AXIAL WIREWOUND RESISTORS - AC

FEATURES

RoHS compliant

- General purpose resistors
- High power dissipation in small volume
- High pulse load handling capabilities
- High temperature silicone coating
- Non-inductive version available on request
- Low inductive available on request
- Various forming styles available

QUICK REFERENCE DATA

DESCRIPTION	AC01	AC02	AC03	AC04	AC05	AC07	AC10	AC15	AC20
Resistance range (1)	0.1 Ω to 2.4 kΩ	0.1 Ω to 4.7 kΩ	0.1 Ω to 5.1 kΩ	0.1 Ω to 6.8 kΩ	0.1 Ω to 8.2 kΩ	0.1 Ω to 15 kΩ	0.68 Ω to 27 kΩ	0.82 Ω to 39 kΩ	1.2 Ω to 56 kΩ
Resistance tolerance (2) and series	±5%; E24								
Rated dissipation at T_{amb} = 40 °C	1 W	2 W	3 W	4 W	5 W	7 W	10 W	15 W	20 W
Rated dissipation at T_{amb} = 70 °C	0.9 W	1.8 W	2.7 W	3.6 W	4.5 W	6.3 W	9.0 W	13.5 W	18.0 W
Temperature coefficient (3)	R < 10 Ω: 0 to 600 ppm/°C R ≥ 10 Ω: - 80 to +140 ppm/°C								
Climatic category (IEC 60068)	40/200/56								
Operating temperature	-40 °C to +200 °C								
Basic specification	IEC60 115-1								
Limiting voltage	$\sqrt{Pn \times R}$								
Stability $\Delta R/R_{max}$ after:									
Load	±5.0% +0.1Ω								
Climatic tests	±1.0% +0.05Ω								
Resistance to soldering heat	±0.5% +0.05Ω								
Short time overload	±2.0% +0.1Ω								

(1) Special resistive values available on request
(2) Tolerances, 1, 3 and 10% available on request
(3) Temperature coefficient 30, 50 and 90 ppm/°C available on request

TECHNOLOGY

The resistor element is a resistive wire, which is wound, in a single layer, on a ceramic rod. Metal caps are pressed over the ends of the rod. The ends of the resistive wire and the leads are connected to the caps by welding. Tinned copper-clad iron leads with poor heat conductivity are employed permitting the use of relatively short leads to obtain stable mounting without overheating. The resistor is coated with a green silicon cement which is non-flammable, will not drip even at high overloads and is resistant to most commonly used cleaning solvents, in accordance with MIL-STD-202, method 215 and IEC 60068-2-45.

MECHANICAL DATA

AXIAL STYLE

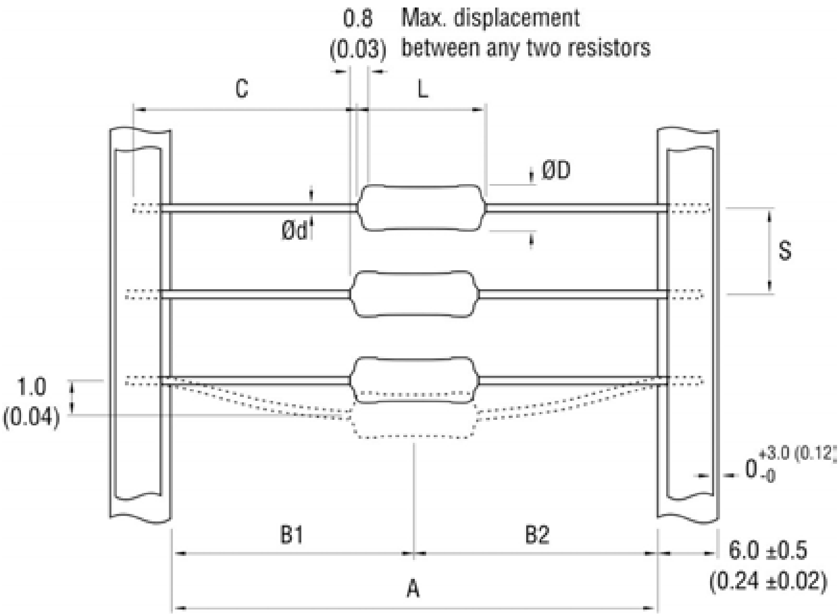

Fig. 1

Table 1. Mechanical data.

PRODUCT	L max.	∅D max.	∅d	C	A	|B1 - B2| max.	S
AC01	10.0 (0.40)	4.3 (0.17)		32.0 ±1.0 (1.26 ±0.04)	63.0 ±2.0 (2.48 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)
AC02	13.0 (0.51)	5.5 (0.22)		30.0 ±1.0 (1.18 ±0.04)	63.0 ±2.0 (2.48 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)
AC03	13.0 (0.51)	5.5 (0.22)	0.80 ±0.03 (0.031 ±0.002)	30.0 1.0 (1.18 ±0.04)	63.0 ±2.0 (2.48 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)
AC04	17.0 (0.67)	5.7 (0.23)		28.0 ±1.0 (1.10 ±0.04)	63.0 ±2.0 (2.48 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)
AC05	17.0 (0.67)	7.5 (0.29)		28.0 ±1.0 (1.10 ±0.04)	63.0 ±2.0 (2.48 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)

PRODUCT	L max.	∅D max.	∅d	C	A	|B1 - B2| max.	S
AC07	25.0 (0.98)	7.5 (0.29)	0.80 ±0.03 (0.031 ±0.002)	28.0 ±1.0 (1.10 ±0.04)	73.0 ±2.0 (2.87 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)
AC10	44.0 (1.73)	8 (0.32)		28.0 ±1.0 (1.10 ±0.04)	89.0 ±2.0 (3.50 ±0.08)	1.2 (0.05)	10.0 ±0.1 (0.40 ±0.01)
AC15	51.0 (2.01)	10 (0.39)		28.0 ±1.0 (1.10 ±0.04)	-	-	-
AC20	67.0 (2.64)	10 (0.39)		28.0 ±1.0 (1.10 ±0.04)	-	-	-

Dimensions unless specified in mm (inches)

ELETRICAL CHARACTERISTICS

DERATING

The power that the resistor can dissipate depends on the operating temperature.

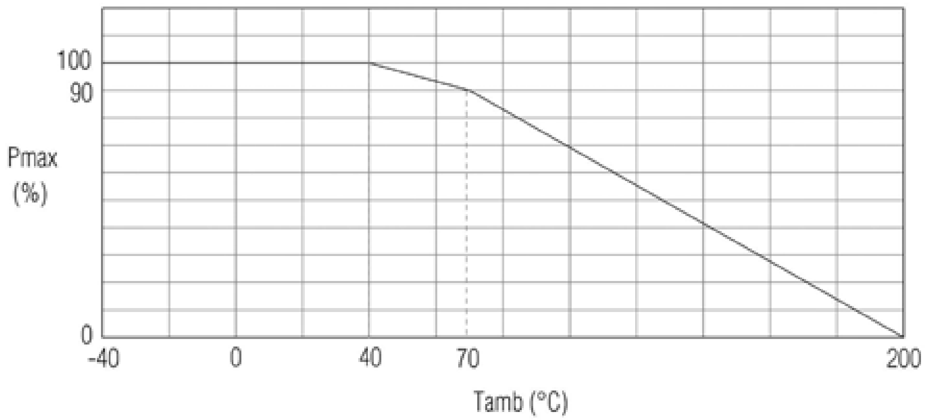

Fig. 2 – Maximum dissipation (P_{max}) in percentage of rated as a function of ambient temperature (T_{amb})

APPLICATION INFORMATION

HOT SPOT

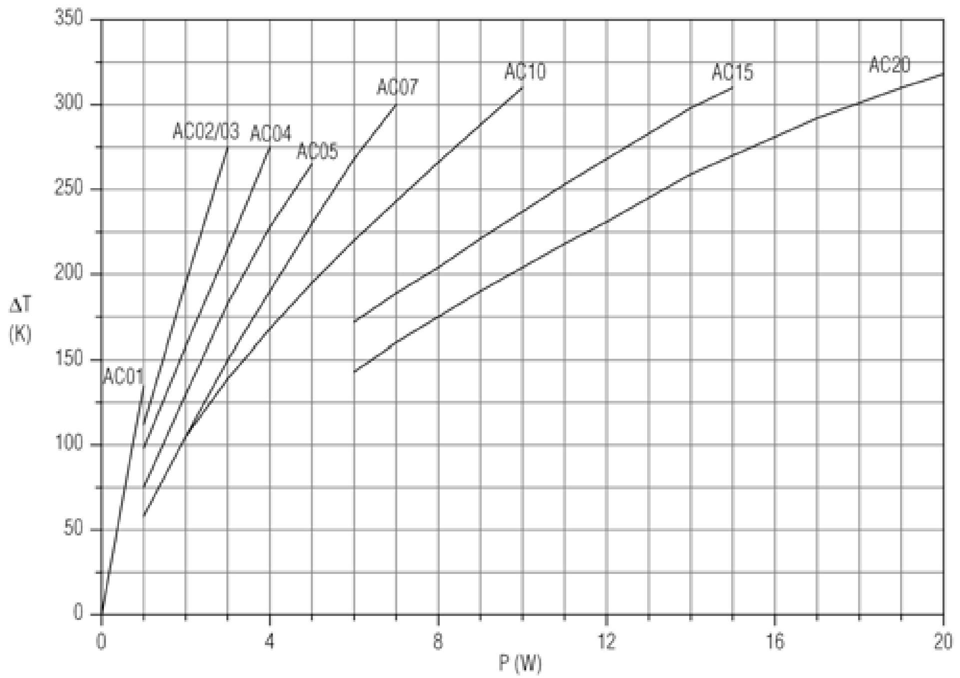

Fig. 3 – Hot spot temperature rise (ΔT) as a function of dissipated power.

SOLDER SPOT

Solder spot lead length as a function of the dissipation with as a parameter the temperature rise at the end of lead (soldering spot).

