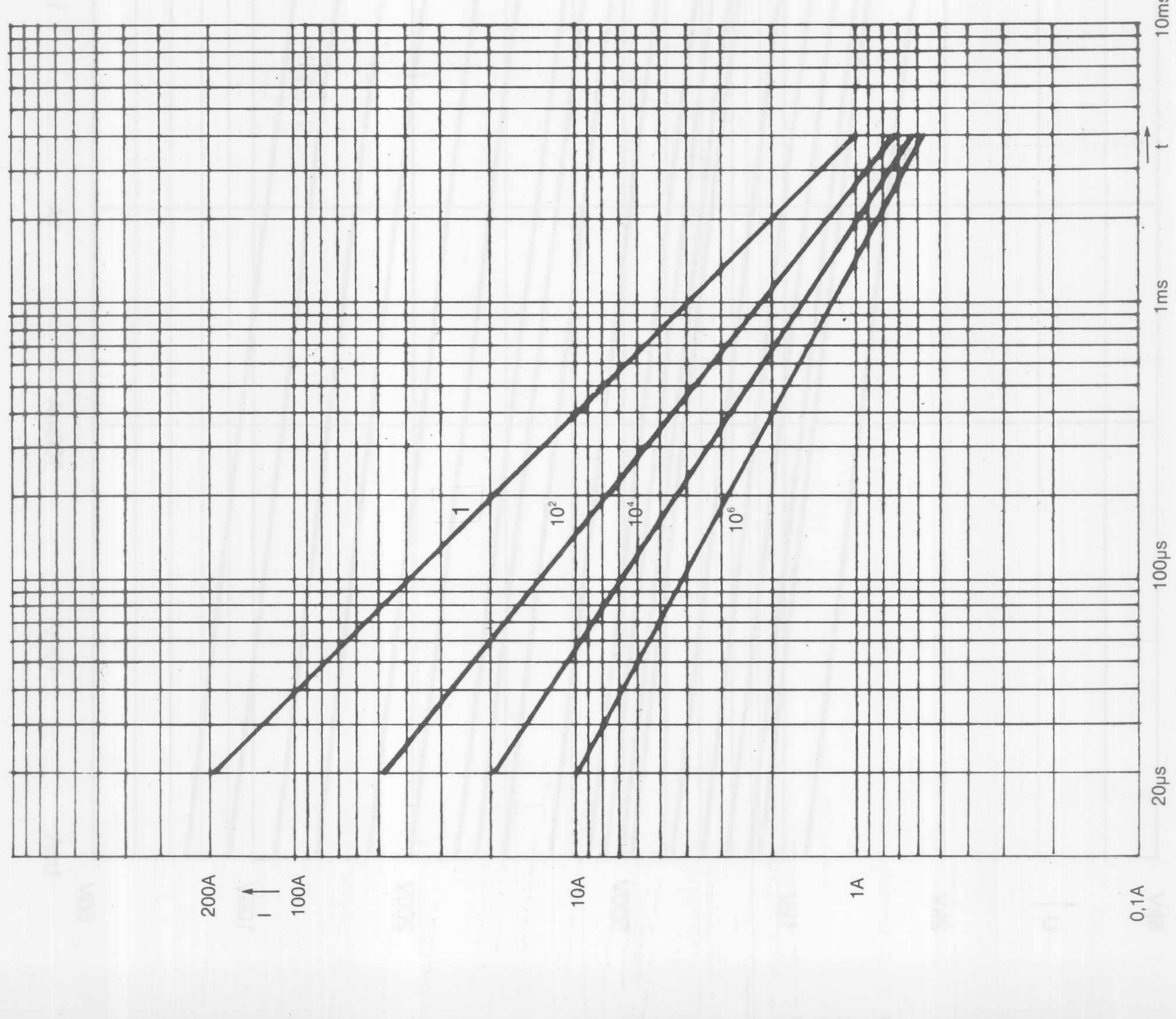
Diagrams:
If the permissible surge current and permissible energy absorption of a varistor cannot be found in the table because the pulse lengths and number of surges do not agree with the data in the table, please refer to the values in diagrams 1 to 5.

