[**An example how to calculate voltage drop and size of electrical cable**](http://electrical-engineering-portal.com/an-example-how-to-calculate-voltage-drop-and-size-of-electrical-cable)

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An example how to calculate voltage drop and size of electrical cable (photo credit: 12voltplanet.co.uk)

**Input information**

**Electrical details:**

Electrical load of **80KW**, distance between source and load is **200 meters**, system voltage **415V three phase**, power factor is **0.8**, [permissible voltage drop](http://electrical-engineering-portal.com/download-center/electrical-software/calculate-bus-bar-size-and-voltage-drop) is  **5%**, demand factor is **1**.

**Cable laying detail:**

Cable is **directed buried** in ground in trench at the depth of **1 meter**. Ground temperature is approximate **35 Deg.** Number of cable per trench is **1**. Number of run of cable is **1 run**.

**Soil details:**

Thermal resistivity of soil is **not known**. Nature of soil is **damp soil**.

**Ok, let’s dive into calculations…**

* **Consumed Load** = Total Load · Demand Factor:
Consumed Load in KW = 80 · 1 = **80 KW**
* **Consumed Load in KVA** = KW/P.F.:
Consumed Load in KVA = 80/0.8 = **100 KVA**
* **Full Load Current** = (KVA · 1000) / (1.732 · Voltage):
Full Load Current = (100 · 1000) / (1.732 · 415) = **139 Amp.**

***Calculating Correction Factor of Cable from following data:***

**Temperature Correction Factor (K1) When Cable is in the Air**

|  |
| --- |
| Temperature Correction Factor in Air: K1 |
| Ambient Temperature | Insulation |
| PVC | XLPE/EPR |
| 10 | 1.22 | 1.15 |
| 15 | 1.17 | 1.12 |
| 20 | 1.12 | 1.08 |
| 25 | 1.06 | 1.04 |
| 35 | 0.94 | 0.96 |
| 40 | 0.87 | 0.91 |
| 45 | 0.79 | 0.87 |
| 50 | 0.71 | 0.82 |
| 55 | 0.61 | 0.76 |
| 60 | 0.5 | 0.71 |
| 65 | 0 | 0.65 |
| 70 | 0 | 0.58 |
| 75 | 0 | 0.5 |
| 80 | 0 | 0.41 |

**Ground Temperature Correction Factor (K2)**

|  |
| --- |
| Ground Temperature Correction Factor: K2 |
| Ground Temperature | Insulation |
| PVC | XLPE/EPR |
| 10 | 1.1 | 1.07 |
| 15 | 1.05 | 1.04 |
| 20 | 0.95 | 0.96 |
| 25 | 0.89 | 0.93 |
| 35 | 0.77 | 0.89 |
| 40 | 0.71 | 0.85 |
| 45 | 0.63 | 0.8 |
| 50 | 0.55 | 0.76 |
| 55 | 0.45 | 0.71 |
| 60 | 0 | 0.65 |
| 65 | 0 | 0.6 |
| 70 | 0 | 0.53 |
| 75 | 0 | 0.46 |
| 80 | 0 | 0.38 |

**Thermal Resistance Correction Factor (K4) for Soil (When Thermal Resistance of Soil is known)**

|  |
| --- |
| Soil Thermal Resistivity: 2.5 KM/W |
| Resistivity | K3 |
| 1 | 1.18 |
| 1.5 | 1.1 |
| 2 | 1.05 |
| 2.5 | 1 |
| 3 | 0.96 |

**Soil Correction Factor (K4) of Soil (When Thermal Resistance of Soil is not known)**

|  |  |
| --- | --- |
| Nature of Soil | K3 |
| Very Wet Soil | 1.21 |
| Wet Soil | 1.13 |
| Damp Soil | 1.05 |
| Dry Soil | 1 |
| Very Dry Soil | 0.86 |

**Cable Depth Correction Factor (K5)**

|  |  |
| --- | --- |
| Laying Depth (Meter) | Rating Factor |
| 0.5 | 1.1 |
| 0.7 | 1.05 |
| 0.9 | 1.01 |
| 1 | 1 |
| 1.2 | 0.98 |
| 1.5 | 0.96 |