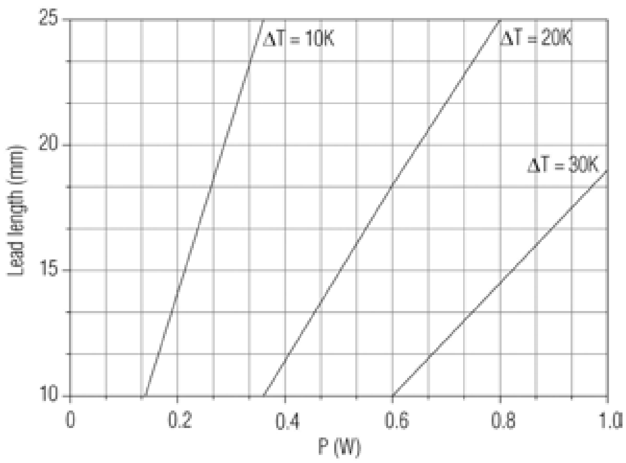

Fig. 4 – AC01

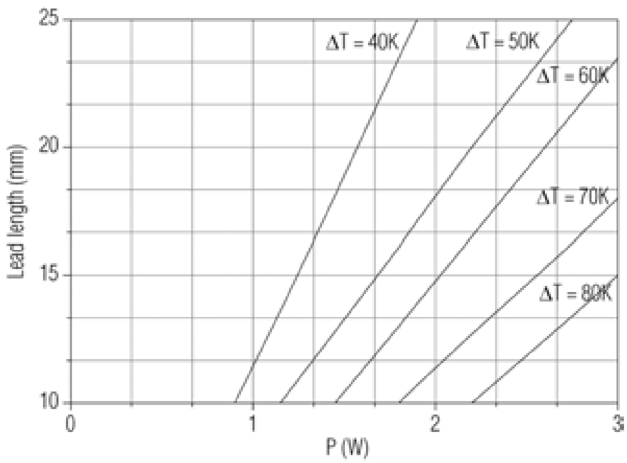

Fig. 5 – AC02/AC03

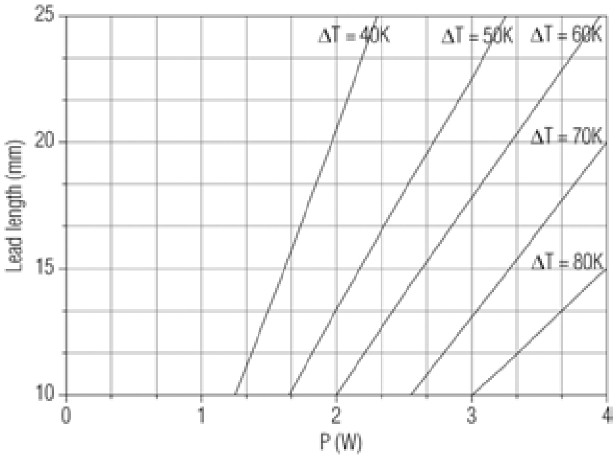

Fig. 6 – AC04

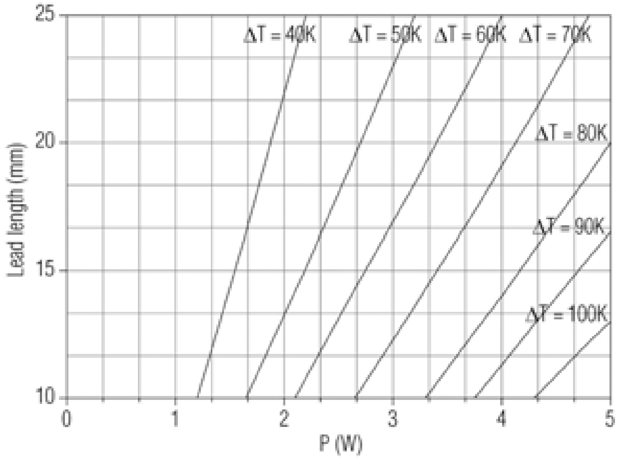

Fig. 7 – AC05

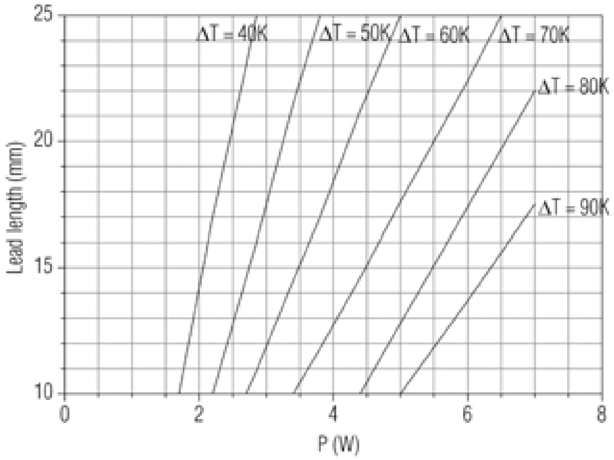

Fig. 8 – AC07

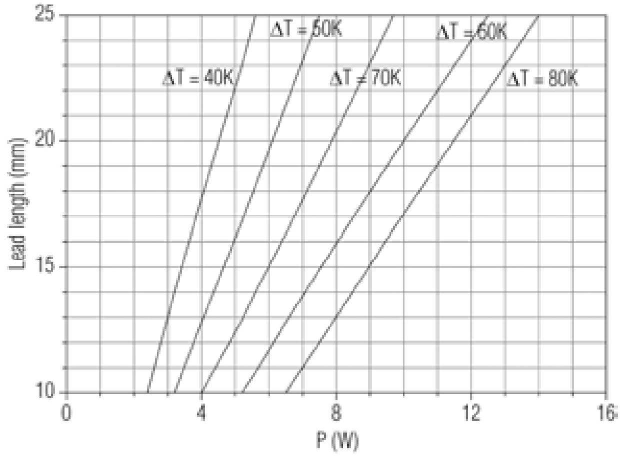

Fig. 9 – AC10

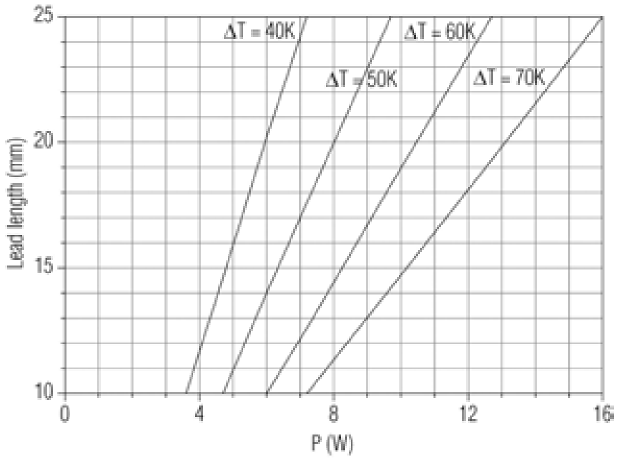

Fig. 10 – AC15

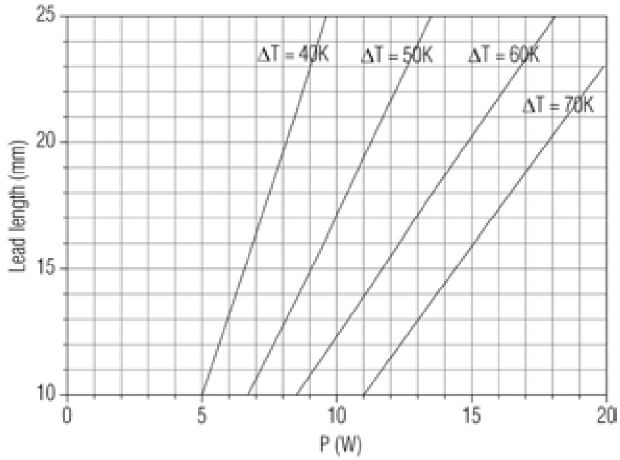

Fig. 11 – AC20

PULSE LOAD CAPABILITIES

How to generate the maximum allowed pulse-load from the graphs composed for wire wound resistors of the AC-types.

SINGLE PULSE CONDITION

If the applied pulse energy in joules or wattseconds is known and also the R-value to be used in the application; take the R-value on the X-axis and go vertically to the curved line. From this point go horizontally to the Y-axis, this point gives the maximum allowed pulse energy in joules/ohm or wattseconds. If this figure is higher than the applied pulse energy the application is allowed. Otherwise take one of the other graphs belonging to AC-types with higher P_n.
If, contrary to the information above, the applied peak-voltage and impulse times t_i are know. Calculate the pulse-voltage (E_p) in joules or wattseconds by the use of the following formula:

$E_p = [(Vp^2 / R) \times t_i]$ (Vp = peak voltage; t_i = impulse-time)

By dividing this result with the R_n-value of the R in use, gives the value wattseconds/ohm on the Y-axis. Draw a line horizontally to the curved line and the intersection the vertical line on the X-axis gives the maximum allowed R_n-value to be used in the application. If this R_n-value is higher than the R-value to be used in the application, the application is allowed. If not, take one of the other graphs belonging to AC-types with higher P_n or change the R_n-value to be used.

REPETITIVE PULSE CONDITION

With these graphs we can determine the allowed pulse energy in watt depending on the impulse-time t_i and the repetition time t_p of the pulses. The parameter is the Resistance Value. If the pulse shape is known (impulse-time t_i and repetition time t_p), draw a line vertically from the X-axis at the mentioned t_i to the line of the involved R-value.
From the intersection the horizontal line to the Y-axis indicates the maximum allowed pulse load at a certain t_p/t_i.
If the vertical line from the X-axis crosses the applied t_p/t_i before reaching the R-line, this t_p/t_i line gives the maximum allowed pulse energy at the Y-axis. If the applied pulse energy is known (in watts) and the impulse-time t_i also, draw a line horizontally from the Y-axis to the crossing with the pulse line (t_i) and find the possible R-value needed in this application. The horizontal t_p/t_i lines give the maximum allowed pulse load till they reach the R-line, that point indicates the maximum allowed impulse-time t_i at the horizontal axis.

