Blade-Fuse-Links

... more than just automotive-fuse-links

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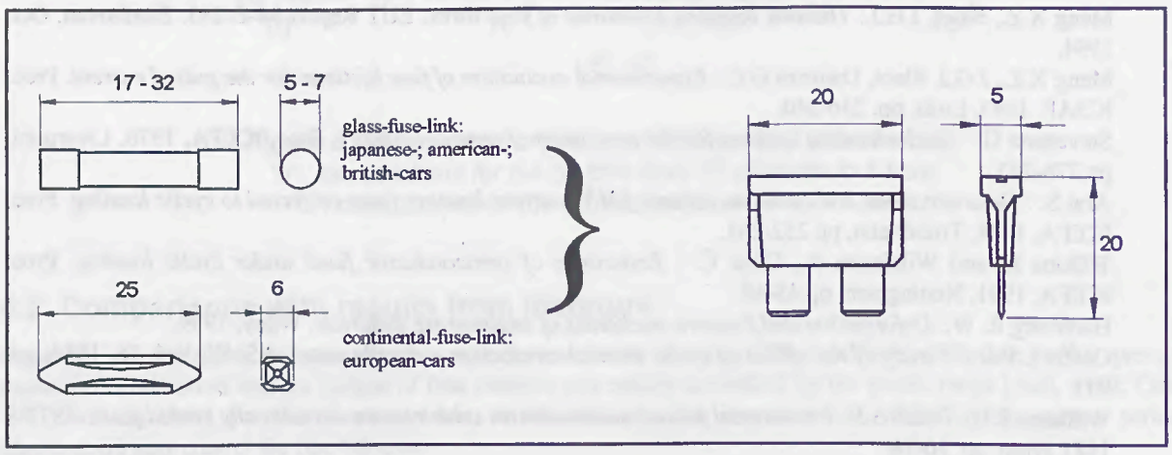
1. Blade-fuse-links

Since more than 10 years blade-fuse-links have been a well known product for the protecting of the electrical-network in vehicles. The blade-fuse-links replace the ancient fuses like for example continental-fuses or glass-fuses (see picture 1).



Picture 1: glass-fuse-link; continental-fuse-link; blade-fuse-link

The advantage of the blade-fuse-link is for example, that the fuse can directly be connected to wiring-harness and that this fuse-type allows a higher packaging in the junction-boxes than the ancient fuse-links.

The "electrical"-environment for such a fuse-link in an automotive application is

- max. operating voltage of vehicles: 24V DC
- max. constant current: 50A
- current-peaks up to: 150A
- max. short-circuit-currents 1.000A
- ambient temperature -40°C up to +100°C

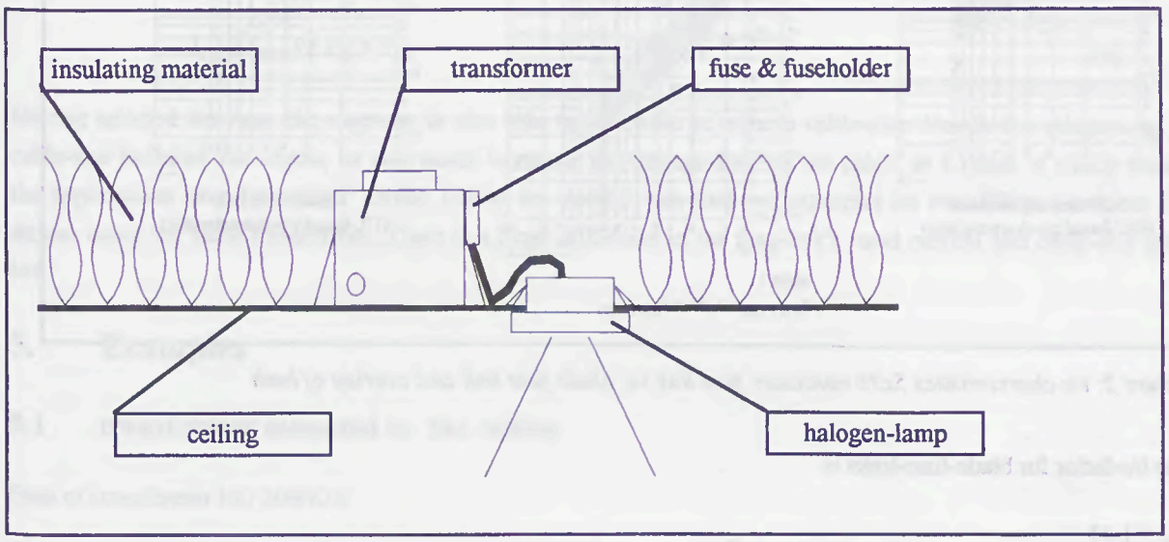
But there are more applications than the automotive application suitable for such a fuse-system. One is the protection of halogen-light-systems.