**Cable Distance correction Factor (K6)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No of Circuit | Nil | Cable diameter | 0.125m | 0.25m | 0.5m |
| 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 0.75 | 0.8 | 0.85 | 0.9 | 0.9 |
| 3 | 0.65 | 0.7 | 0.75 | 0.8 | 0.85 |
| 4 | 0.6 | 0.6 | 0.7 | 0.75 | 0.8 |
| 5 | 0.55 | 0.55 | 0.65 | 0.7 | 0.8 |
| 6 | 0.5 | 0.55 | 0.6 | 0.7 | 0.8 |

**Cable Grouping Factor (No of Tray Factor) (K7)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No of Cable/Tray | 1 | 2 | 3 | 4 | 6 | 8 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 0.84 | 0.8 | 0.78 | 0.77 | 0.76 | 0.75 |
| 3 | 0.8 | 0.76 | 0.74 | 0.73 | 0.72 | 0.71 |
| 4 | 0.78 | 0.74 | 0.72 | 0.71 | 0.7 | 0.69 |
| 5 | 0.77 | 0.73 | 0.7 | 0.69 | 0.68 | 0.67 |
| 6 | 0.75 | 0.71 | 0.7 | 0.68 | 0.68 | 0.66 |
| 7 | 0.74 | 0.69 | 0.675 | 0.66 | 0.66 | 0.64 |
| 8 | 0.73 | 0.69 | 0.68 | 0.67 | 0.66 | 0.64 |

***According to above detail correction factors:***

- Ground temperature correction factor (K2) = **0.89**
- [Soil correction factor](http://electrical-engineering-portal.com/determining-the-soil-resistivity-to-design-a-good-substation-grounding-system) (K4) = **1.05**
- Cable depth correction factor (K5) = **1.0**
- Cable distance correction factor (K6) = **1.0**

***Total derating factor = k1 · k2 · k3 · K4 · K5 · K6 · K7***

- Total derating factor = **0.93**

**Selection of Cable**

***For selection of proper cable following conditions should be satisfied:***

1. Cable derating amp should be **higher than full load current of load**.
2. Cable voltage drop should be **less than defined voltage drop**.
3. No. of cable runs **≥** (Full load current / Cable derating current).
4. [Cable short circuit capacity](http://electrical-engineering-portal.com/download-center/electrical-software/short-circuit-current-calculation-isc) should be **higher than system  short circuit capacity at that point**.

**Selection of cable – Case #1**

***Let’s select 3.5 core 70 Sq.mm cable for single run.***

* Current capacity of 70 Sq.mm cable is: **170 Amp**,
Resistance = 0.57 Ω/Km and
Reactance = 0.077 mho/Km
* Total derating current of 70 Sq.mm cable = **170 · 0.93 = 159 Amp**.
* **Voltage Drop of Cable =**
(1.732 · Current · (RcosǾ + jsinǾ) · Cable length · 100) / (Line voltage · No of run · 1000) =
(1.732 · 139 · (0.57 · 0.8 + 0.077 · 0.6) · 200 · 100) / (415 · 1 · 1000) = **5.8%**

***Voltage drop of cable = 5.8%***

Here voltage drop for **70 Sq.mm Cable (5.8 %)** is higher than define voltage drop (5%) so either select higher size of cable or increase no of cable runs.

***If we select 2 runs, than voltage drop is 2.8% which is within limit (5%) but to use 2 runs of cable of 70 Sq.mm cable is not economical, so it’s necessary to use next higher size of cable.***

**Selection of cable – Case #2**

***Let’s select 3.5 core 95 Sq.mm cable for single run, short circuit capacity = 8.2 KA.***

* Current capacity of 95 Sq.mm cable is **200 Amp**,
Resistance = **0.41 Ω/Km** and
Reactance = **0.074 mho/Km**
* Total derating current of 70 Sq.mm Cable = 200 · 0.93 = **187 Amp**.
* **Voltage drop of cable =**
(1.732 · 139 · (0.41 · 0.8 + 0.074 · 0.6) · 200 · 100) / (415 · 1 · 1000) = **2.2%**

***To decide 95 Sq.mm cable, cable selection condition should be checked.***

1. **Cable derating Amp (187 Amp)** is higher than full load current of load (139 Amp) = **O.K**
2. **Cable voltage Drop (2.2%)** is less than defined voltage drop (5%) = **O.K**
3. **Number of cable runs (1)** ≥ (139A / 187A = 0.78) = **O.K**
4. **Cable short circuit capacity (8.2KA)** is higher than system short circuit capacity at that point (6.0KA) = **O.K**

95 Sq.mm cable satisfied all three condition, **so it is advisable to use 3.5 Core 95 Sq.mm cable**.