7.1 U/I characteristic 1: 6M

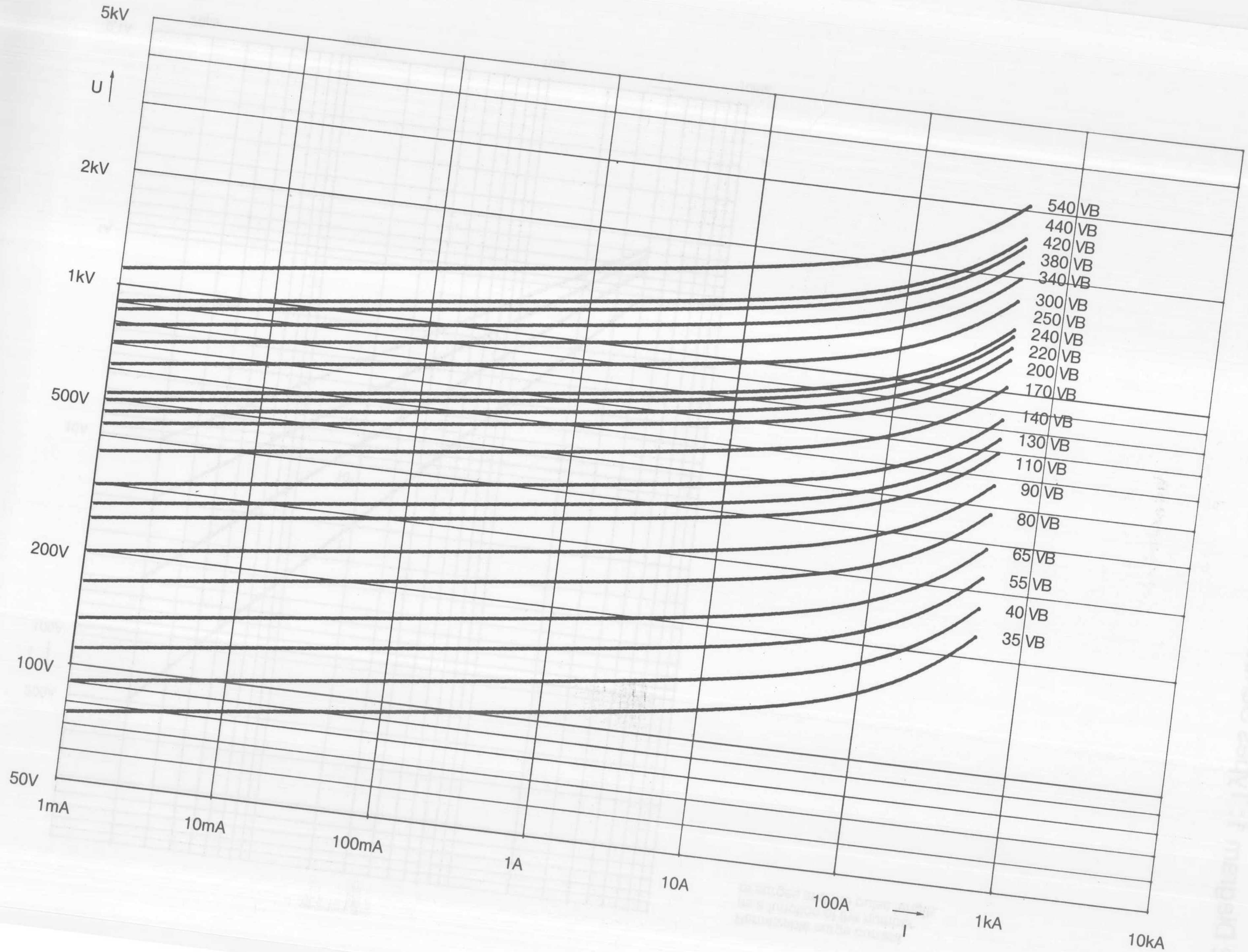


7.2 Diagram 1: Types Series 6M

Permissible surge current
as a function of the number
of surges and the pulse length.