AC01 - SINGLE PULSE

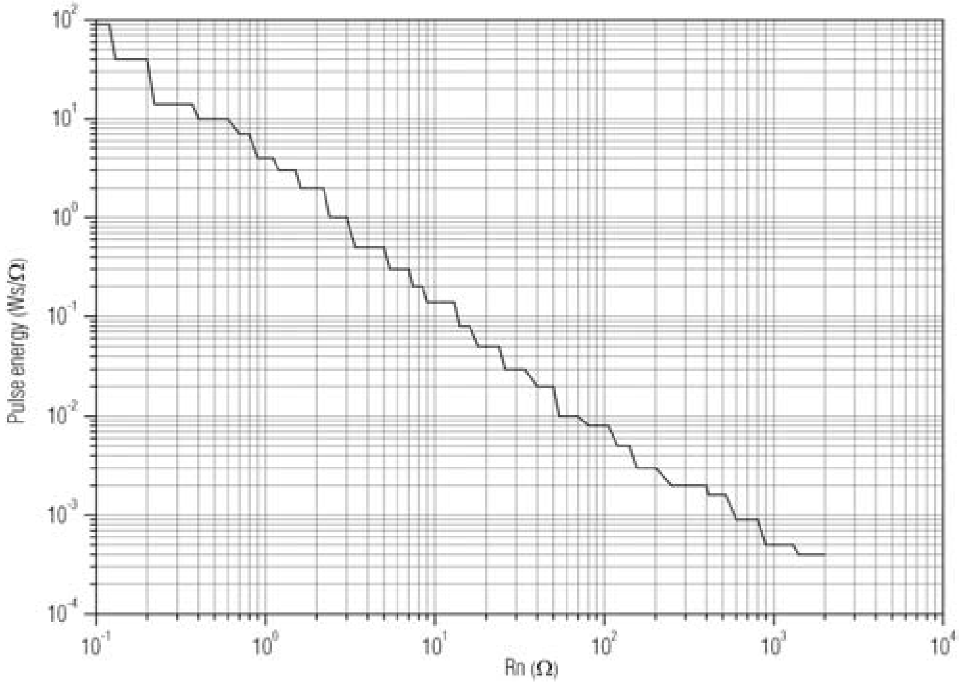

Fig. 12 – Pulse capability; Ws as a function of Rn

AC01 - REPETITIVE PULSE

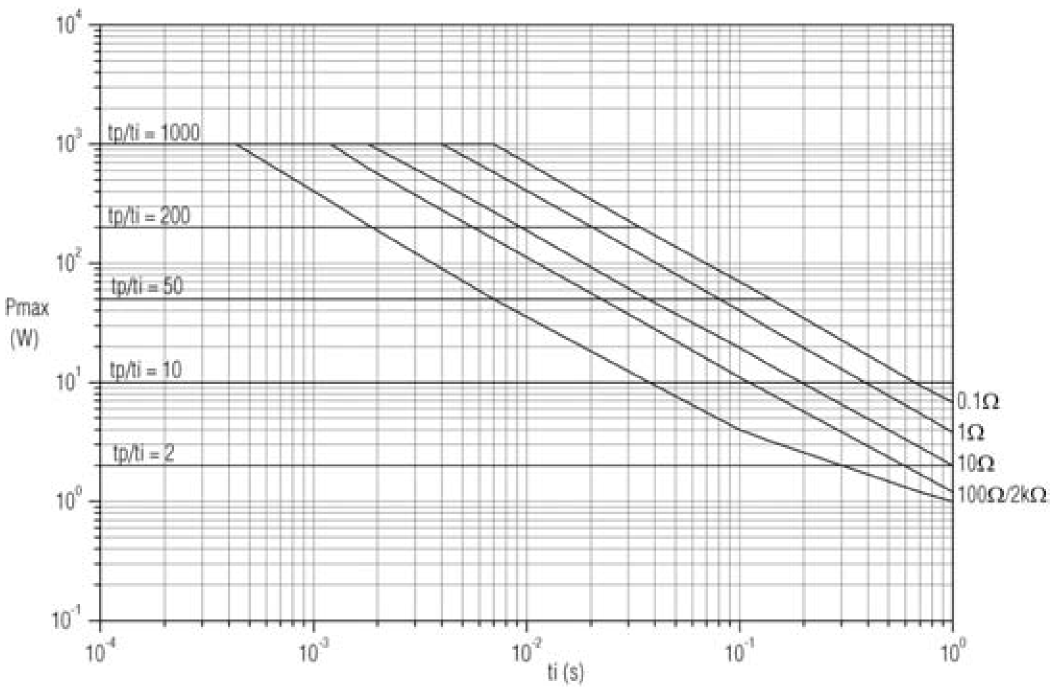

Fig. 13 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC01

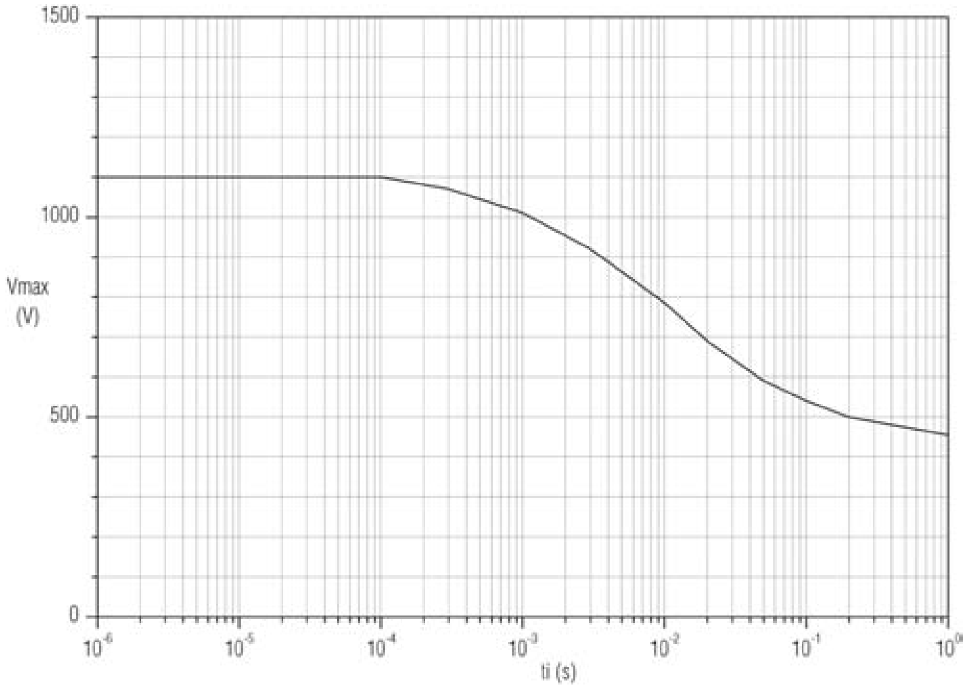

Fig. 14 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

AC02/AC03 - SINGLE PULSE

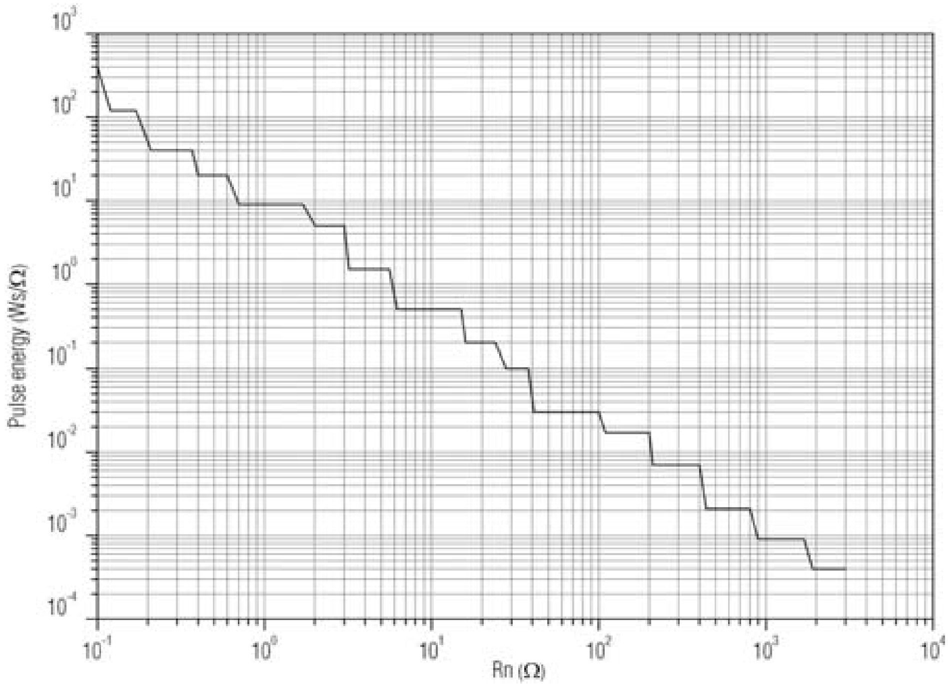

Fig. 15 – Pulse capability; Ws as a function of Rn

AC02/AC03 - REPETITIVE PULSE

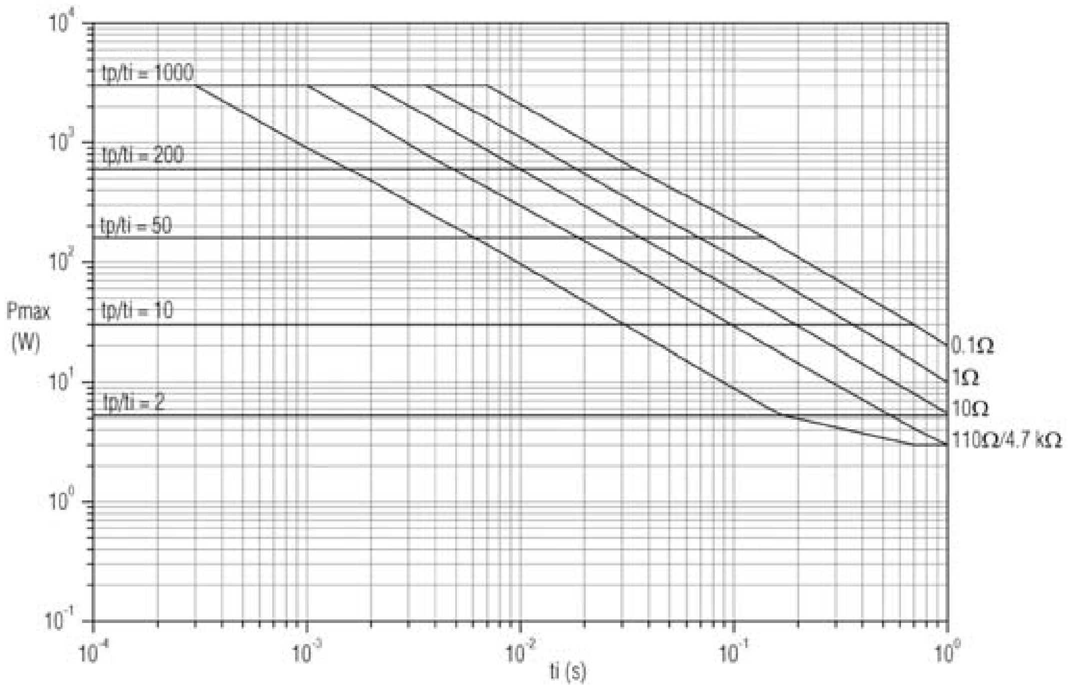

Fig. 16 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC02/AC03

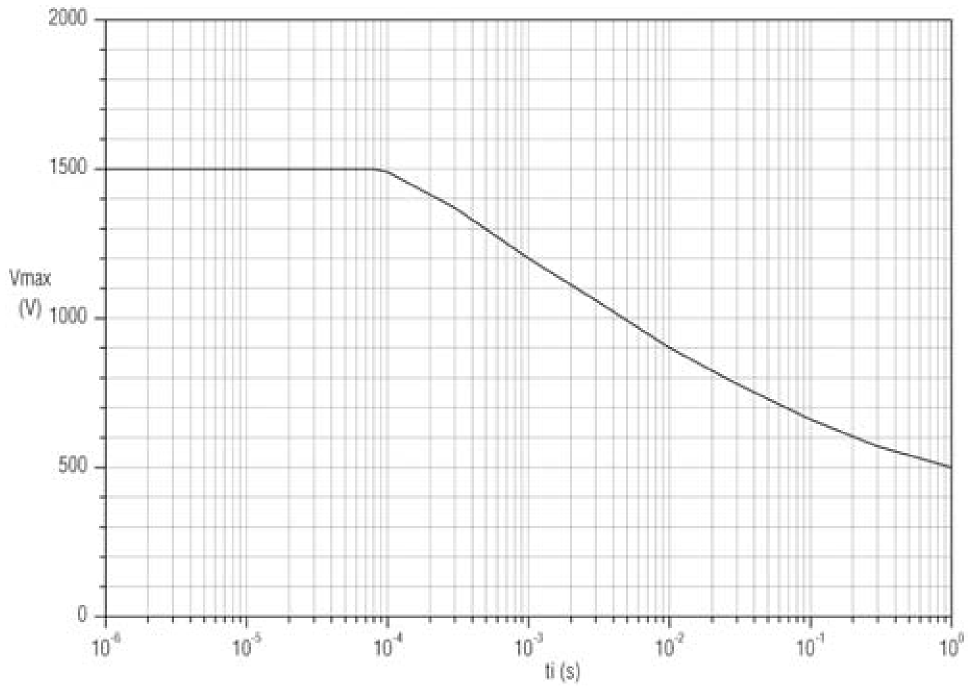

