Rated Resistance
Resistance value indicated upon the resistor

Critical Resistance
Resistance value at which the rated voltage is equal to the limiting element voltage

Resistance Tolerance
Permitted variation of the nominal resistance value expressed as a percentage of that value

Nominal Dissipation
Maximum permitted load at a defined ambient temperature e.g. $T_{@}$ = 70°C, which ensures that resistance stability limits in the relevant specification are not exceeded.

Limiting Element Voltage
Maximum d.c. or a.c. effective voltage which can be applied continuously to the resistor

Temperature Coefficient
The permissible change of the resistance value depending on temperature and can be described by the following equation:

$TC\ (10^{-6}/K) = (R_{\vartheta} - R_{TREF}.) / (R_{TREF} * \Delta\vartheta) * 10^{-6}$

$\Delta\vartheta$ is the difference between Reference Temperature (T_{REF}) and the corresponding ambient temperature.
The maximum permissible increase of the resistance value by the TC, in case of electric load can be determined by way of the maximum permissible film temperature. The change of resistance value is calculated by:

$R_{\vartheta max} = R_N[(1+(\vartheta_{smax}-20°C)*TC_{max})]$

Consequently the maximum permissible current for the voltage for P_{70} can be calculated by $R_{\vartheta max}$

Insulation Voltage
Maximum peak voltage which may be applied under continous operating conditions between the resistor terminations and any conducting mounting surface.

Insulation Resistance
Electrical resistance value of the encapsulent measured between the terminations of the resistor and applied V-block according to IEC60115-1

Derating
Boundary curve of maximum allowable dissipation at $T_{@}$ between upper and lower category temperatures.

Thermal Resistance
Under electrical load a film resistor generates heat which increases the film temperature. At the same time heat is dissipated to the environment, so that with constant electric load and constant convection a thermal balance appears between the heat, generated by the electrical load and the heat lost by convection.

These proportions are characterized by the thermal resistance. The thermal resistance is defined by the mechanical dimensions of a resistor, the heat dissipation by the wire leads as well as the convection, radiation and the mounting of the resistor.

The thermal resistance R_{th} is defined as follows:

$R_{th} = (\vartheta_s - \vartheta_U)) / P = \vartheta_{Ü} / P$

ϑ_s = film temperature in °C

ϑ_u = ambient temperature in °C

$\vartheta_{ü}$ = temperature rise

P = load in Watts

The thermal resistance measurement is made under defined conditions according to DIN.

The maximum power rating can be calculated using the following equation:

$P_{max} = (\vartheta_s - \vartheta_u) / R_{th}$

Thus, the maximum permissible power rating P_{max} is dependant on the maximum permissible film temperature, the ambient temperature ϑ_u and the thermal resistance.

Current Noise
The current noise voltage expressed in µV, is that portion of noise voltage that arises from d.c. current in a resistor in addition to the thermal noise voltage. The relative noise voltage, expressed in µV/V is independent of the applied dc-voltage $U_=$

Non linearity A_3
The harmonic index and the voltage coefficient of resistors are a criteria for the non-linearity of the current voltage characteristic. The harmonic index is defined as the logarithm of the ratio of the fundamental U_1 to the 3rd harmonic E_3. It is specified in dB:

$A_3 = 20\ lg\ (U_1 / E_3)$ in dB

Measurements are according to IEC 60440

Stability

The change of resistance values at certain loads and ambient temperatures can be obtained from the Stability Nomogram which consists of 4 diagrams; these can also be used independently. The stability nomogram for different products can be seen on the relevant data sheets. Additionally the limiting values stated in the data sheets such as maximum load, surface temperature etc., have to be observed.The following examples show how to use a nomogram:

Example 1:
Known: size D
R= 1KΩ, P = 0.5W, U_{LEV}= 350V, t = 5000h, ϑ_u = 70°C

Unknown: ΔR /R after 5000h
From Diagram A we see a temperature rise of
$\vartheta_ü$ = 65°C for size D at P = 0.5W