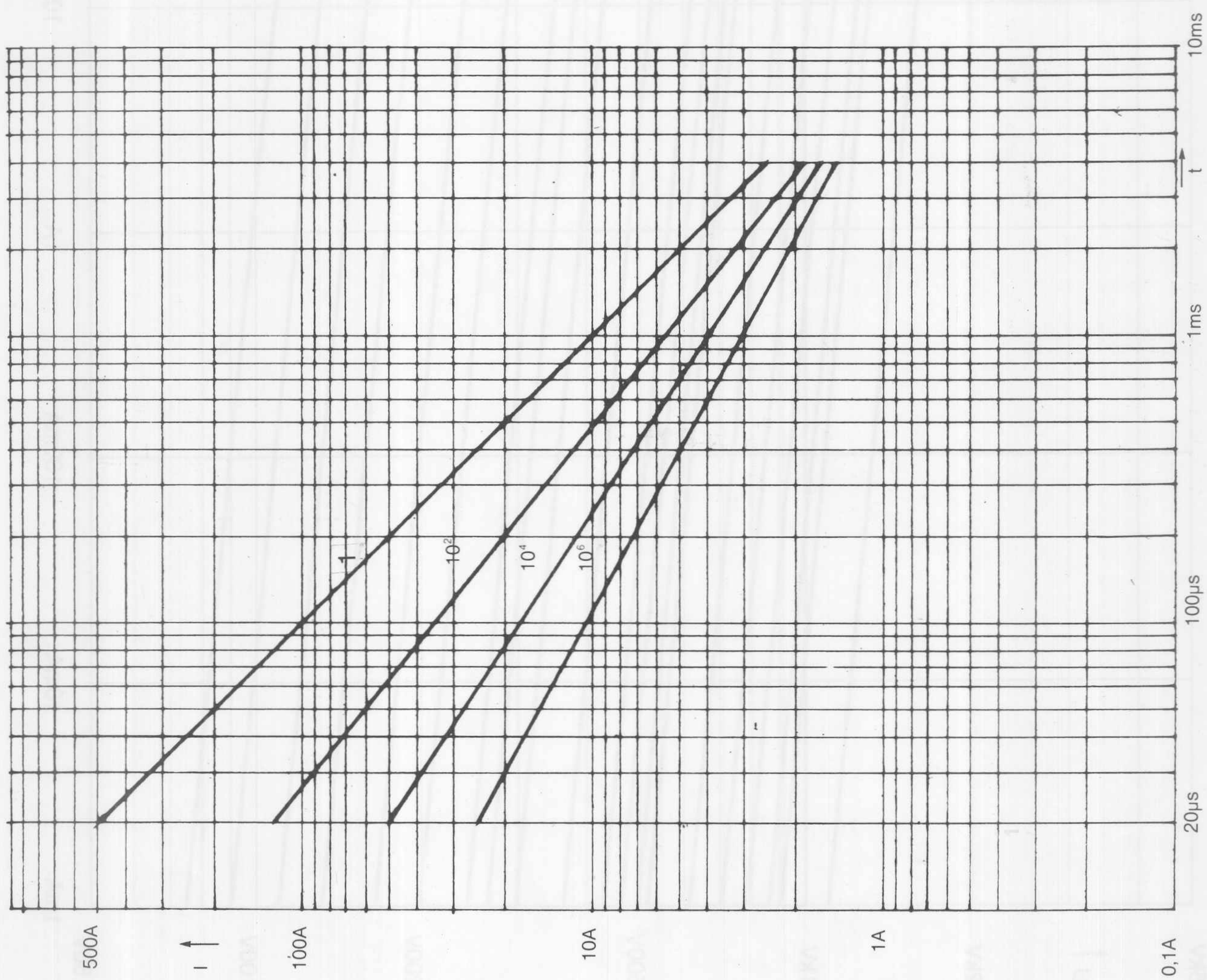


7.3 U/I characteristic 2/ 8M

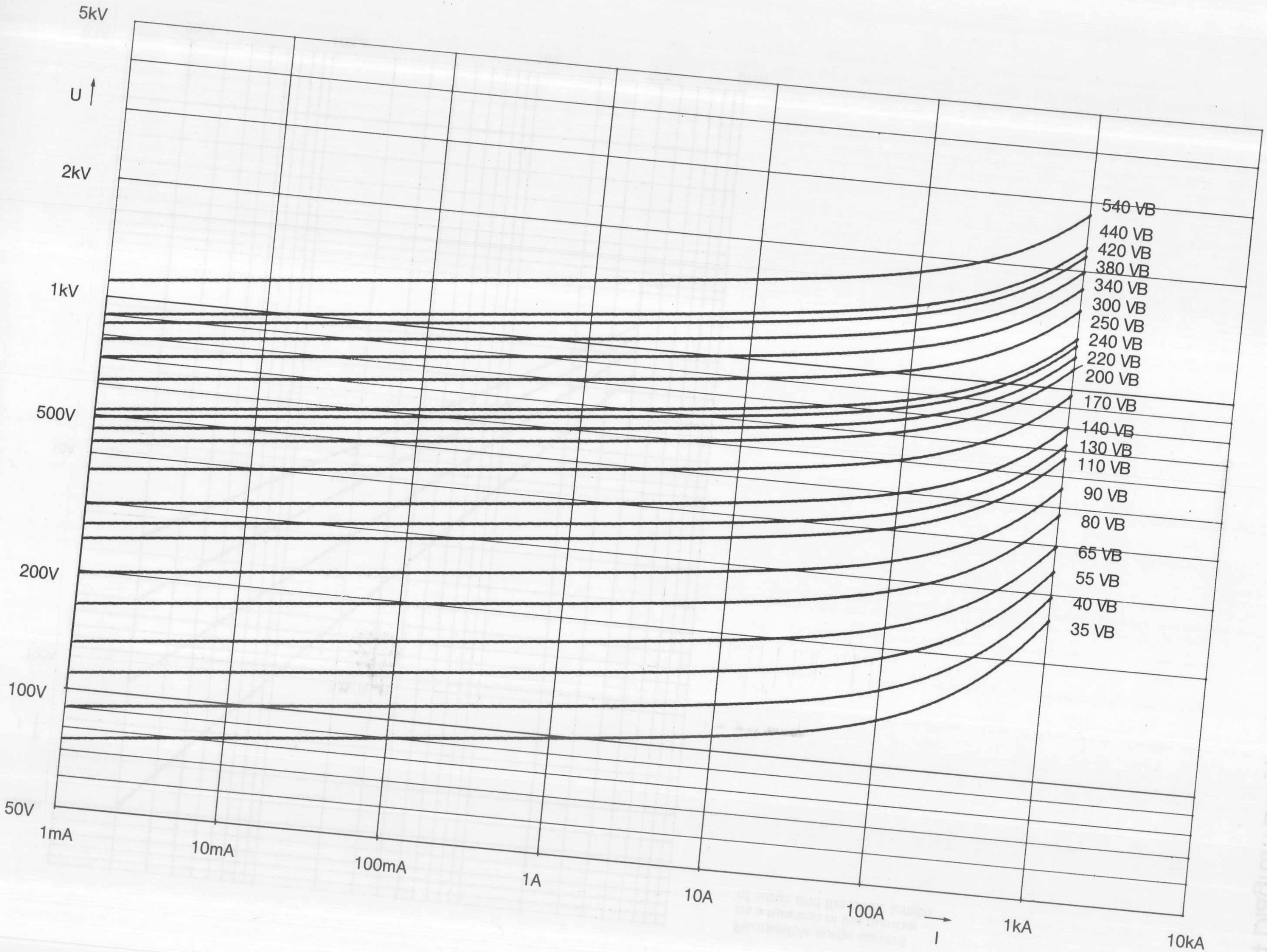


7.4 Diagram 2: Type Series 8M

Permissible surge current
as a function of the number
of surge and the pulse length

