



Safehouse

The power to protect

Guide to
Electric Cables



Introduction

The purpose of electric cable is to convey electrical energy from the point where it is available to a point where it is required. In order to do this safely and reliably, the cable needs certain attributes.

1. The voltage rating of the cable must be equal to, or greater than, the voltage rating of the system into which it is connected.
2. The current carrying capacity of the cable must be equal to, or greater than, the current to be carried, taking into account any applicable current de-rating factors.
3. The short circuit and earth fault rating of the cable must be greater than the prospective short circuit and earth fault currents that the electrical system may impose on the cable.
4. The cable must be compatible with, and able to withstand, the environmental conditions in which it is installed.
5. Special attention must be paid to contributing factors such as cable voltage drop and the nature of the supplied load.

Cables are made for the following voltages. 300/500 V; 600/1 000 V; 1,9/3,3 kV; 3,8/6,6 kV; 6,35/11 kV; 8,7/15 kV; 12,7/22 kV and 19/33 kV; as well as high voltage cables from 44 kV to 275 kV.

Voltage Rating

The first of the two numbers is the phase-to-earth rating, and the second number is the phase-to-phase voltage rating. Both 300/500 V and 600/1 000 V cables are the voltage ratings typically used in the wiring of domestic and small commercial installations.

Municipalities and industry primarily use 6,35/11 kV cables for the distribution of electricity. The other higher voltage ratings mentioned are less common.



Current Rating

Electric cable manufacturers publish tables of current ratings applicable to the size and type of cables they manufacture. Different current ratings apply for cables, depending on the size of the conductor, and whether the cable is installed underground, in free air, or in ducts.

These 'standard' current ratings must be modified for each unique installation by taking into account the actual conditions of installation, in particular: ambient air temperature; presence of solar radiation; number of cables and their spacing from each other; depth of cable laying; ground thermal resistivity; etc.

Standard conductor sizes are: 1,5 mm²; 2,5 mm²; 4 mm²; 6 mm²; 10 mm²; 16 mm²; 25 mm²; 35 mm²; 50 mm²; 70 mm²; 95 mm²; 120 mm²; 150 mm²; 185 mm²; 240 mm²; 300 mm²; 400 mm²; 500 mm²; 630 mm²; 800 mm²; 1 000 mm²; 1 600 mm²; 2 000 mm²; and 2 500 mm².

Short Circuit Rating

The short circuit rating of any conductor can be calculated by referencing manufacturers' brochures. Alternatively, the value can be calculated by multiplying the cross-sectional area of the conductor by the appropriate factor, which yields the one second short circuit rating.

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| <p>1. The factors for MV cross-linked polyethylene (XLPE) cable are:</p> <ul style="list-style-type: none">• Copper conductor: 143 A/mm².• Aluminium conductor: 92 A/mm². | <p>2. The factors for paper insulated lead covered (PILC) MV cables and LV polyvinyl chloride (PVC) insulated cables are:</p> <ul style="list-style-type: none">• Copper conductor: 115 A/mm².• Aluminium conductors: 76 A/mm². |
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Actual figures for any particular conductor size and fault duration are available from manufacturers' brochures.

Earth Fault Rating

The earth fault rating of an electrical cable may also be obtained from manufacturers' brochures or calculated. When calculated, the value is obtained by multiplying the cross-sectional area of the earth path by the appropriate factor. The factors are 24 A/mm² for lead sheath on PILC cables and 143 A/mm² for copper tape screen on MV XLPE cables. Actual figures are available from manufacturers' brochures.



Electric Cable Components:

Conductor

The conductor carries the current, and must be of a sufficiently large cross-sectional area to avoid the conductor overheating. The conductor may be solid circular, stranded circular, solid shaped or stranded shaped, depending on the cable specification to which it was manufactured. Copper and aluminium are metals with good electrical conductivity and this, together with other favourable attributes, makes them ideal for use in electric cables. These are the only materials specified for conductors in South African cable specifications. The conductors are critical components within the cable. Conductors are available with water blocking.

Insulation

The insulation around the conductors must exhibit high resistivity to withstand the applied voltage. It must also be able to withstand relatively high conductor temperatures before becoming soft or melting. In addition, it must be capable of being applied to the conductors using extrusion technology (paper cables are lapped not extruded). Insulation is an important component of electric cable and determines the cable's lifetime.