Fig. 17 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

AC04 - SINGLE PULSE

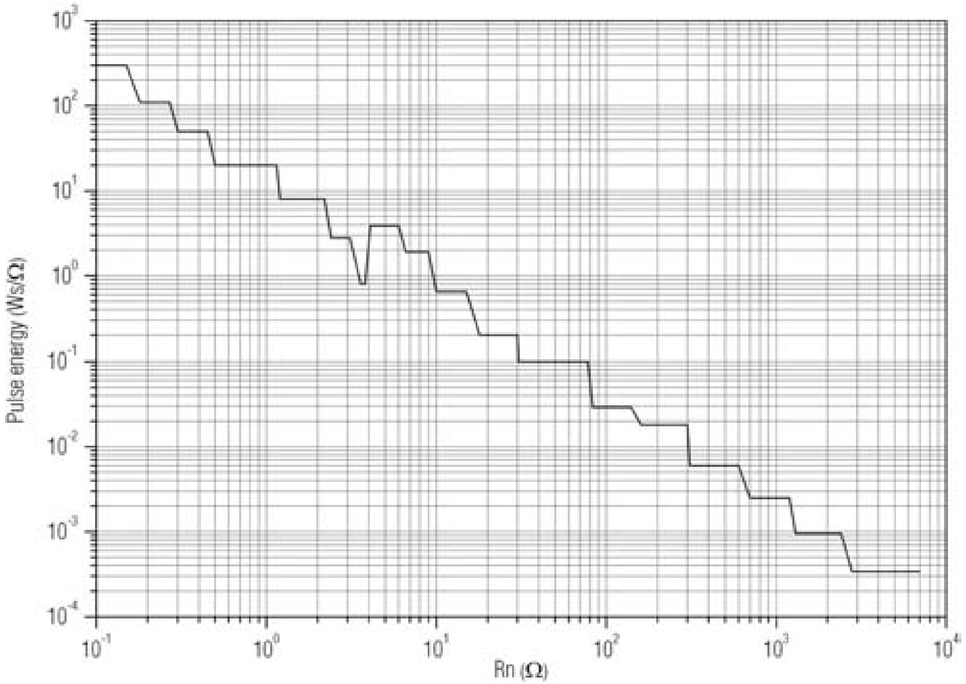

Fig. 18 – Pulse capability; W_s as a function of Rn

AC04 - REPETITIVE PULSE

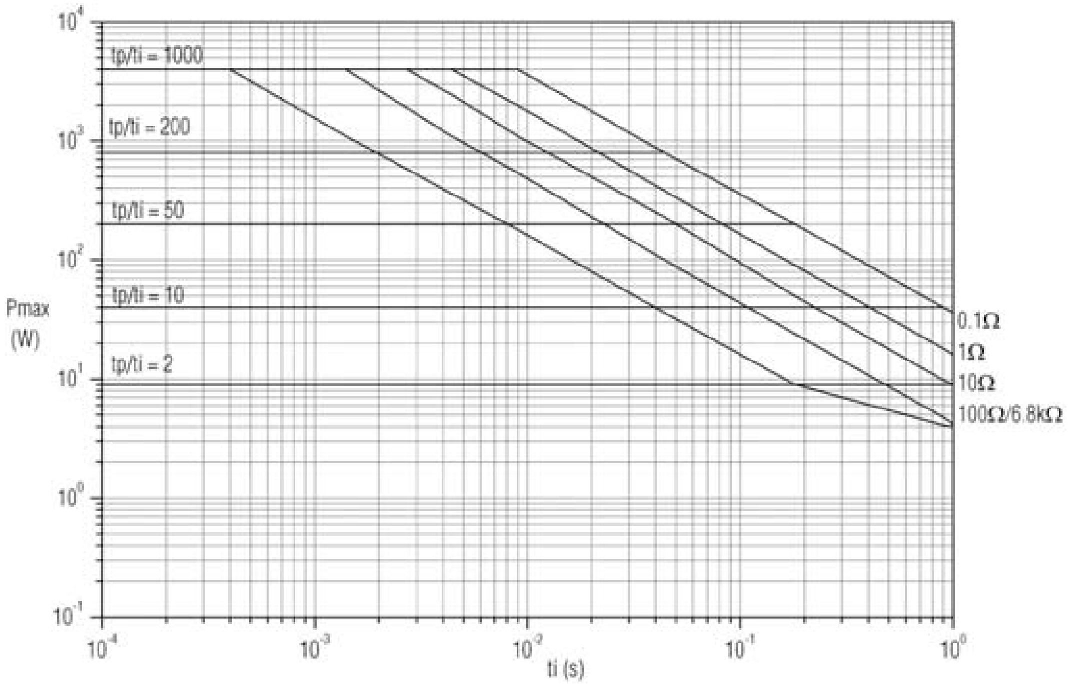

Fig. 19 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC04

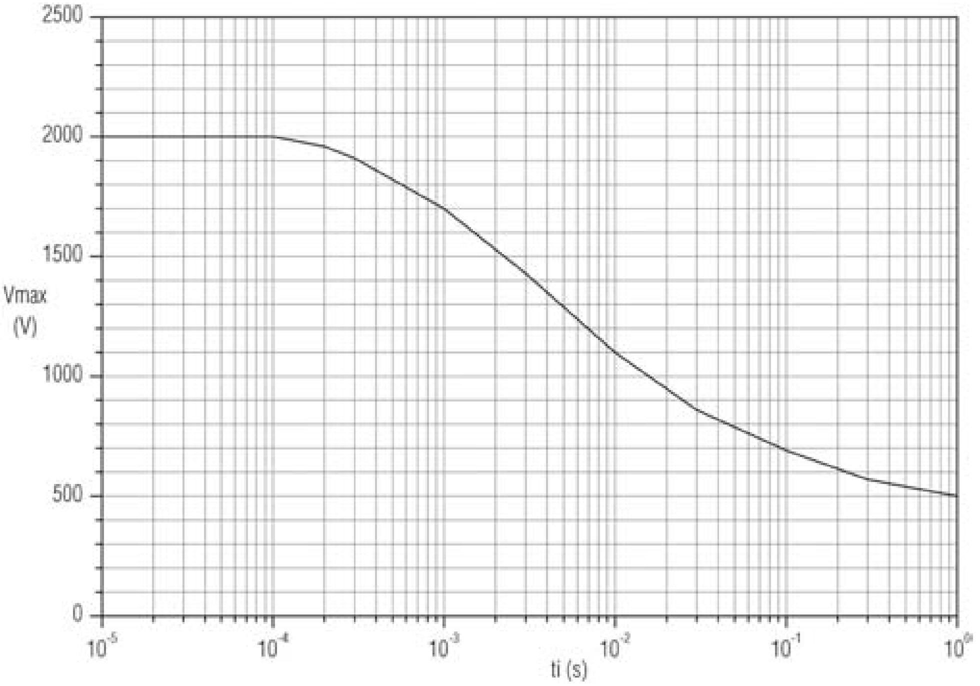

Fig. 20 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration

AC05 - SINGLE PULSE

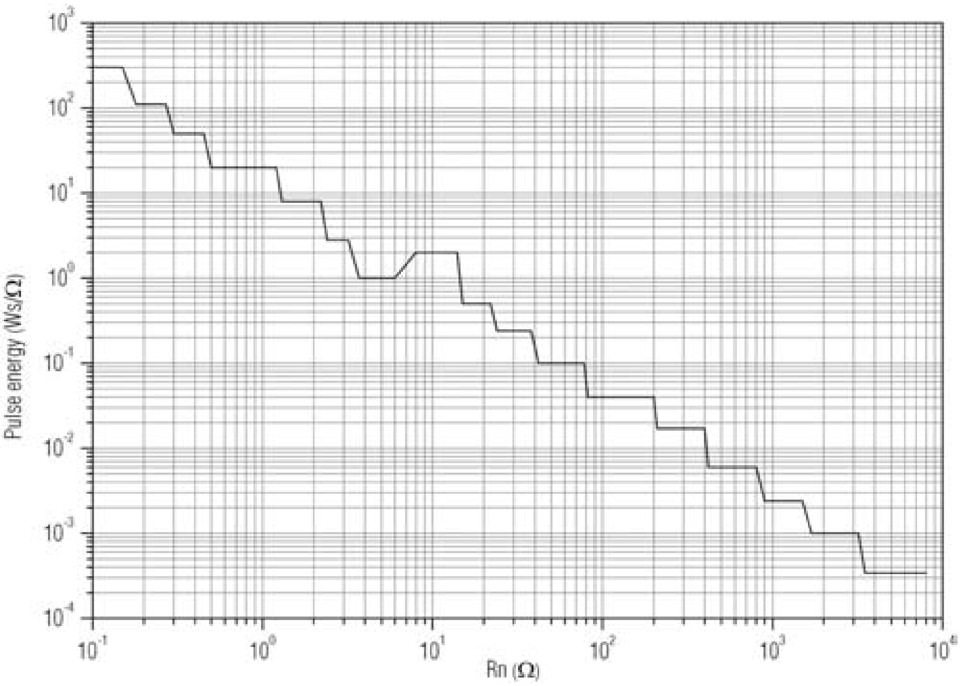

Fig. 21 – Pulse capability; Ws as a function of Rn

AC05 - REPETITIVE PULSE

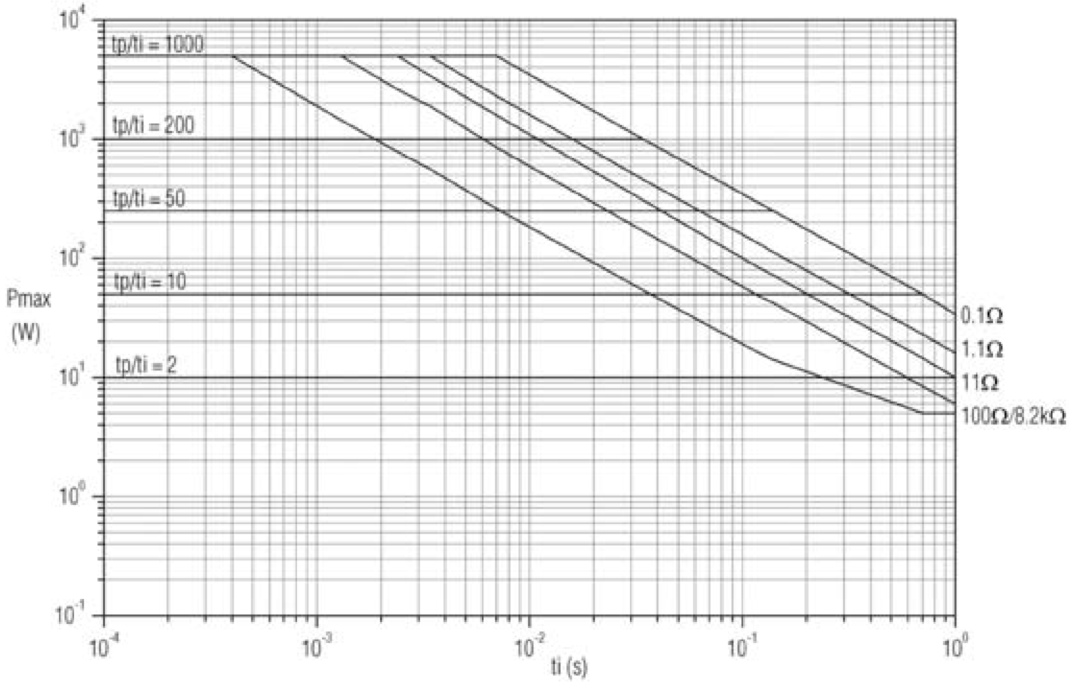

