Current Ratings for In-Vacuum Cables

Not an easy answer is possible to give the max. current rating for in-vacuum cables.
For air side cables, the max. current is typically defined by the current, which increases the temperature from 30°C ambient temperature to 70°C. If other insulation materials are used, the upper temperature can be also 90°C or even up to 180°C.

This current is dependant from:

- Type of cable (round/ flat)
- Insulation material (giving the max. temperature)
- Number of conductors (normally 3 off)
- Number of used conductors (normally only 2 off)
- Wire diameter
- Conducting material (Copper / Aluminium ...)
- Mounting (free in air / in a tube / in an insulated tube …)

These rules apply also to vacuum. The main difference in vacuum is, that the heat dissipation can no longer happen by convection but only by radiation or by direct contact to other materials. As the intensity goes with T^4 (Stefan-Boltzmann-Law), at low temperature the radiation is very low.

A positive aspect is, that the max. temperature of Kapton insulated wires is high, depending on the cables the limit is between 250°C and 300°C. By this at elevated temperatures a reasonable high energy is dissipated. Nevertheless, if the cable was not baked out, trapped water will be evaporated and will effect the vacuum. To avoid these problems, motors and coils should be heated by applying current during the bake out to a higher value than during normal run.

The heat created by the cable is calculated by the ohmic law, $P = U*I = R * I^2$
So as an example the thin 0.1mm wire 311-KAP-010 will create at 1A 2.27W/m (resistivity 2270Ohm/km), a 1mm ø multi strand wire 311-KAPM-100 with 30 Ohm/km will create only 0.03W/m.
(Any RF effects are not taken into account in this calculation).

The physical limit of use is the max. temperature of the cable, either defined by the insulation material or by the application.
The current ratings given by Allectra are approximate values for free in vacuum cables at continuous use. For short periods, significant higher current can be applied, the limit is only the temperature of the cable.
If coils are made, the current is significantly lower, typically max. 50% of the given values can be used.
For critical applications we recommend, that in a testing phase the temperature of the cable is measured.

All data given in this sheet are carefully checked but subject to change at any time.

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