About Shock Safety For Power Entry Modules, continued

2. Thermal requirements of the fuseholder

2.1 Influencing factors

The design engineer of electrical equipment is responsible for its safety and functioning to humans, animals and real values. Above all, it is his task to make sure that the state of the art as well as the valid national and international standards and regulations be observed.

In view of the safety of electrical equipment the selection of the most suitable fuseholder is of great importance. Among other parameters, one has to make sure that the maximum admissible power acceptances and temperatures defined by the manufacturer are followed. Differing definitions and requirements in the most important standards for fuses and fuseholders are time and again origin for the incorrect selection of fuseholders.

To equate the rated current of a fuse with the rated current of the fuseholder, may, especially at higher currents, cause high, not admissible temperatures, when the influence of the power dissipation in the contacts of the fuseholder was not taken into consideration.

For a correct selection, the following influence factors, depending on the application and mounting method, have to be followed:

1. Rated power dissipation of the suitable fuse.
2. Admissible power acceptance, operating current and temperatures of the suitable fuseholder.
3. Differing ambient air temperatures outside and inside of the equipment.
4. Length and cross section of the connecting wire.
5. Head dissipation/cooling, ventilation. Heat influence of adjacent components.

2.2 Rated current of a fuseholder

The value of current assigned by the manufacturer of the fuseholder and to which the rated power acceptance is referred.

2.3 Rated power dissipation of the fuse

(power dissipation at rated current)
See product group "fuses," page 102.

2.4 Rated power acceptance and admissible temperatures of a fuseholder.

The rated power acceptance of a fuseholder is determined by a standardised testing procedure according to IEC 60127-6. It is intended to be the power dissipation caused by the inserted dummy fuse at the rated current of the fuseholder and at an ambient air temperature of $T_{A1} = T_{A2} = 23°C$ (over a long period). During this test the following temperatures must not be exceeded on the surface of the fuseholder:

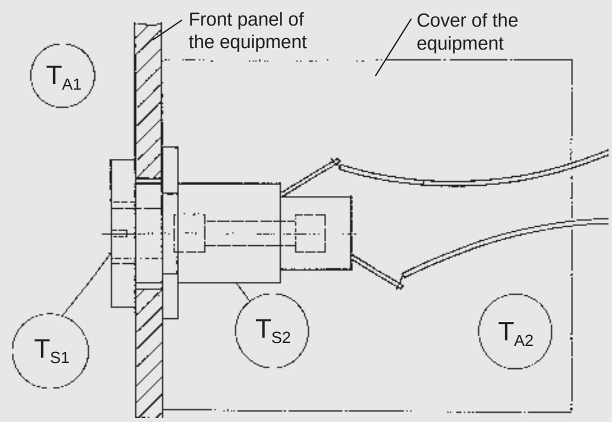
Fuseholder surface area	Maximum allowable temperature measuring points (see figure 1)	°C
1. Accessible parts [1]	T_{S1}	85
2. Inaccessible parts [1] Insulating parts	T_{S2}	[2]

NOTES:

1) When the fuseholder is properly assembled, installed and operated as in normal use, e.g., on the front panel of equipment.

2) The maximum allowable temperature of the used insulating materials corresponds to the Relative Temperature Index (RTI) according to IEC 60216-1 or UL 746 B.

Illustration of temperatures experienced in practice

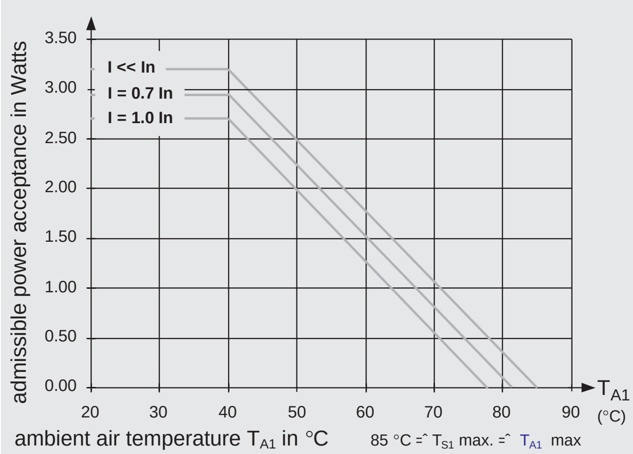


T_{A1} = ambient air temperature, surrounding the equipment
T_{A2} = ambient air temperature in the equipment
T_{S1} = temperature of accessible parts on fuseholder surface
T_{S2} = temperature of inaccessible parts on fuseholder surface

2.5 Correlation between operating current I, ambient air temperature T_{A1} and the power acceptance Ph of the fuseholder.

Example of a derating curve

I = operating current of the fuseholder



The derating curves demonstrate the admissible power acceptance of a fuseholder depending on the ambient air temperature T_{A1} for the following fuseholder operating currents: $I << I_n$, $I = 0,7 \cdot I_n$ and $I = 1,0 \cdot I_n$. This power acceptance corresponds to the max. admissible power dissipation of a fuse-link.