Fig. 22 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC05

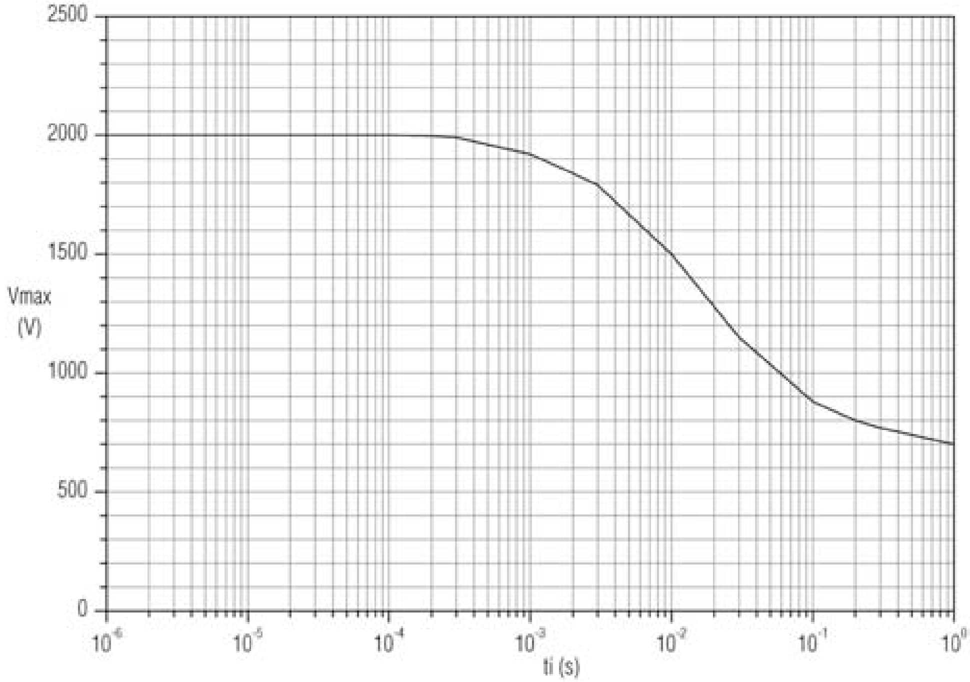

Fig. 23 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

AC07 - SINGLE PULSE

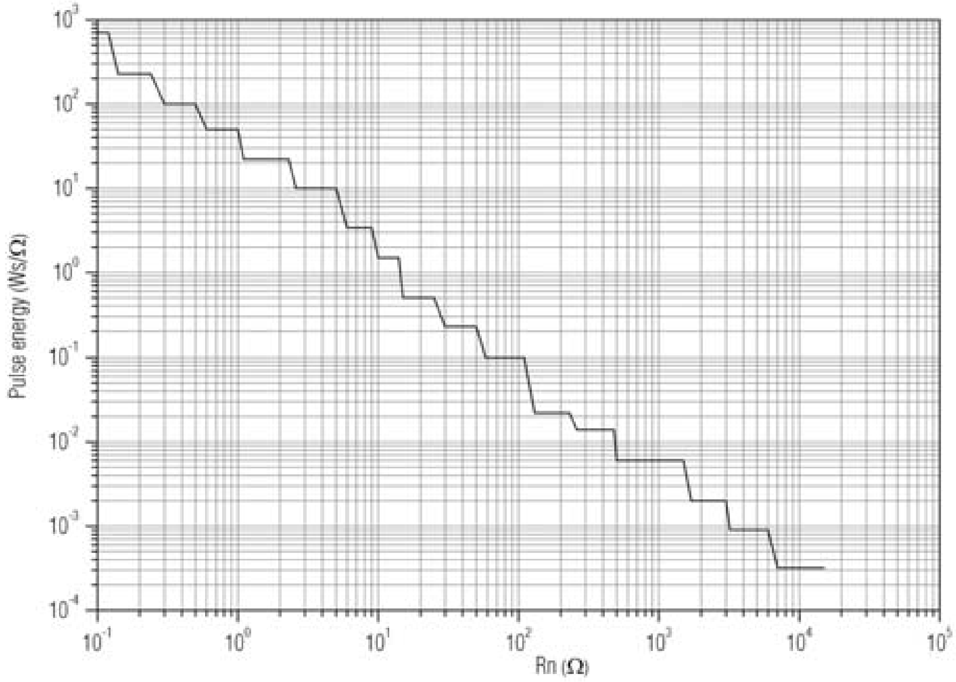

Fig. 24 – Pulse capability; W_s as a function of Rn

AC07 - REPETITIVE PULSE

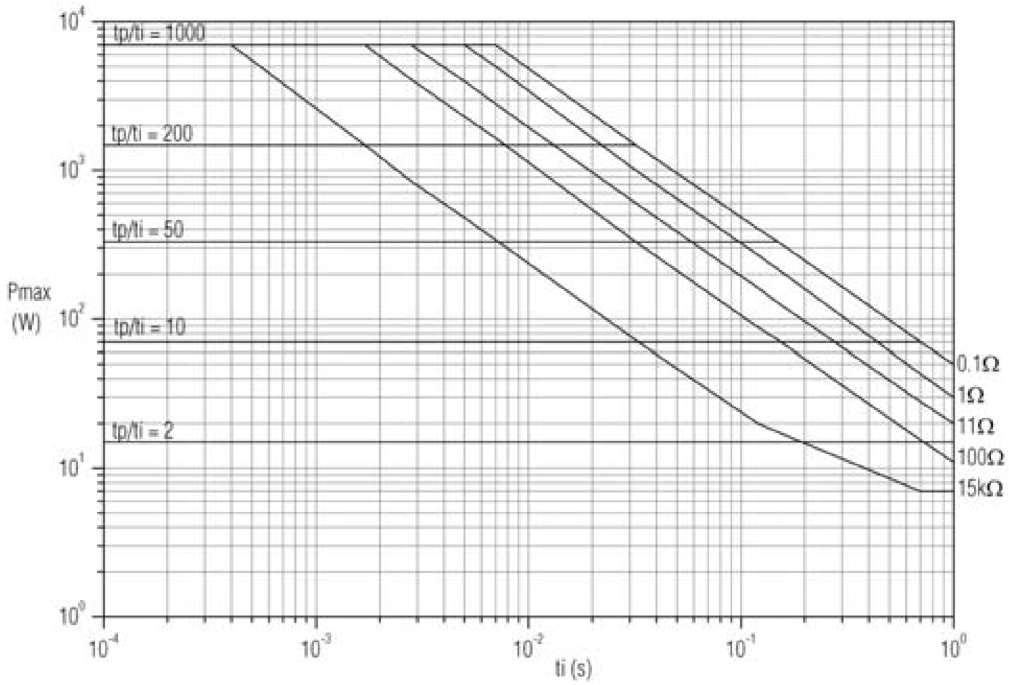

Fig. 25 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC07

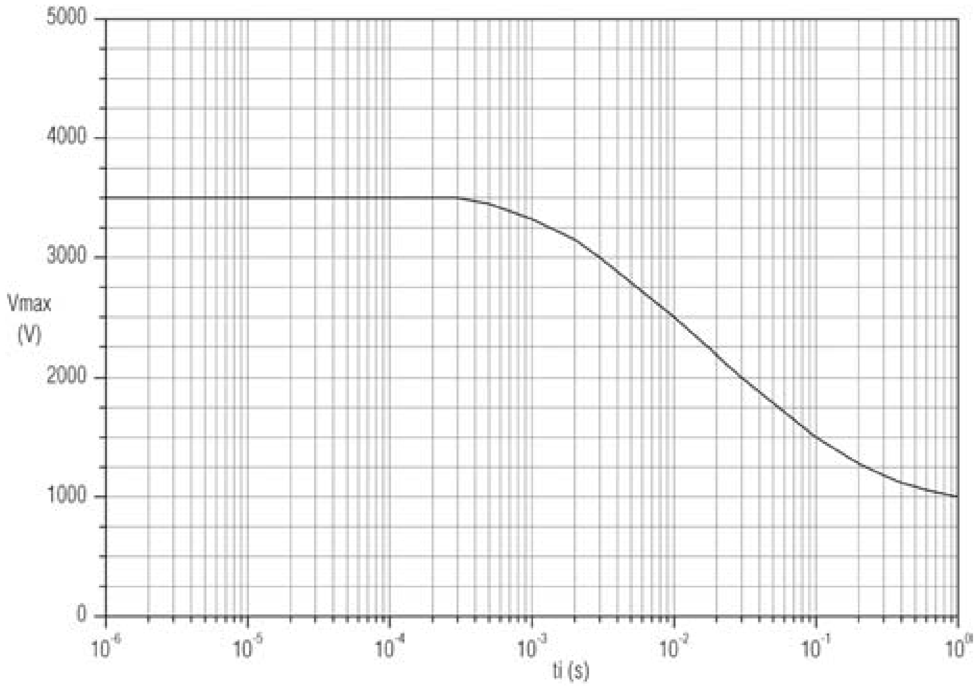

Fig. 26 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

AC10 - SINGLE PULSE

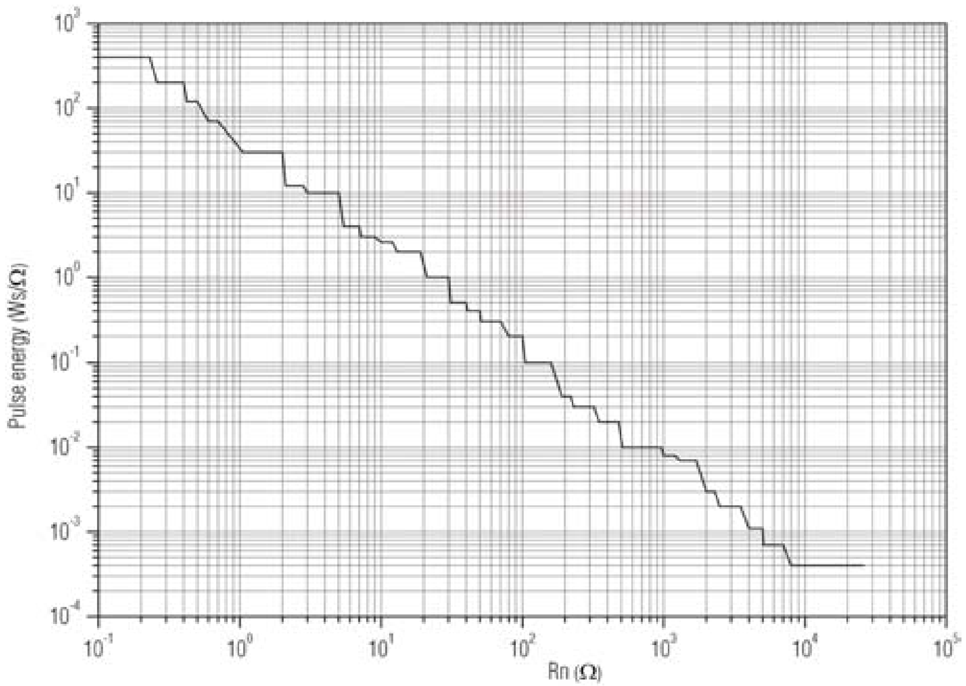

Fig. 27 – Pulse capability; W_s as a function of Rn