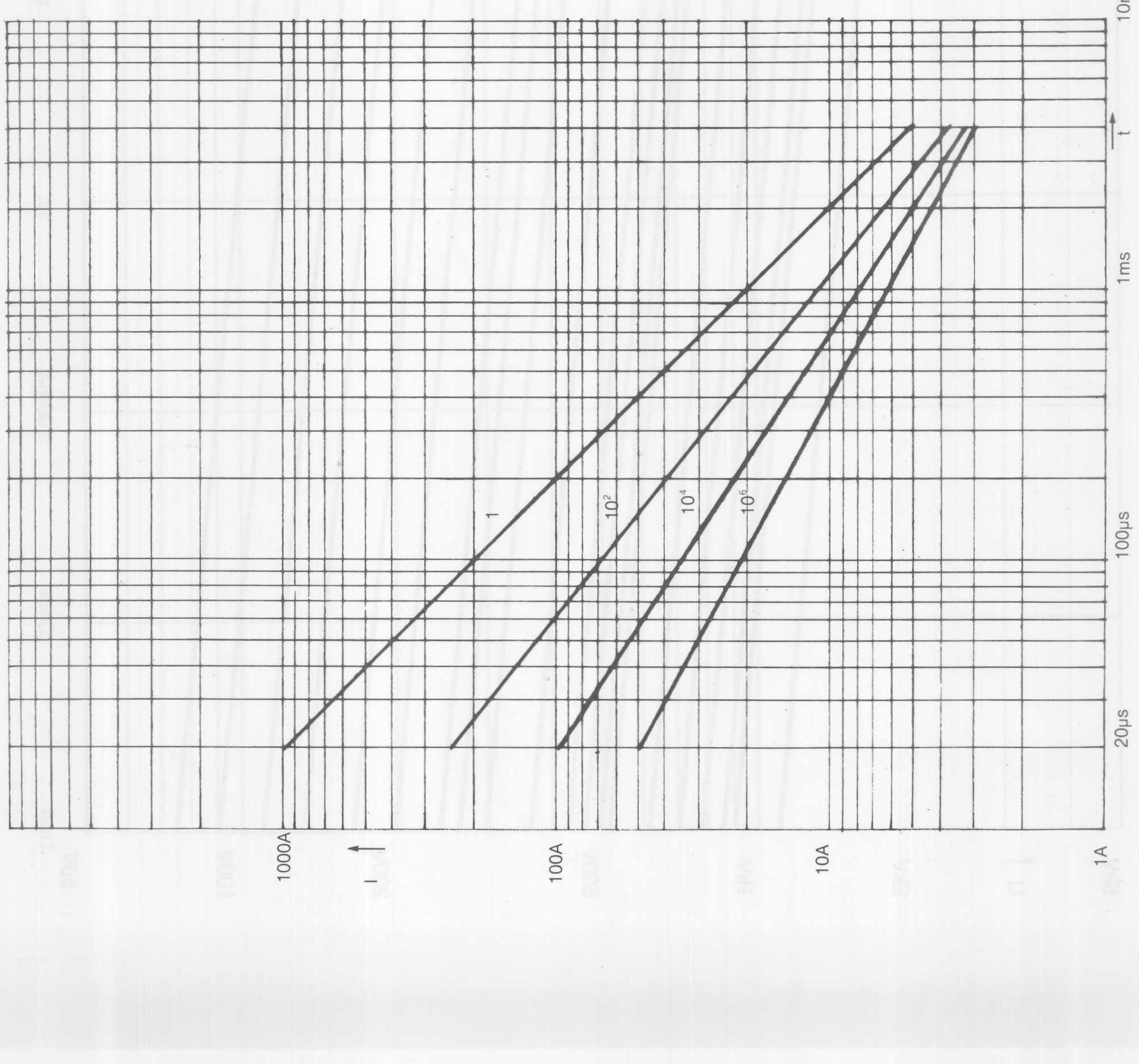


7.5 U/I characteristic 3: 12M

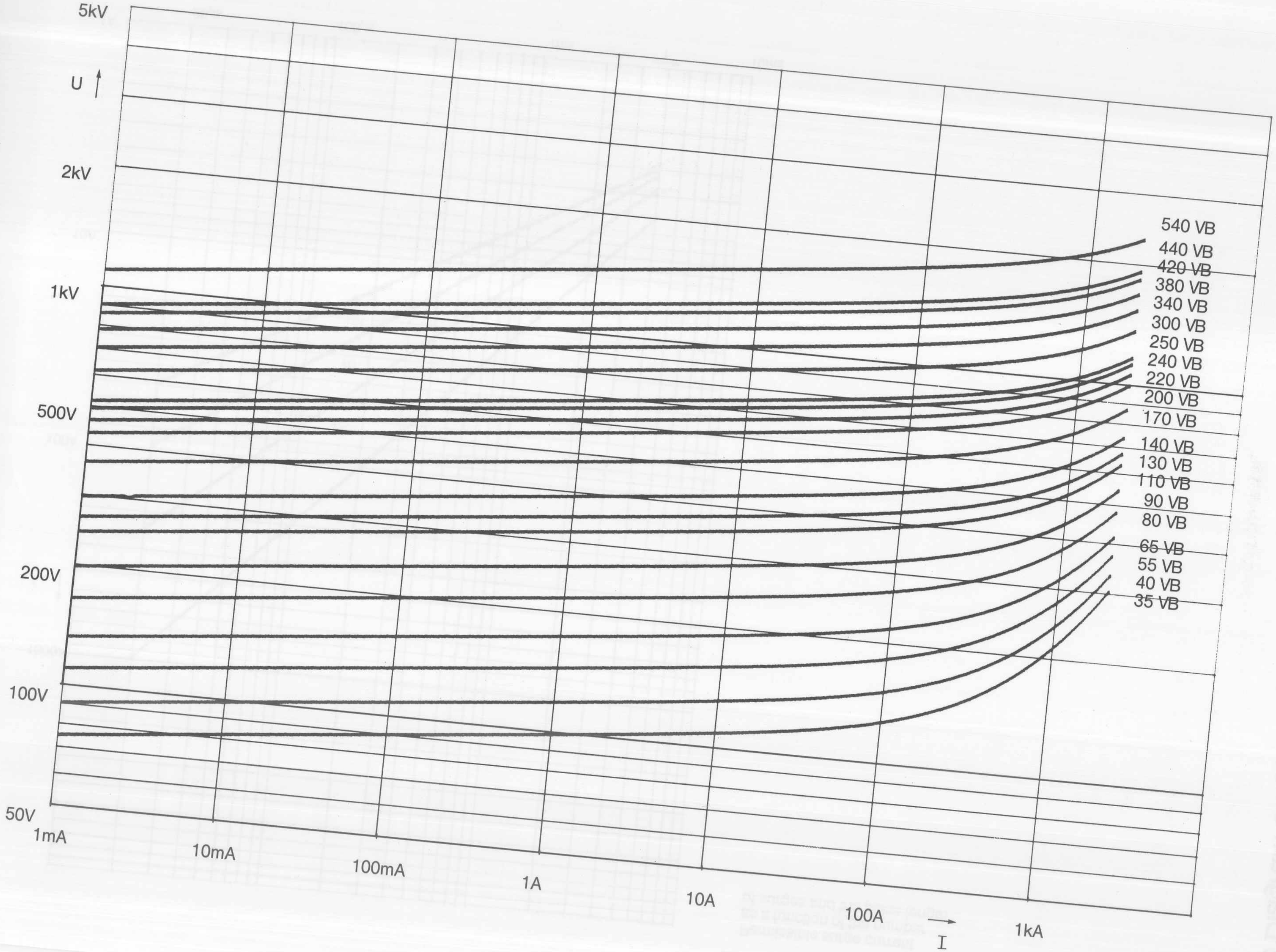


7.6 Diagram 3: Type Series 12M

Permissible surge current
as a function of the number
of surges and the pulse length