The corresponding values for other operating currents can be interpolated between the existing curves or calculated as follows:

$$P_h = P_o - P_c = P_o - (R_c \cdot I2)$$

P_h = admissible power acceptance in watt of the fuseholder, depending on T_{A1}

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Po = admissible power acceptance in watt of a fuseholder at $I << I_n$, depending on T_{A1}. The values can be taken from the derating curve $I << I_n$ of the corresponding fuseholder.
Pc = power dissipation in watt in the fuseholder contacts at the operating current in ampere.
I = operating current in ampere of the fuseholder.
Rc = contact resistance in ohm between the fuseholder terminals according to SCHURTER's catalog.

3. Selection of a suitable fuseholder with respect to the power acceptance at the corresponding ambient air temperature.

Summary

The adherence to the limits, indicatd by SCHURTER, in particular the power acceptance limits at the corresponding ambient air temperatures and mounting conditions of the fuseholder, is important for the safety of the product. It is therefore necessary to observe the following two steps:

Step 1
Selection of the fuseholder based on the power acceptance P_h at operating current I and maximum ambient air temperature T_{A1}.

$$P_f \leq P_h = P_o - P_c = P_o - (R_c \cdot I2)$$

Pf = rated power dissipation in watt of the fuse-link, calculated from (I_n . ΔU), whereas:
I_n = rated current in ampere of the fuse-link
ΔU = voltage drop in volt at I_n; values according to SCHURTER's catalog.
P_h, P_o, P_c, Rc = see pos. 2.5

Step 2
The reduction of the power acceptance of the fuseholder (from step 1) based on the different conditions at the mounting place etc. have to be determined by the design engineer responsible.

Examples:

- ambient air temperature is considerably higher inside of an equipment than outside ($T_{A2} > T_{A1}$)
- cross-section of the conductor, unfavourable heat dissipation
- heat influence of adjacent components

Therefore, temperature measurements on the appliance under normal and faulty conditions are absolutely necessary.

4. Example

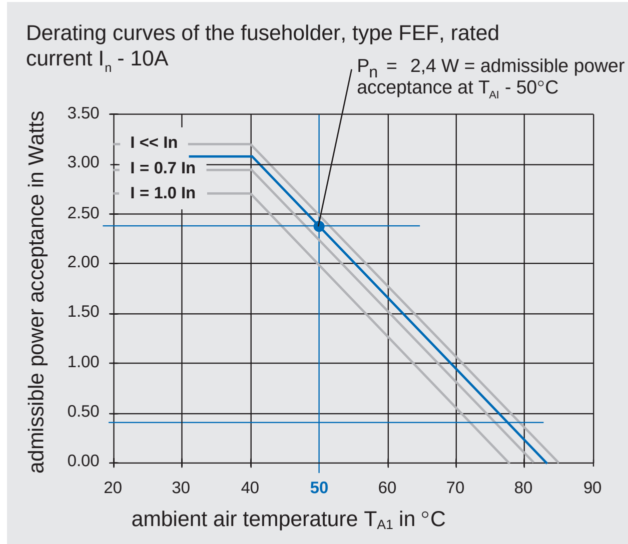
4.1 What's given?

- Fuse FSF 0034.1523, rated current I_n = 5 A.
  Voltage drop ΔU at I_n = 80 mV, typ.
  Rated power dissipation $P_f = (I_n \cdot \Delta U) = (5\ A \cdot 0{,}08\ V) = 0{,}4$ W.
- Fuseholder FEF 0031.1081, rated current I_n = 10 A
  Rated power acceptance at T_{A1} 23 °C = 3,2 W.
- Ambient air temperature = 50 ºC.
  Admissible power acceptance P_h at an ambient air temperature T_{A1} 50 °C according to the derating curve:
  P_h at $I << I_n$ = 2,5 W
  $I = 0{,}7 \cdot I_n$ = 7 A = 2,2 W
  $I = 1{,}0 \cdot I_n$ = 10 A = 2 W
- Contact resistance R_c = 5 m Ω

4.2 What is the admissible power acceptance P_h of the fuseholder?

Solutions

4.2.1 The result of the interpolation for the rated current I = 5 A is a P_h of approx. 2,4 W.
4.2.2 The result of the calculation is
$P_h = P_o - (R_c \cdot I2) = 2{,}5 - (0{,}005 \cdot 52) = 2{,}37$ W P 2,4 W.



4.4 Verification of the thermal requirements

Step 1
The following condition must be fulfilled:

$P_f \leq P_h$ © this means: the rated power dissipation P_f of the fuse-link must be less/equal than the admissible power acceptance P_h of the fuseholder.

Pf = 0,4 W; Ph = 2,4 W at T_{A1} = 50 °C

Step 2
To consider the different conditions at the mounting place according to step 1, see illustration in section 2.4.

4.5 Conclusion (without consideration of step 2)

- The value P_f is less than P_h. The condition according to formula is fulfilled. It has been chosen a suitable fuseholder.
- If the value P_f were greater than P_h the condition wouldn't be fulfilled. In that case, do select another fuseholder with a higher power acceptance or change the thermal conditions at the fuseholder mounting place.