Bedding

Certain cable constructions require a layer of bedding under the armour layer. Its purpose is to protect the underlying components during the armouring application by providing a soft layer on which the armour can be applied without damaging the underlying cable components. It is probably the least important component within the cable, but its thickness and material quality are nevertheless stipulated in the cable specifications. Normally PVC with fire retardant properties are used.

Armouring

Armouring may consist of steel wire armour (SWA), aluminium wire armour (AWA), or steel tape armour. Galvanised steel wire has many advantages over steel tape and is most commonly used. The armour minimises damage to and protects the underlying components from external impact. Importantly, SWA provides the cable with better tensile strength, which is important if ground movement is likely to occur.

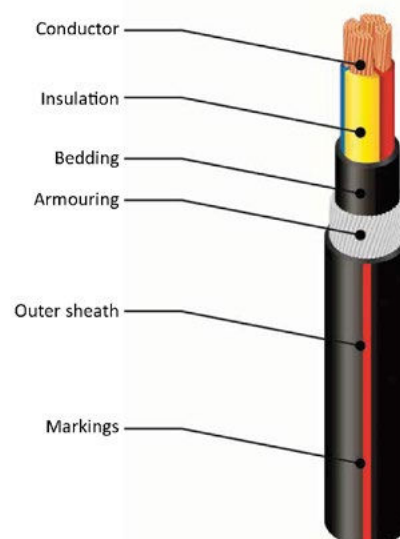
Outer sheath

The cable outer sheath protects it from ingress of moisture and provides overall mechanical protection: weather, chemical and electrical. PVC is commonly used and is satisfactory for most applications. Where the cable is to be installed underwater or in marshy land, medium density polyethylene (MDPE) is often specified because of its superior radial water blocking advantages and its toughness.

Marking

All national and international electric cable specifications call for certain markings on the cable outer sheath. At the very least, this should include the manufacturer's name; the specification to which the cable is manufactured; a description that includes the number of cores; and the voltage rating of the cable. Where large orders are negotiated with the manufacturer, it is possible to include conductor size and even metre-by-metre marking along the length of the cable. Sometimes the cable marking may include 'Property of ...' or a contact number to assist in the event of the cable being stolen. On request, unique conductor markings can be printed on cables that carry a risk of theft.

In many respects, the outer sheath is the most important component of the cable. It keeps water out of the cable, thereby assuring a longer life span and fewer problems during operation.





Different types of **low voltage electric cable**



Low friction single-core general cable/housewire.



PVC single-core flexible panel wiring cable.



HRQ high temperature insulation wire (105 C) cable.



Cabtyre flexible cable.



Audio flexible cable (rip-cord).



Illumination flexible wiring cable (Maconite).



PVC single-core general purpose housewire.



Flat twin and earth.



Surfix.



Submersible pump cable green (four-core)



Submersible pump cable blue (three-core)



Nitrile trailing cable.



PVC nitrile welding cable.

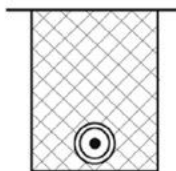


EPM/CM or EPM/CR welding cable.

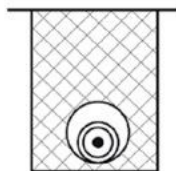


Low voltage three- and four-core SWA cable.

Standard **Cable Installations**

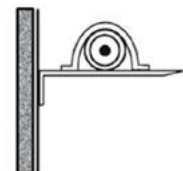
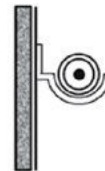


Cable in trench



Cable in sleeve/pipe

Cable on ladder





Who polices the electric cable industry in South Africa?

The Association of Electric Cable Manufacturers of South Africa (AECMSA) represents the interests of consumers and manufacturers.

The South African Bureau of Standards (SABS) sets the National Standards and also operates a voluntary product certification scheme for these products, which ensures continued compliance of SABS certified products. The National Regulator for Compulsory Specifications (NRCS) sets local compulsory specifications for some cable types and carries out market surveillance inspections to monitor compliance.

The policing of standards was not being carried out effectively and this led to the formation of Safehouse to ensure that products supplied in South Africa comply with applicable standards.

Compulsory specifications for South African electric cable

SANS 1507: Low voltage PVC and XLPE insulated cables (includes armoured cables).

SANS 1574: Flexible cores, cords and cables, including panel wire, cabtyre and ripcord.

SANS 1418: LV aerial bundled conductors.

SANS 1520: Rubber insulated cables. Parts 1 and 2 cover LV and MV respectively.