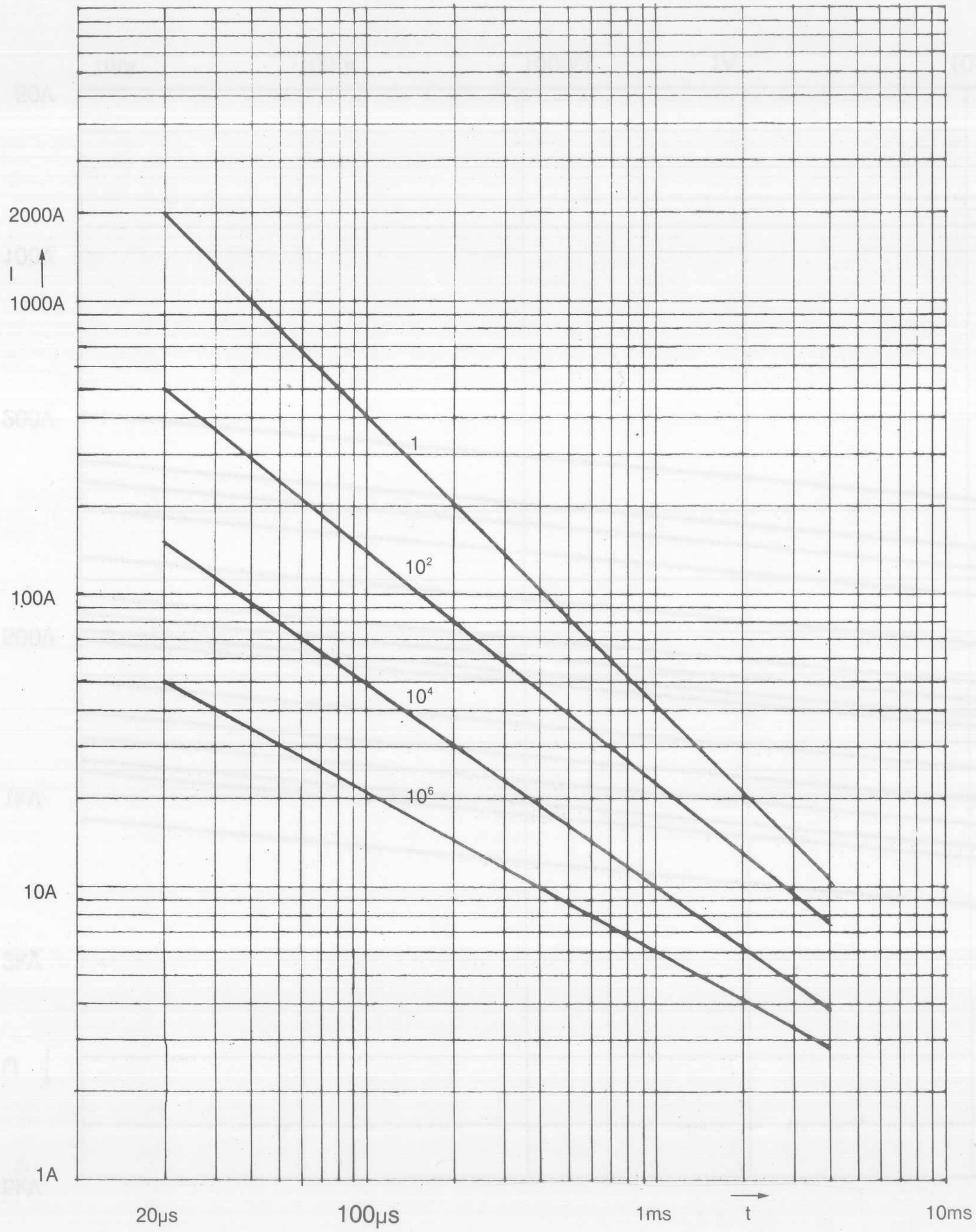


7.7 U/I characteristic 4: 17M

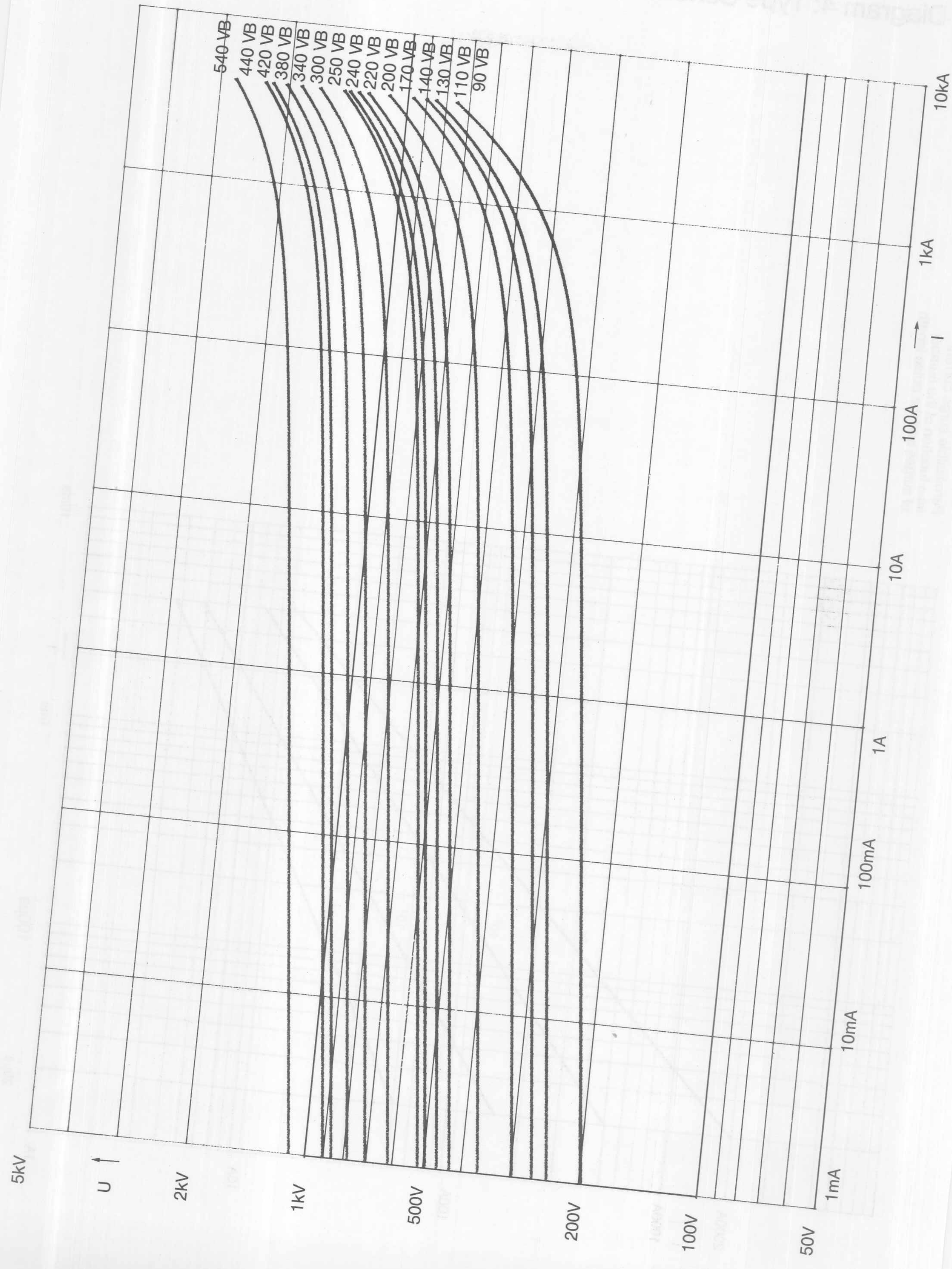


7.8 Diagram 4: Type Series 17M

Permissible surge current
as a function of the number
of surges and the pulse length

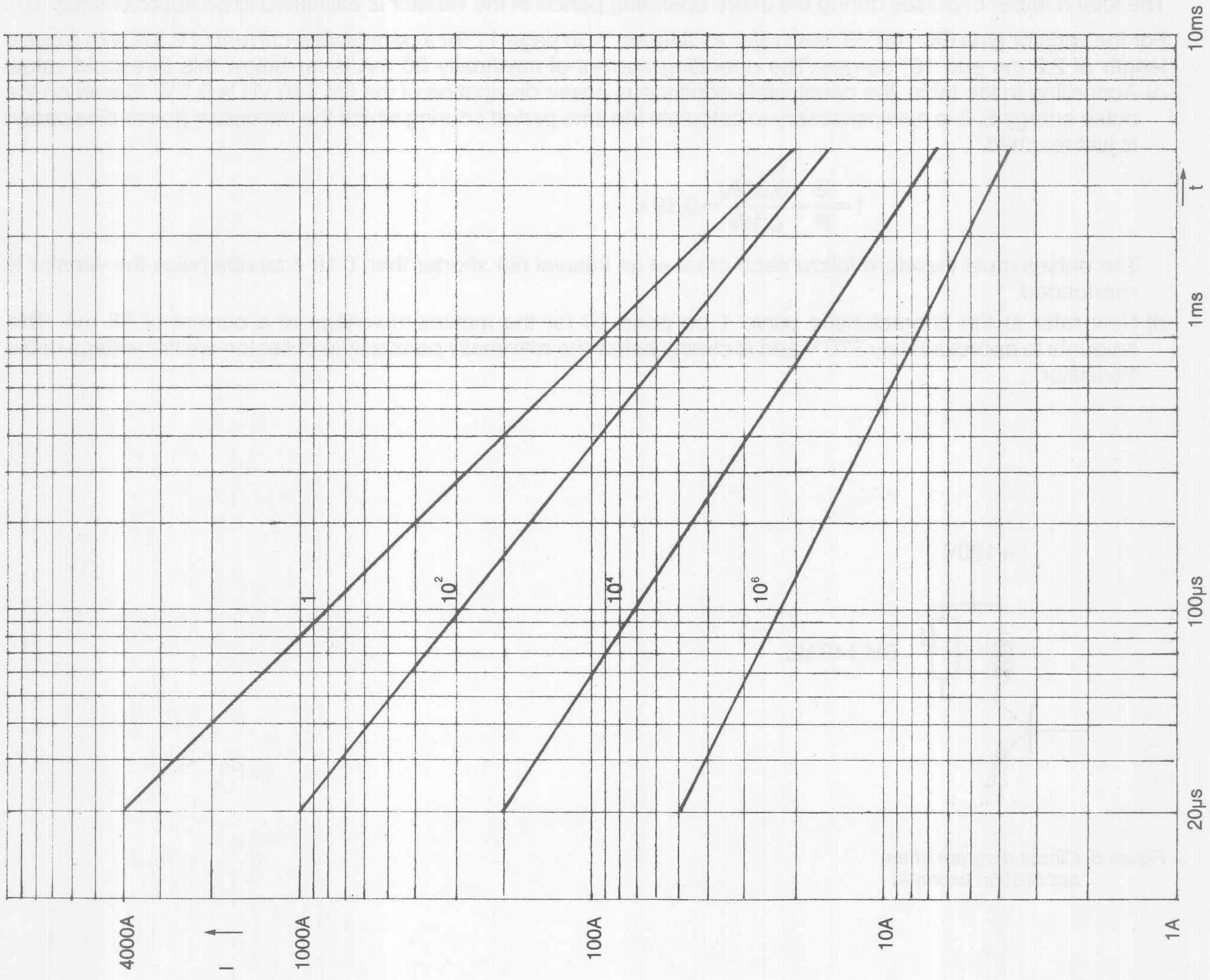


7.9 U/I characteristic 5: 24M



7.10 Diagram 5: Type Series 24M

Permissible surge current
as a function of the number
of surges and the pulse length



8. Application example

A lifting magnet is driven by a switching transistor. During switching off of the magnet, an overvoltage pulse occurs which destroys the transistor. A varistor must be used to limit the pulse to a safe voltage value.

