Medium Voltage cables

Standard rated voltage

The standard rated voltage of a cable consists of three values $U_o - U$ and $U_m$ expressed in kilovolts in the form $U_o/U/U_m$, stated in the description of the cable and according to the insulation thickness, conditions of voltage tests and cable working voltages.

- $U_o$: is the rated power-frequency voltage between conductor and earth or metallic screen, for which the cable is designed
- $U$: is the rated power-frequency voltage between conductors, for which the cable is designed
- $U_m$: is the maximum value of the "highest system voltage" for which the equipment may be used.

(see IEC 60038)

The standard rated voltages $U_o/U/(U_m)$ of the cables considered are as follows:

- $U_o/U/(U_m) = 3.6/6(7.2)$ KV
- $6/10(12)$ KV
- $8.7/15(17.5)$ KV (on request)
- $12/20(24)$ KV
- $18/30(36)$ KV

Current ratings (as per IEC 60502-2)

Conditions:
Rated frequency: 50 Hz
Steady state conditions.
All the ratings for single core assume that the cable screens are solidly bonded (i.e. bonded at both end of the cables).

Underground:
- Ground temperature: 20 °C
- Thermal resistivity: 1.5 K.m/W
- Depth : 0.8 m
- Armoured or unarmoured cables
- Three core cables buried direct in ground
- Single core cables buried direct in ground in trefoil formation.

Above ground:
- air temperature: 30 °C
- single core cables in air and trefoil formation.

For the above values of $U_o$, it is assumed that in the system considered earth faults are automatically cleared within an hour and that the overall operating time with an earthed phase will not exceed 12 hours in a year. If such conditions are not met, a higher value shall be taken for $U_o$.

For installations where rated voltage $U$ is not mentioned in the standard, the user shall take for $U_o$ the standard voltage which is the next higher than the one obtained from the formula $U\sqrt{3}$.

For other conditions (such as thermal resistivity of the ground other than 1.5 K.m/W, temperature other than 20 °C or 30 °C, depth of lying other than 0.8 m...) please refer to the IEC 60502-2 correction factors as well as rating factors for grouped circuits.
### Electrical details

**Short-Circuit Current (I.c.c.)**

Short-circuit current and breakdown time shall not cause a too high temperature rise which depends on the nature of the insulation compound.

The admissible current density in short-circuit is given by the formula:

\[ D = \frac{K}{\sqrt{t}} \]

- **D**: admissible current density in amperes by mm² of cross-section
- **K**: coefficient depending on the conductor nature, on the initial temperature at overload moment and on the admissible temperature at the end of overload.
- **t**: duration of short-circuit in seconds
- **I.c.c.**: short-circuit current (A)

**Voltage Drop (∆u)**

We recommend voltage drop not to exceed:
- 3 % for lighting wire systems
- 5 % for driving force wire systems
- 10 % on starting time for motors

**Formula**

- In D.C. \[ ∆u = 2I \cdot R_c \]
- In single-phase alternating current \[ ∆u = 2I (Ra \cos\varphi + L\omega \sin\varphi) \]
- In three-phase A.C. \[ ∆u = \sqrt{3}I (Ra \cos\varphi + L\omega \sin\varphi) \]

**Values of K**

<table>
<thead>
<tr>
<th>Nature of insulation</th>
<th>Copper cond.</th>
<th>Alu. cond.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>115</td>
<td>76</td>
</tr>
<tr>
<td>XLPE</td>
<td>143</td>
<td>94</td>
</tr>
<tr>
<td>EPR</td>
<td>143</td>
<td>—</td>
</tr>
</tbody>
</table>

**Current density: D in Amperes / sq.mm**

<table>
<thead>
<tr>
<th>Conductors</th>
<th>Temperature (°C)</th>
<th>Duration of overload (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Final</td>
</tr>
<tr>
<td>Copper</td>
<td>90</td>
<td>250</td>
</tr>
<tr>
<td>Aluminium</td>
<td>90</td>
<td>250</td>
</tr>
</tbody>
</table>

**Section ≥ \[ \frac{I.c.c. (A)}{D \text{ (A/sq.mm)}} \]**

- \[ \Delta u \]: voltage drop
- \[ R_c \]: conductor resistance in D.C. at operating temperature (Ω/km)
- \[ Ra \]: conductor resistance in A.C. at operating temperature (Ω/km)
- \[ L \]: core inductance (H/km)
- \[ \omega \]: pulsation equal to \( 2 \pi f \) (314 for \( f = 50 \text{ Hz} \))
- \[ \cos \varphi \]: power factor
- \[ I \]: Carried intensity in normal operating condition or \[ I_d \]: intensity at starting time in the core (A)
- \[ t \]: simple length of cable (km)