From Diagram B a surface temperature of 135°C can be obtained for ϑ_U = 70°C

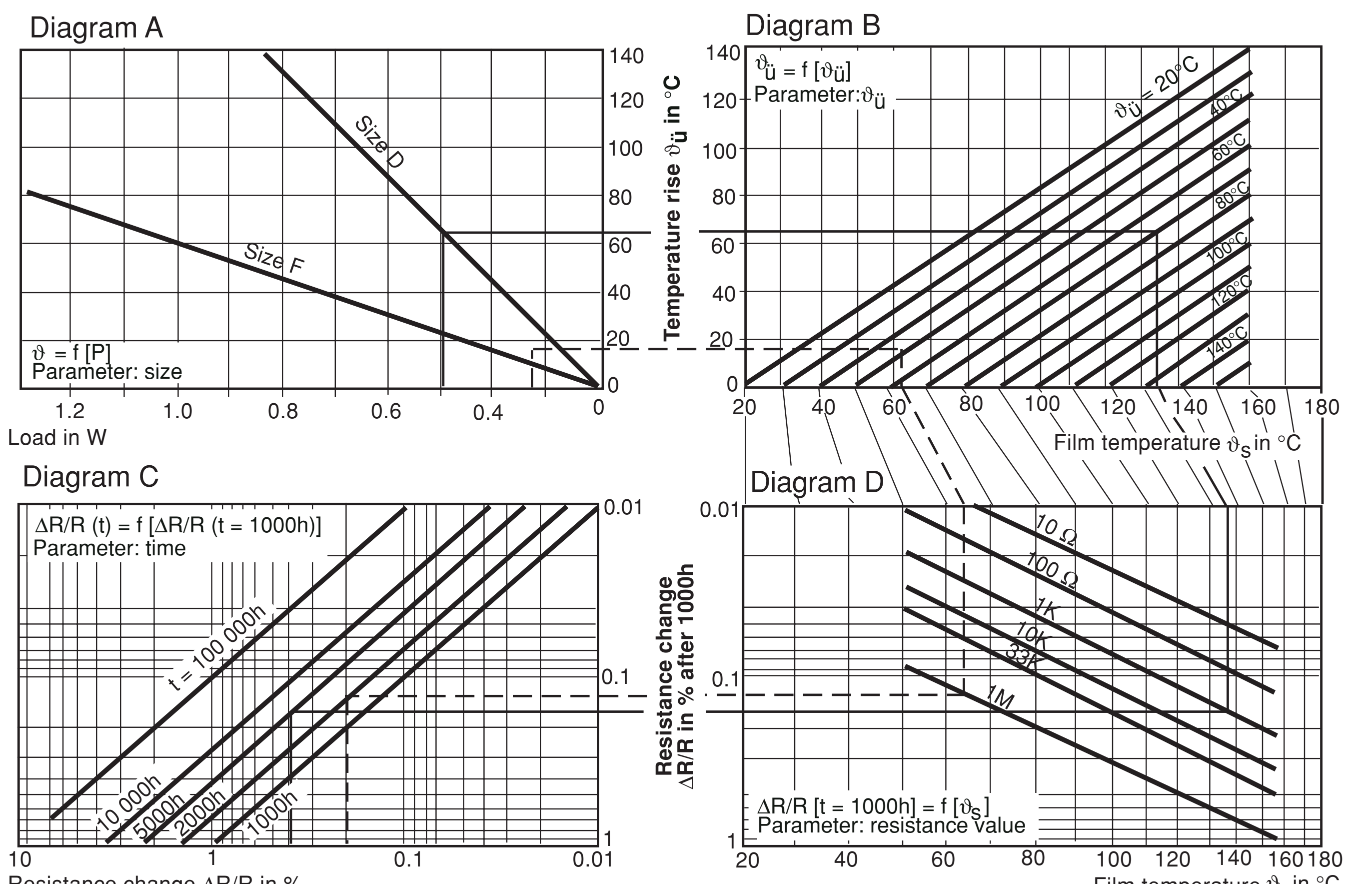
From Diagram D a ΔR /R after 5000h of 0.4% can be obtained for a surface temperature of 135°C of a 1KΩ resistor (see solid line in nomogram)

Example 2:
Known: size F; R = 1M, P_{70} = 1.5W, U_{LEV}= 500V,
t = 2000h at ϑ_u = 50°C

Unknown: ΔR /R after 2000h

For R = 1M the following equation applies:

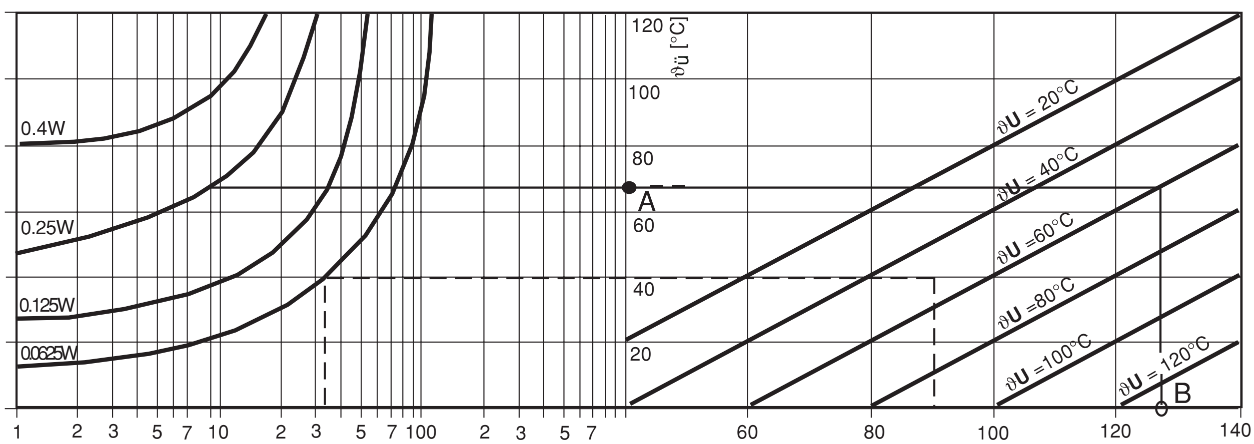
P = (U^2_{LEV} / R = 0.25W as U = $\sqrt{P*R}$ > U_{LEV} (see the dotted line in the nomogram).



Stability nomogram typical values

Packaging density

The temperature rise in respect of the surface temperature of the hottest SMD component on the board can be obtained from the nomogram below. It is necessary that the components are distributed uniformly over the whole circuit board.



Example 1:

Known: 9 resistors each rated at 0.25W

$\vartheta u = 60°C$

Unknown: temp.rise $\vartheta_{ü}$, surface temp. ϑ_s of the hottest component

$\vartheta_u = 65°C$ (A), $\vartheta_s = 125°C$ (B), see solid line

Example 2:

Load of each resistor = 0.0625W, $\vartheta_u = 50°C$ maximum admissible surface temperature 90°C

How many components may be mounted?

- 33 pcs, see dotted line

Pulse Load

When a resistor is subjected to impulses the following points have to be observed:

1. The maximum pulse load permissible $\hat{P}_{max}$ depends on the pulse duration t_i
   This also applies to the maximum permissible pulse voltage $\hat{U}_{max}$
2. The average load P may not exceed the corresponding nominal load. For resistors with resistance values greater than the critical value the nominal value is determined by the critical value and the maximum operating voltage permissible.
   Required

$$\overline{P} = \frac{1}{t_p \bullet R}\int_{t_1}^{t_2} U2(t)\,dt\,P_\vartheta$$

   Explanations:
   R = nominal value
   t_p = period of time
   U (t) = pulse voltage
   P_ϑ = nominal load of the resistor for the ambient temperature ϑ $t_2 - t_1$ = pulse duration t_i

3. Differences arise when resistors are subject to single shot (switching-on processes) or repetitive pulses.
   Approximate values for the load with rectangular pulses for each model are stated in the appropriate sections of the catalog.
   All other pulses have to be converted to rectangular pulses which show the same energy content and the same pulse voltage.

   Example: Exponential pulse

   $\tau\, Us^2 / 2R = t_i\, Us^2 / R$ e.g. $t_i = \tau / 2$

   Explanations:
   τ = time constant of the exponential pulse
   ti = pulse duration or the rectangular pulse
   Ûs = peak voltage
   R = nominal value of the resistor

   The maximum permissible pulse voltages $\hat{U}_{max}$ are also stated. The permissible pulse loads have been fixed in such way that the changes which appear in resistance values are comparable to those stated for the electrical long time load according to IEC 60115-1.