SANS 97: Paper-insulated metal sheathed cables up to 33 kV.

SANS 1339: XLPE insulated cables up to 33 kV.

SANS 182: Overhead line conductors.

There are many other specifications, however the above are most commonly used.

SANS 1576: Welding cable (voltage rating 100 V) is not compulsory.



Other locally manufactured **electric cable products**

This brochure covers only some of the low voltage electric cable products. Reputable local manufacturers make a full range of low voltage, medium voltage and high voltage cables and accessories, which include

- 1.9/3.3 kV three-phase four-wire low cost cable.
- House service connection cable.
- Silicone rubber insulated cabtyre and other cables.
- Ranges of fire performance cables.
- Aerial bundled conductors (ABC) rated from 600/1000 V up to 19/33 kV.
- Rubber insulated flexible trailing cables from 300/500 V up to 19/33 kV.
- Overhead lines, including ACSR, AAC, AAAC.
- Medium voltage paper insulated and lead covered cables (PILC).
- Medium voltage cross-linked polyethylene (XLPE) insulated cables.
- High voltage XLPE cables (44 kV to 275 kV up to 2500 m²).
- Renewable energy (Solarflex) cables.
- Locomotive and rolling stock rail cables.
- Anti-theft cable solutions.

What to look for when buying cable

- Does the cable carry the SABS mark? Is a SANS standard indicated on the cable?
- Is the manufacturer's name on the cable? Do you recognise the manufacturer's name?
- Is the Safehouse logo on the packaging?
- Does a visual inspection of the cable reveal defects such as inconsistent radials, rough surfaces, bulges on the sheath, and other irregularities that are a cause for concern?
- Does the cable contain copper coated steel in the conductor? As copper is not magnetic, a simple test using a magnet can reveal the presence of steel.
- Does the cable feel too light for its diameter or does the price of the cable seem 'too good to be true'? This is more common in cabtyre (extension leads) when copper clad aluminium has been used.



Examples of substandard cables being sold in South Africa

Copper coated aluminium and steel passed off as pure copper: Typically cable size corresponds approximately to the measured physical cross-sectional area, but the resistance would be much higher. The cross-sectional area is only nominal and the important property associated with a particular size is its electrical resistance, on which its current rating is based. For example, it is not necessary for a 2,5 mm² cable to have a physical cross-sectional area of 2,5 mm², but it is essential that its electrical resistance does not exceed 13,3 Ω/km at 20 °C.

Alloys, such as brass, used instead of pure copper: This is important for the same reasons as above. Also the cables can end up being much stiffer, making some domestic jointing practices in common use in South Africa quite dangerous.

Incorrect size: This has not yet been seen in South Africa but we should be aware of it. In countries where there is little control, it has been found that cables are marked one size bigger than they actually are. The sting in the tail is that any supplier who chooses to actually supply the correct sized cable is priced out of the market, so the situation persists.

Undersized insulation radials: With low voltage cables, including flexible cables, the dielectric properties of the insulation are not as important as the physical separation they create between live conductors and their surroundings. This is because the electrical stress that the insulation is subjected to is usually much lower than the material is capable of withstanding. However, a thinner radial is more likely to be damaged during normal domestic use, exposing users to the possibility of electrocution or fire.

Cheap insulation compounds: Most small cables for domestic use are insulated with PVC-based compounds. PVC readily accepts fillers and additives required for properties such as flexibility, insulation resistance, UV-resistance, and colour. However, unscrupulous manufacturers cheapen products by increasing filler loadings, resulting in a loss of physical and electrical properties. Be aware of insulation that strips too easily or that becomes brittle when exposed to sunlight.

Cable sheaths: The sheaths of cables for domestic use are usually made from PVC compounds and physically protect the cable cores; however, as sheaths are made to slightly different standards, they can also be cheapened detrimentally.



About Safehouse

Safehouse is a non-profit organisation that protects South African businesses and people from preventable harm caused by unsafe electrical products and services.

We're a voluntary group of electrical industry stalwarts, technical experts and leaders of our respective businesses and fields. We believe it's our civic and commercial duty to protect our industry and fellow South Africans from suppliers of unsafe electrical products and services.

We work to eradicate dangerous products from the market, to make electrical safety information understandable and accessible and to hold one another, and our industry, to the highest standards of excellence.

Safehouse members have signed a code of conduct that commits them to dealing only in safe electrical products and to responsible behaviour.

If you have doubts about a particular product or service, contact Safehouse for guidance.

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