The "electrical"-environment for a halogen-light-system application is [1]

- max. operating voltage: 12V AC
- max. constant current: 24A
- current-peaks up to: 140A
- max. short-circuit-currents 500A
- ambient temperature +15°C up to +85°C

2. Halogen-light-systems

Halogen-light-systems become more and more popular as home-light-systems or for shop windows. In home-installations the transformer of the light-system is, in general, build in furnitures or in the ceiling. In both applications the transformer is in a heat insulation area, means the heat of the transformer can't be reduced by e.g. forced air. In shop window applications the transformer is build in the ceiling or under the ground area of the shop window. So nearly the same applies for the shop window application. In this applications there is a great influence from heat radiation of the transformer on the fuse-link (see Picture 2).



Picture 2: transfomer and lamp mounted in the ceiling

If the transfomer is loaded with rated power, than it is allowed that the temparature on the surface of the transformer reaches +85°C. The ambient temperatur of the fuseholder and fuse-link is approximately 60°C to 80°C. The ϑ-derating-factor of the fuse-link can be calculated with the following formular:

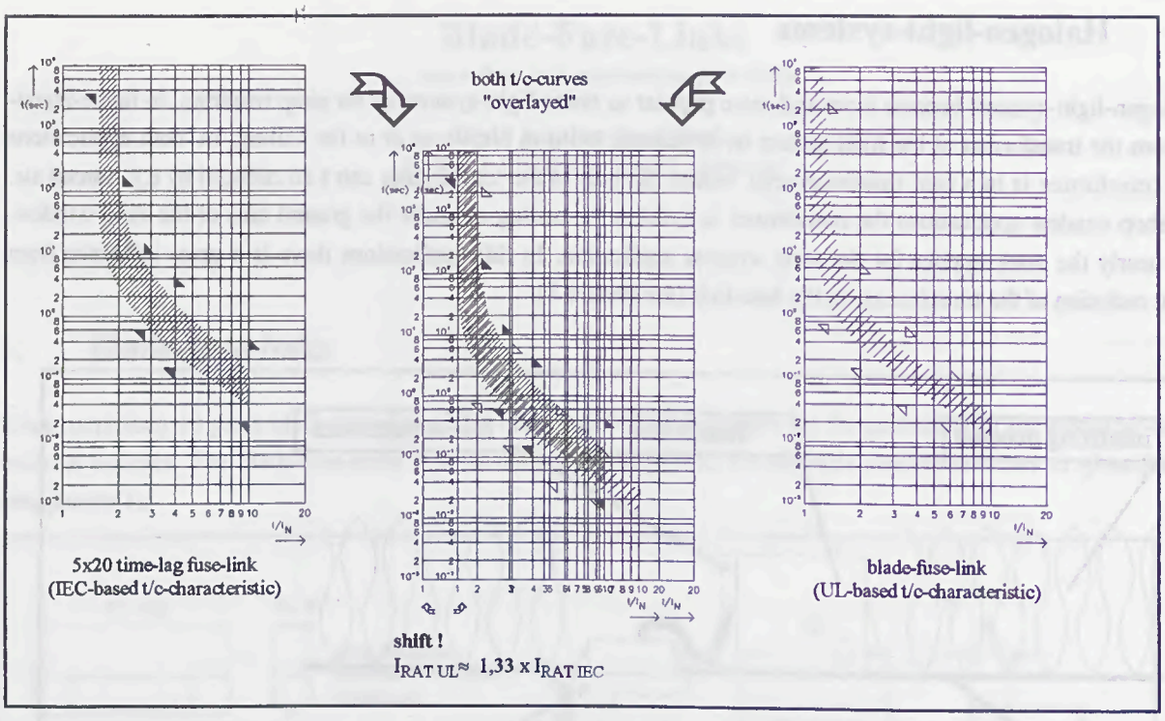
$F_\vartheta = (1+ (\vartheta_{ambient} - 23°C)*0{,}0015/K)^4$ (1) [2]

$F_{\vartheta 60°C} = 1{,}24$ $F_{\vartheta 80°C} = 1{,}39$

3. Protection by fusing the secondary side

3.1 Time-current-characteristic

On the secondary side more and more blade-fuse-links are used. One of the main problems in Europe is, that the t/c-characteristic of this fuses is not according to the IEC [3] standard. The t/c-characteristic is based on the UL-[4] or SAE-standard [5]! Means ("UL") gates $1{,}1I_{RAT}$; $1{,}35I_{RAT}$ instead of $1{,}5I_{RAT}$; $2{,}1I_{RAT}$ (see graphs below). If an engineer wants to use such fuses with UL-based-characteristic than he has to adapt the UL-based fuses with a faktor to IEC-fuses.



