CAUTION, LONG CABLE!

The critical parameter internal resistance

or when Ohm's law does not allow the required current to be generated…

The internal resistance of a circuit is of major importance in the case of a fault, therefore it represents a critical parameter. What good is the best reserve capacity in a power pack if Ohm's law does not permit the required current to be generated? The cable resistance is a major influence which is frequently underestimated.

The following example clarifies the issue:

A device with a current consumption of 5 A is installed 30 m [outward and return cable = 60 m] away from the control cabinet. A 10 A power supply unit, a cable with 1 mm^2 wire diameter and a 6 A miniature circuit breaker with a C tripping characteristic are used to protect the cable and the connected device.

Calculation of the internal resistances:

- Internal resistance, power supply unit 30 mΩ
- Connection technology (terminals) 20 mΩ
- Miniature circuit breaker 20 mΩ
- Short circuit (in the affected device) 45 mΩ
- Cable 60 m 1mm2

The cable resistance is calculated using the formula:

R = 1.07 Ohm

The total resistance of the application results then as:

1.19 Ohm

In case of a short circuit, this results in a short-circuit current of 20.2 A

If we now consider the tripping curve of the selected fuses, we can determine that this runs with the available factor I/IN (20.2/6) = 3.37 in the overcurrent range.

Usually, the miniature circuit breaker would trip in 3 to 10 seconds at this current level.

This does not correspond with the required performance, but rather over-loads or damages the cable used.

A brief overview of cable resistances with different cable cross-sections:

Cable cross-section A in mm²	**0,14**	**0,25**	**0,34**	**0,50**	**0,75**	**1,00**	**1,50**
Distance L in metres (= single length)	**Total cable resistance in Ohm = (R0 x 2 x L) / A**						
5	1,27	0,71	0,52	0,36	0,24	0,18	0,12
10	2,54	1,42	1,05	0,71	0,47	0,36	0,24
15	3,81	2,14	1,57	1,07	0,71	0,53	0,36
20	5,09	2,85	2,09	1,42	0,95	0,71	0,47
25	6,36	3,56	2,62	1,78	1,19	0,89	0,59
30	7,63	4,27	3,14	2,14	1,42	1,07	0,71
35	8,90	4,98	3,66	2,49	1,66	1,25	0,83
40	10,17	5,70	4,19	2,85	1,90	1,42	0,95
45	11,44	6,41	4,71	3,20	2,14	1,60	1,07
50	12,71	7,12	5,24	3,56	2,37	1,78	1,19
75	19,07	10,68	7,85	5,34	3,56	2,67	1,78
100	25,34	14,24	10,47	7,12	4,75	3,56	2,37
125	31,79	17,80	13,09	8,90	5,93	4,45	2,97
150	38,14	21,36	15,71	10,68	7,12	5,34	3,56
175	44,50	24,92	18,32	12,46	8,31	6,23	4,15
200	50,86	28,48	20,94	14,24	9,49	7,12	4,75
225	57,21	32,04	23,56	16,02	10,68	8,01	5,34
250	63,57	35,60	26,18	17,80	11,87	8,90	5,93