AC10 - REPETITIVE PULSE

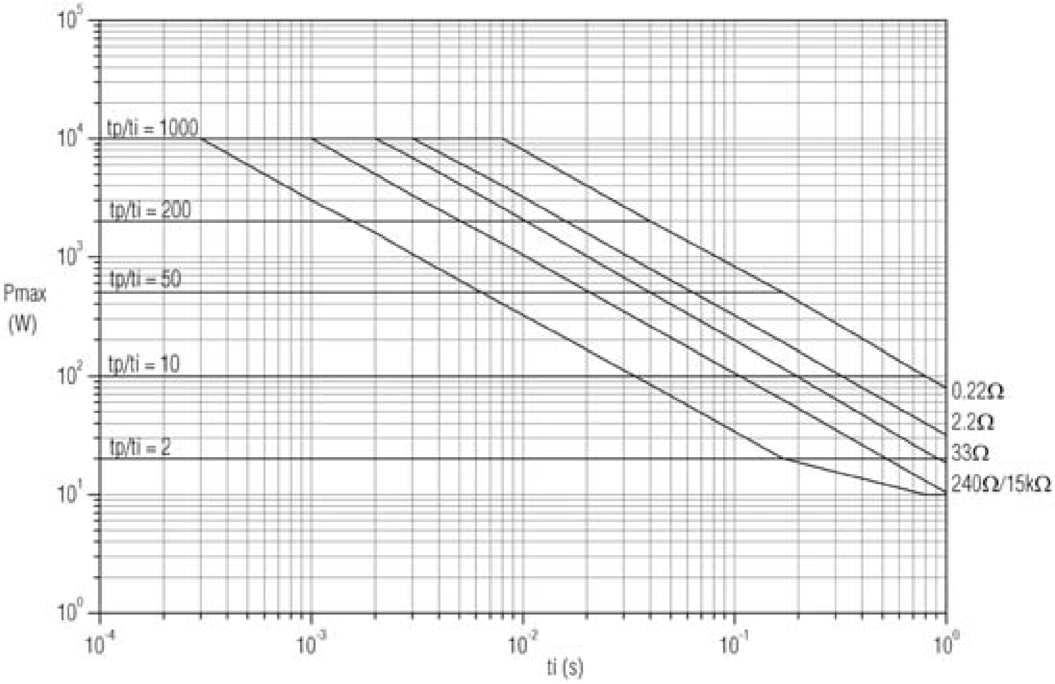

Fig. 28 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC10

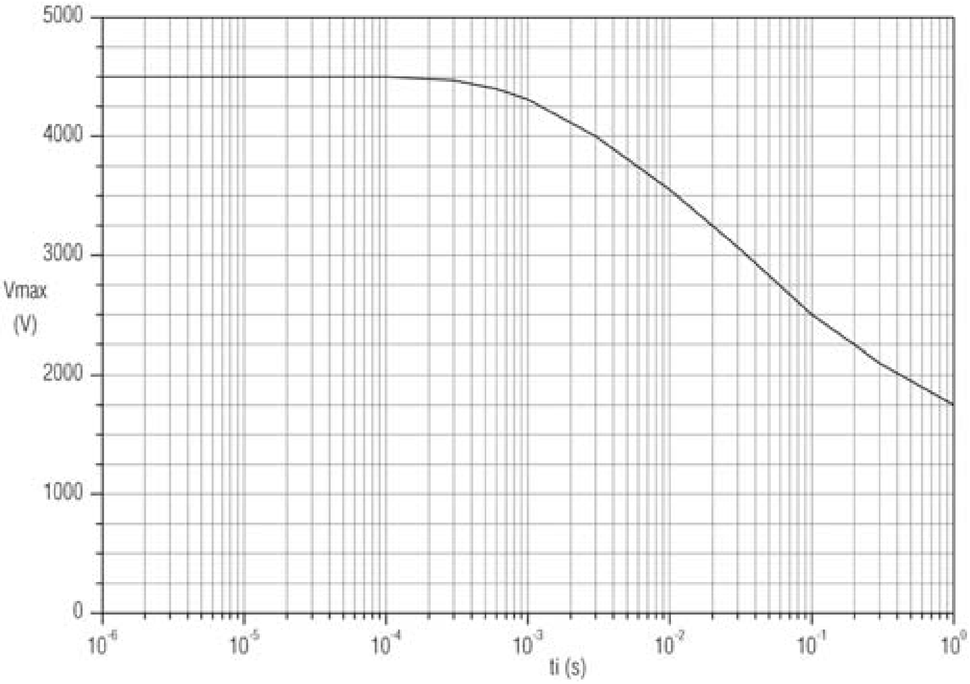

Fig. 29 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

AC15 - SINGLE PULSE

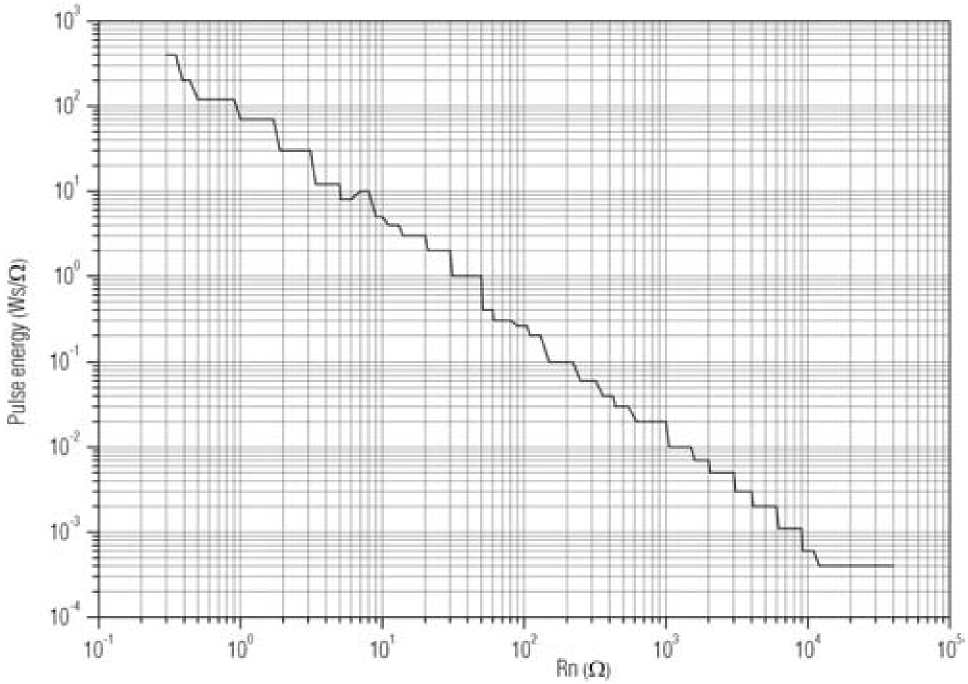

Fig. 30 – Pulse capability; W_s as a function of Rn

AC15 - REPETITIVE PULSE

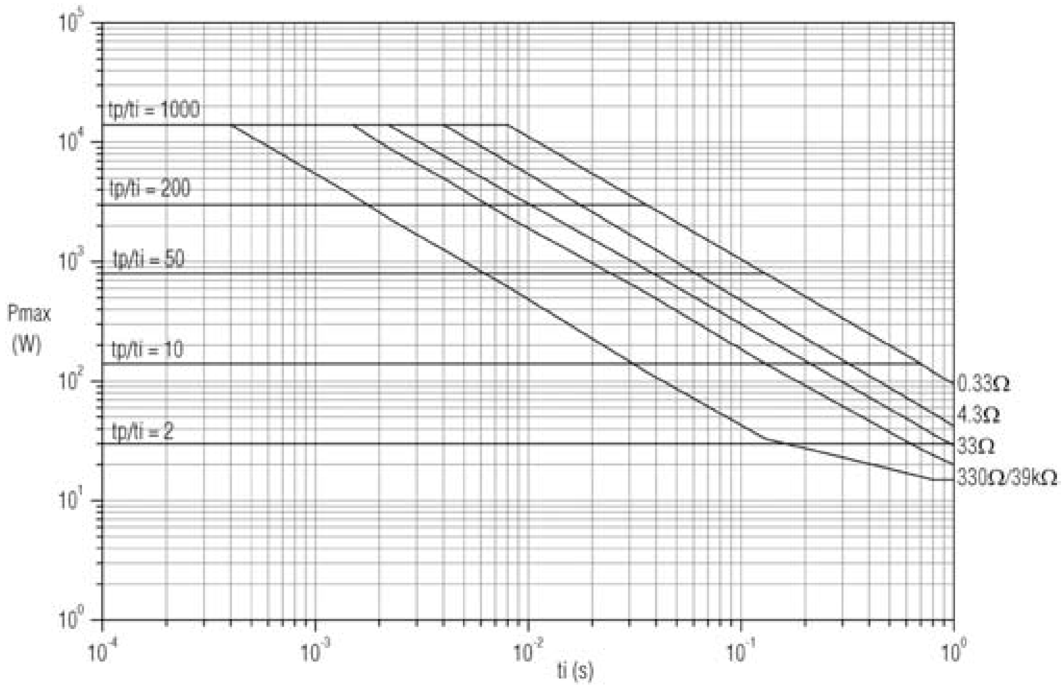

Fig. 31– Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC15

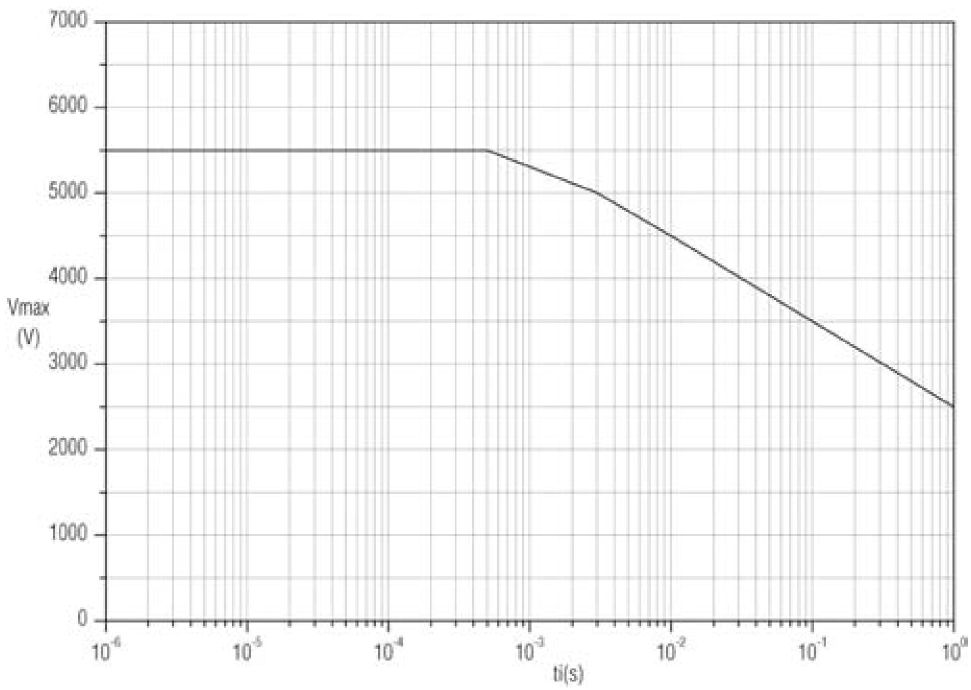

Fig. 32 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

AC20 - Single Pulse

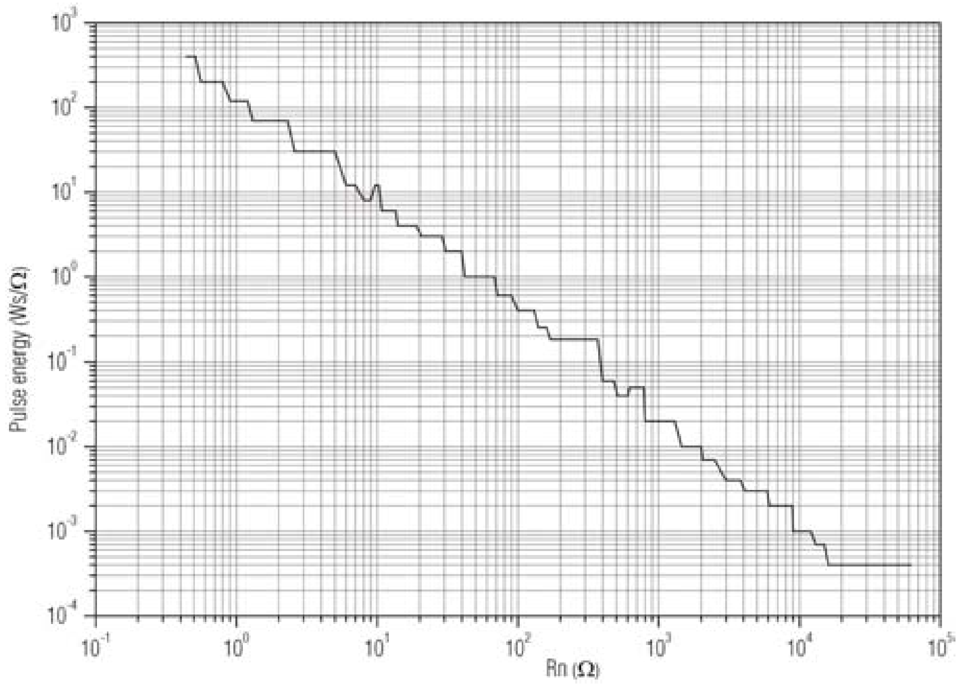