Picture 2: t/c-charcteristics 5x20 miniature fuse link vs. blade fuse link and overlay of both

The t/c-factor for blade-fuse-links is

$F_{t/c} = 1{,}33$

3.2 Cable-size

Beside the ambient temperature and t/c-curve the cable size has an influence on the fuse selection. VDE 0100 stipulates a factor that fixes the minimum cable size based on the t/c-curves.

$I_b \leq I_{RAT} \leq I_z$ (3)

and

$I_2 \leq 1{,}45\ I_z$ (4)

with:

I_b	operating current of the system
I_{RAT}	rated current of the fuse
I_z	maximum cable current
I_2	fusing current of the fuse ($1{,}35 I_{RAT}$)

cable size/ mm²	$I_{z30°C}$/ A	$I_{z60°C}$/ A
1	19	10,5
1,5	24	13
2,5	32	17,5
4	42	23
6	54	30

4. Conclusion

Blade-fuse-links are not only useful for automotive applications! By considering the above mentioned, these fuses can be use for applications with voltage ratings up to 32V and constant currents up to nearly 22A. Beside the possibilties of various fuseholder-systems there is one big advantage for the user of blade-fuse-links: he can buy these fuse-links 24h a day, 7 days a week on nearly every gas-station! This is an unique availability. The important point is, that the engineer knows the background of the different t/c-characteristics otherwise he will put the wrong current rating in his application. The selection of the right rated current could be calculated with the following formula by using the above mentioned factors.

$$I_{rat} \geq I_{const} \times F_{\vartheta} \times F_{t/c} \qquad (4)$$

Having selected the fuse, the engineer is also able to select the minimum cable-size. Beside the selection of the cable-size based on fuse-datas, he also needs to reduce the voltage drop on the cable, as a result of which most of the applications have "oversized" cables. Below, see point 5, you find two examples for two different ambient conditions using the same transformer. There is a large difference in the fuse-link's rated current and cable-size selected.

5. Examples

5.1 transformer mounted in the ceiling

Data of transformer HG 200/K/S

S	200VA
U_{pri}	230V
U_{sec}	11,5V
I_{sec}	16A

Mounted in the ceiling

ϑ	60°C
F_{ϑ}	1,24
$F_{t/c}$	1,33
I_{RAT}	≥ 16A x 1,33 x 1,24
I_{RAT}	≥ 26,4A

choosen fuse-link = 30A, blade-fuse-link

Minimum cable-size

$$I_z \geq \frac{1,35}{1,45} \cdot 30A$$

Iz ≥ 27,9A

The minimum cable-size is 6mm²

5.2 Same transformer under room temperature condition

ϑ 23°C
F_ϑ 1
Ft/c 1,33
I_{RAT} ≥ 16A x 1,33 x 1
I_{RAT} ≥ 21,3A
choosen fuse-link = 25A, blade-fuse-link
Minimum cable-size

$$I_z \geq \frac{1,35}{1,45} 25A \qquad Iz \geq 27,9A \text{ at } 23°C$$

The minimum cable-size is 2,5mm²

6. Acknowledgement

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7. References

[1] BLOCK-catalogue, page 12 - 15
BLOCK Transformatoren Elektronik GmbH & Co. KG, D-27283 Verden (Aller) 1995

[2] **Dipl.-Ing. Joachim Reichelt**
Wickmann Circuit Protection Information
Technology of Miniature Fuse-links
Wickmann-Werke GmbH, Witten 04/92

[3] IEC 127

[4] UL 198G

[5] SAE J 1284

[6] DIN VDE 0100

Remark: The above mentioned information bases on studies of blade-fuse-links from *Wilhelm PUDENZ GmbH, D-27243 Dünsen* and transformers from *BLOCK Transformatoren Elektronik GmbH & Co. KG, D-27283 Verden (Aller)*. The author will take, **at no account**, any responsibility for applications with fuse-links and/or transformers from other manufacturers!