The data of the lifting magnet and circuit are:

Operating voltage:	180 V DC ± 10 %, smoothed, without hum component
Operating current:	80 mA
Ohmic resistance R:	2250 Ω
Inductance L:	5 H
Maximum collector-emitter voltage of the transistor:	500 V

a) The maximum operating voltages is 198 V and therefore a varistor in the voltage class 140 VB with a maximum DC voltage of 208 V can be considered.

b) The suitable varistor is found on the basis of the energy and current load: A maximum current of 80 mA + 10 % = 88 mA flows through the varistor. The energy of the pulse amounts to

$$E=\frac{1}{2}LI^2=\frac{1}{2}5H\cdot(0{,}088A)^2=0{,}019J$$

The pulse length lies within the order of magnitude the time constant τ

$$\tau=\frac{L}{R}=2{,}2\text{ ms}$$

The total number of pulses during the entire operating period of the varistor is estimated to be approximately 10^4.

For the varistor type 6M 140 VB, then refer to diagram 1 on page 11 for a permissible current of 0.9 A with a pulse length of 2.2 ms and 10^4 surges. The operating current of maximally 80 mA is far below this threshold value.

c) According to the table, the permissible continuous power dissipation of the 6M 140 VB is 0.1 W. Based on the pulse energy E, it is now nexessary to calculate the time period t during which the maximum power dissipation is just reached.

$$t=\frac{E}{P}=\frac{0{,}019J}{0{,}1W}=0{,}19\text{ s}$$

The pulses must therefore follow each other at an interval not shorter than 0.19 s as otherwise the varistor is overloaded.

d) Now refer to the characteristic curve 1 on page 10 for the maximum voltage at a current of 88 mA. This amounts to approximately 370 V and is clearly below the maximally permissible collector-emitter voltage of the transistor.

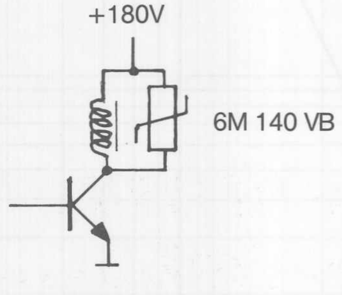


Figure 5: Circuit diagram of an application example

9. Questionnaire

If you cannot find the type you need in the type list, please specify the following when making inquiries and orders:

a) What is to be achieved by the CONOX® varistor? Please provide a brief description of the circuit including a sketch and values.

b) Which maximum operating voltage will be continously applied to the varistor?
DC voltage (smoothed) : .... V ± .... %
rectified AC voltage : .... V ± .... %
Type of rectification: half-wave rectification
full-wave rectification
three-phase bridge
other form of rectification
rms AC voltage: .... V ± .... % .... Hz.
If sinusoidal voltages or pulses are involved, e.g. in the case of thyristors or transducers, please fully specify the waveform.

c) Nominal current of the load (coil, field)
in the case of direct current: .... A.
Magnetization current or quiescent current (transformer, coil)
in the case of alternating current: .... A.

d) Inductance: .... H.
or the energy stored in the filed or coil: .... J.

e) Switching frequency: .... /sec
(how often is the coil or field etc. switched?)

f) Required limiting of voltage peaks during switch-off to: .... V.

g) Ambient temperature: .... K.

h) Please precisely specify off times and operating times if the operating voltage is not continously applied.

i) circuit diagram

C. CONRADTY
NÜRNBERG **GmbH & Co. KG**

Post Box 1752
D-8500 Nürnberg
Telephone (09 11) 598-1
Telegrams Ceconradty Nürnberg
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For a long time now, electrical carbon, electrical graphite and the special materials manufactured by us have been indispensable materials of modern industry thanks to their particular physical, electrical and chemical properties. C. Conradty is one of the most important and long-standing manufacturers of these products and has been active in this special field since 1855. The production range includes:

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- *Carbon electrodes*
- *Graphite heating elements and contact pieces*
- *Ground carbons (cathodes)*
- *Carbon bricks*
- *Anode plates*
- *Carburizing materials*
- *Gouging blowpipe carbons*
- *Carbon welding rods*
- *Graphite molds*
- *Carbon and electrical graphite tubes*
- *Carbon and electrical graphite crucible*
- *Saggers and plates of carbon and electrical graphite*
- *Graphite bars and blocks*
- *Graphite-shaped elements*
- Graphite tubes
- Graphite cylinders and plates
- Heating elements
- Graphite plates and graphite canisters

2. Chemical products

- Anode plates and power busbars
- High load anodes
- Coated titanium anodes
- Platelets and granulate
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- Carbon and graphite tubes
- Carbon and graphite seals and bearings
- Carbon heating elements
- Graphite rods, blocks and plates
- Graphite rollers and shaped elements
- Porous carbons
- Carbon plates and rods
- Carbon and graphite felts CECOTEX®
- Reaction carbons
- Column fillers

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- Tube anodes
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- CONOX® varistors
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- SILICO® resistors

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- Graphite sliding rails
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- Graphite lubrication plates
- Graphite electrodes for spark erosion

5. Products for lighting systems

Arc light carbons for
- cinema projection
- the graphic industry
- therapeutic applications
- colorfastness testers

6. Products for medicine technique

- Therapeutic carbons
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Post Box 1752
D-8500 Nürnberg 1
Telephone (0911) 598-1
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