Fig. 33 – Pulse capability; W_s as a function of Rn

AC20 - Repetitive Pulse

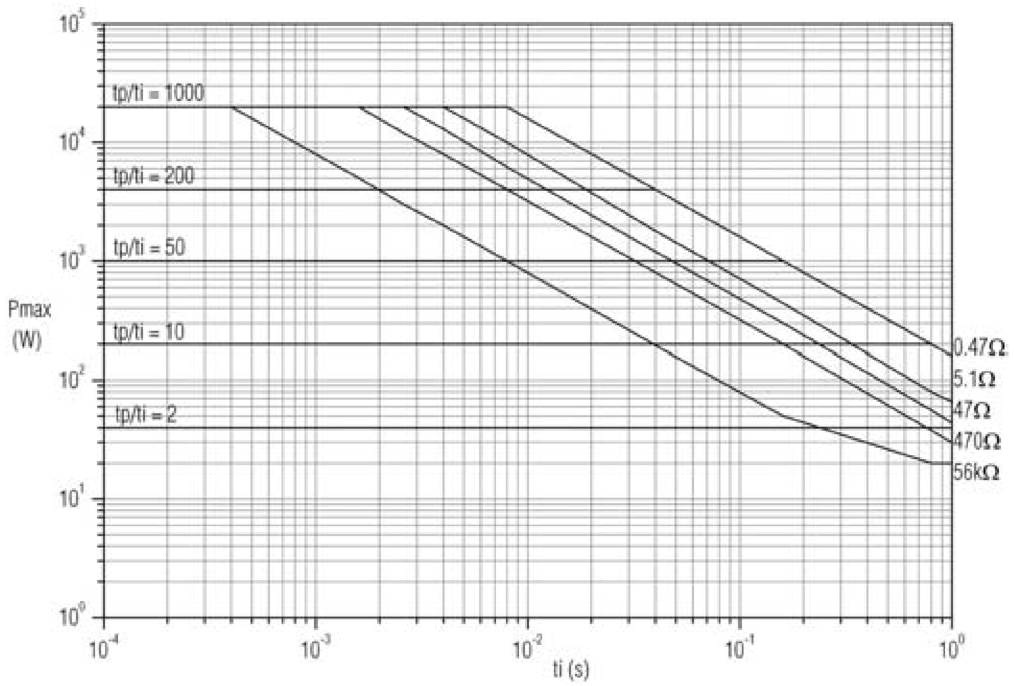

Fig. 34 – Pulse on regular basis; maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

AC20

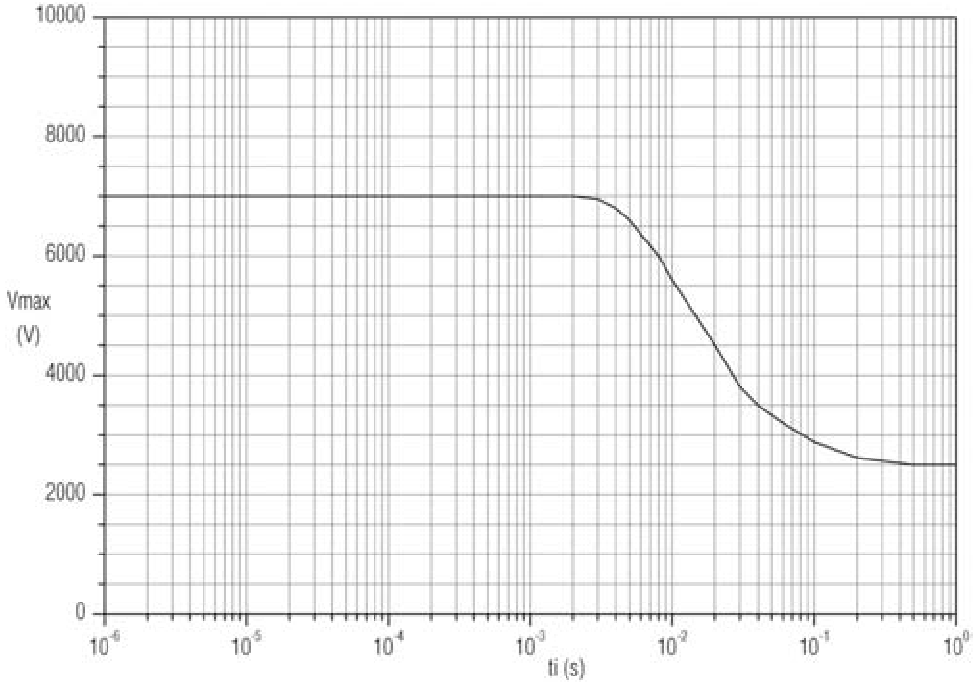

Fig. 35 – Pulse on regular basis; maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

MARKING

The resistor is marked with the nominal resistance value, the tolerance on the resistance and the rated dissipation at T_{amb} = 40 °C. For values up to 910Ω, the R is used as the decimal point. For values of 1000 Ω or higher the letter K is used as a decimal point.

Example:

6K8 5%
5W

ORDERING INFORMATION

Table 2. Ordering code.

PRODUCT	TOLERANCE	ORDERING CODE	TAPING	LEAD ∅	PACKAGING	QUANTITY (pcs)
AC01	±5%	**2306 328 33xxx**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	1000
AC02	±5%	**2306 326 33xxx**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC03	±5%	**2322 329 03xxx**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC04	±5%	**2322 329 04xxx**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC05	±5%	**2322 329 05xxx**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC07	±5%	**2322 329 07xxx**	73.0 (2.87)	0.80 (0.031)	AMMOPACK	500
AC10	±5%	**2322 329 10xxx**	89.0 (3.50)	0.80 (0.031)	AMMOPACK	500
AC15	±5%	**2322 329 15xxx**	-	0.80 (0.031)	BOX	100
AC20	±5%	**2322 329 20xxx**	-	0.80 (0.031)	BOX	100

Dimensions unless specified in mm (inches)

Table 3. Last digit of ordering code.

RESISTANCE DECADE	LAST DIGIT
0.1 - 0.91 Ω	7
1 - 9.1 Ω	8
10 - 91 Ω	9
100 - 910 Ω	1
1 - 9.1 kΩ	2
10 - 91 kΩ	3

The resistors have a 12 digit ordering code starting with 2306 or 2322.
The next 5 digits indicate the resistor type and packaging, see table 2.
The last 3 digits indicate the resistance value:
- The first 2 digits of these last 3 indicate the actual resistance value;
- The last digit indicates the resistance decade in accordance with table 3.

Example:
AC01, 47 Ω, ±5% is **2306 328 33479**

NAFTA ORDERING INFORMATION

Table 4. NAFTA Ordering code.

PRODUCT	TOLERANCE	NAFTA ORDERING CODE	TAPING	LEAD ∅	PACKAGING	QUANTITY (pcs)
AC01	±5%	**AC01WxxxxxJ**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	1000
AC02	±5%	**AC02WxxxxxJ**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC03	±5%	**AC03WxxxxxJ**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC04	±5%	**AC04WxxxxxJ**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC05	±5%	**AC05WxxxxxJ**	63.0 (2.48)	0.80 (0.031)	AMMOPACK	500
AC07	±5%	**AC07WxxxxxJ**	73.0 (2.87)	0.80 (0.031)	AMMOPACK	500
AC10	±5%	**AC10WxxxxxJ**	89.0 (3.50)	0.80 (0.031)	AMMOPACK	500
AC15	±5%	**AC15WxxxxxJ**	-	0.80 (0.031)	BOX	100
AC20	±5%	**AC20WxxxxxJ**	-	0.80 (0.031)	BOX	100

Dimensions unless specified in mm (inches)

Table 5. Examples of the ohmic value.

VALUE	5 DIGITS
1 Ω	1R000
10 Ω	10R00
100 Ω	100R0
1 kΩ	1K000
10 kΩ	10K00
100 kΩ	100K0
1 MΩ	1M000

The ohmic value in the NAFTA ordering code (see table 4) is represented by the “xxxxx” in the middle of the above ordering code. Table 5 gives some examples on how to use these 5 digits.

Example:
AC01, 1000Ω, ±5%, ammopack 1000pcs is **AC01W1k000J**

PACKAGING

TAPE IN BOX

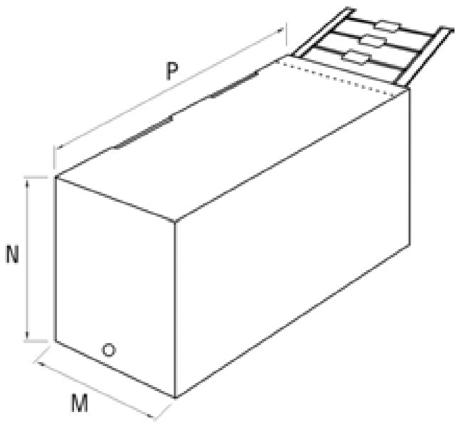

Table 6. Box.

PRODUCT	M	N	P	QUANTITY (pcs)
AC01	85 (3.4)	66 (2.6)	263 (10.4)	1000
AC02	85 (3.4)	66 (2.6)	263 (10.4)	500
AC03	85 (3.4)	66 (2.6)	263 (10.4)	500
AC04	85 (3.4)	66 (2.6)	263 (10.4)	500
AC05	85 (3.4)	112 (4.5)	263 (10.4)	500
AC07	93 (3.7)	112 (4.5)	263 (10.4)	500
AC10	117 (4.6)	117 (4.6)	263 (10.4)	500
AC15	130 (5.12)	52 (2.05)	264 (10.4)	100
AC20	130 (5.12)	52 (2.05)	264 (10.4)	100

Dimensions unless specified in mm (inches)

TAPE IN REEL (SPECIAL PART NUMBER UNDER REQUEST)

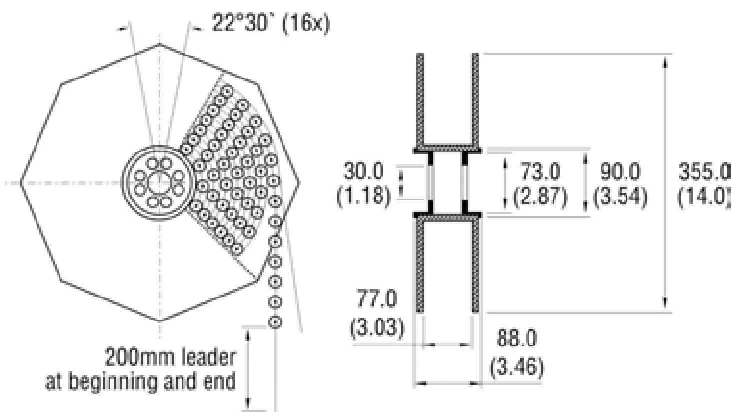

Table 7. Reel.

PRODUCT	TAPING	QUANTITY (pcs)
AC01	63.0 (2.48)	4000
AC02		1500
AC03		1500
AC04		1500
AC05		1000

Dimensions unless specified in mm (inches)

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance to the schedule of IEC publications 60115–1, category 40/200/56 (rated temperature range -40 to +200 °C; damp heat, long term, 56 days and along the lines of IEC publications 60068-2); “Recommended basic climatic and mechanical robustness testing procedure for electronic components” and under standard atmosphere conditions according to IEC 60068-1 subclause 5.3, unless otherwise specified.
In some instances deviations from IEC applications were necessary for our method specified.

Table 8. Test and requirements.

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.8	-	Temperature coefficient	Between - 40 °C and + 200 °C: R < 10 Ω R ≥ 10 Ω	 0 to 600 ppm/°C - 80 to +140 ppm / °C
4.13	-	Short time overload	Room temperature; dissipation 10 x Pn; 5 s (voltage not more than 1000 V / 25 mm)	$\Delta R/R_{max}$ ±2% +0.1Ω
4.16	21(U)	Robustness of terminations:		No visual damage $\Delta R/R_{max}$ ±0.5% +0.05Ω
4.16.2	21(Ua)	Tensile all samples	Load 10 N; 10 s	
4.16.3	21(Ub)	Bending half number of samples	Load 5 N; 4 x 90°	
4.16.4	21(Uc)	Torsion other half number of samples	2 x 180° in opposite directions	
4.17	20(Ta)	Solderability (after ageing)	16 h at 155 °C; leads immersed in flux 600, leads immersed 2 mm for 2 ±0.5 s in a solder bath at 235 ±5 °C	Good tinning; (≥ 95% covered) no visible damage
4.18	20(Tb)	Resistance to soldering heat	Thermal shock: 3 s; 350 ±10 °C; 2.5 mm from body	$\Delta R/R_{max}$ ±0.5% +0.05Ω
4.19	14(Na)	Rapid change of temperature	30 minutes at - 40°C and 30 minutes at + 200°C; 5 cycles	No visible damage $\Delta R/R_{max}$ ±1% +0.05Ω
4.22	6(Fc)	Vibration	Frequency 10 to 500 Hz (1 to 7W) and 10 to 55 Hz (10 to 20W), displacement 0.75 mm or acceleration 10 g, three directions; total 6 h (3x2 h)	No visible damage $\Delta R/R_{max}$ ±0.5% +0.05Ω

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.23		Climatic sequence		
4.23.2	2(Ba)	Dry heat	16 h; +200°C	
4.23.3	30(Db)	Damp heat (accelerated) 1st cycle	24 h; 25°C to 55 °C; 90 to 100% R.H.	$\Delta R/R_{max}$ ±1% +0.05Ω
4.23.4	1(Aa)	Cold	2 h; -40°C	
4.23.6	30(Db)	Damp heat (accelerated) remaining cycles	5 days; 25°C to 55°C; 90 to 100% R.H.	
4.24	3(Ca)	Damp heat (steady state)	56 days; 40°C; 90 to 95% R.H.; loaded with 0.01Pn	No visible damage $\Delta R/R_{max}$ ±1% +0.05Ω
4.25.1	-	Endurance (at 40 °C)	1000 h load with Pn; 1.5 h ON and 0.5 h OFF.	No visible damage $\Delta R/R_{max}$ ±5% +0.1Ω
4.29	45 (Xa)	Component solvent resistance	Isopropyl alcohol followed by brushing in accordance with MIL STD 202	No visible damage