Terms from the world of cables

Absence of halogen

Halogen-free cables are without any halogens with regard to the composition of the plastic materials. Materials used at SAB as for example SABIX®, Besilen®, Polyethylene, Polypropylene and other thermoplastic elastomer compounds (TPE) do not contain any hazardous stabilisers that contain heavy metals or plasticisers. The additives for flame protection (if existent) are ecologically without any risk. Many of the halogen free SABIX® (PO-base) compounds used at SAB do not develop any corrosive and toxic gases in case of fire and avoid a strong smoke emission. They have a very good flame protection and prevent fire propagation. The absence of halogen for plastic materials used in cable industry are tested according to standard IEC 60754-1 (DIN EN 60754-1, VDE 0482-754-1). During the test the content of hydro halogenic acid is determined. In order to designate a material as halogen-free according to standard, the proportion of hydro halogenic acid must be smaller than 0,5%.

Adhesive (smooth, sticky, adhesive)
Low adhesion (sliding, rough, not sticky, non-adhesive)

Adhesive force is called the attraction of particles of different materials and compounds. Adhesive forces act for example between wall and colour or chalk and board. The forces can be very different dependent on the material. Adhesive (smooth, shiny) surfaces of plastic materials can for example attract dust from the air. Within the range of cable chain cables matt surfaces of the outer sheath with low adhesion are very important in order to ensure a gliding of the cable in the energy chains.

Bending radius and minimum bending radius

The **bending radius** is the radius with which the cable can be bent without any damage or deterioration of function. The smaller the bending radius the higher the necessary flexibility of the cable respectively the constructional demands on the cable.

Types of minimum bending radius:

unique bend	the cable is installed permanently. The product remains permanently in the same position (for example wiring of a switchboard).
fixed laying	the cable or core is permanently installed. After removal the product can be installed again at another place.
flexible application	the cable or core is used in flexible application without forced movement control (for example as connection cable of a control panel).
permanent flexible application	the cable or core is exposed to forced movement control (for example the application in cable chains or guided over deflection pulleys).

Notes:

- Cables or cores are not allowed to be bent directly after the plug or the crimping area.
- Cables or cores are not allowed to be bent in a smaller bending radius than recommended. The single wires of the conductor could be compressed or stretched and finally break.
- Cables or cores are not allowed to be guided over sharp edges. Besides the breaking of the wires there is the danger that the insulation is damaged and thus the product is not safe for humans and machines any more.

Calorific value

The specific calorific value (Hi) indicates how much energy is released in case of the complete combustion of a material. In general the calorific value is indicated in MJ/kg or kWh/kg.

Approximate values for calorific value:

FEP, ETFE, PFA:	approx. 1-2 kWh/kg
SABIX® (PO-Basis)	approx. 3-5 kWh/kg
Besilen®:	approx. 4-5 kWh/kg
PVC:	approx. 5-7 kWh/kg
PUR:	approx. 7-9 kWh/kg
PE/PP:	> 12 kWh/kg

Corrosiveness of conflagration gases

Halogenated plastic materials release corrosive gases in case of fire. PVC for example releases hydrogen chloride gas that forms together with humidity hydrochloric acid. Hydrochloric acid is extremely hazardous for the respiratory tract. As an electrically conductive substance it can cause short circuits, attack metals and destroy appliances. The corrosiveness of conflagration gases of plastic materials used in cable industry is tested according to standard IEC 60754-2 (DIN EN 60754-2, VDE 02482-754-2). During this test the pH value and the conductivity are determined by burning the material and washing it out. The standard is fulfilled if the pH value is >4,3, and the conductivity < 10µS/mm. Materials containing halogens do not fulfil this requirement.

EX area

The EX area is a so called „area subject to explosion hazards" is a special case of electrical applications. Due to the occurrence of flammable substances in air (gases, liquids or dust) an explosive mixture can develop. In case that sparks are created by electric equipment, the consequences are possibly disastrous. Therefore, we know different measures to avoid this.

Most of these measures are related to application: transitions where sparks can arise are separated from environment by protection gas, pressure or additional enclosure.

For cables the requirements are limited: first of all the cable construction shall avoid easy damage. Furthermore, they have to be round and compact so that they withstand a sealing process. In case that you connect EX areas with areas that are not subject to explosion hazards it has to be ensured that flammable material can't be transported through the interior of the cable (gas tight).

A special form are the so called intrinsically safe circuits: here it is calculated how much electrical energy in the operating components and cables is stored by capacities and inductivities. The released energy due to a short circuit or interruption shall not be sufficient to create ignition sparks. With the help of of capacity optimisation an adaptation to demanded insertion length can be reached.

The areas are classified by the kind of hazardous material (gas, liquid or dust) and how often the danger arises (division or zone: always, regularly or in case of a failure). Primarily the requirements on the protection class of application result thereof. This has got only indirect influence on the cable itself.

Terms from the world of cables

FRNC, LSHF, LS0H/LSZH

Frequent descriptions for cables with insulation and sheath materials with improved burning characteristics in cable industry are:

LS0H/LSZH	low smoke, “0” (zero) halogen / low smoke density , halogen free
LSHF	low smoke, halogen free / low smoke density, halogen free
FRNC	flame retardant, non corrosive / flame retardant, halogen free

We recommend to check the whole data sheet. Therein you will find the corresponding indications which details of the standard are fulfilled.

Halogens

Elements as for example fluorine, chlorine, bromine, iodine, and astatine are halogens and are to be found in the 7th main group of the periodic table of elements. They are contained in many chemical compounds and plastic materials, chlorine for example in Polyvinyl chloride (PVC), fluorine in Fluoro Ethylene propylene (FEP). Halogens are added to plastic materials in order to improve for example their flame protection characteristics. In case of fire, however,such halogens release corrosive and toxic gases and cause considerable smoke emission. Halogenated gases can form strongly corrosive acids in combination with extinguishing water or humidity. These characteristics can be hazardous to health for humans and animals. Furthermore, machine components can be damaged permanently by corrosion.

Screening

Screening means a constructive characteristic of a cable that shall avoid radiation impacts from outside or the emission of signals from the cable itself.

Different screening techniques have various advantages and disadvantages:

Foil screens are light and made of comparatively cheap material that increase the cable diameter only insignificantly. They show a low conductivity compared with other cable conductors. Primary a foil screen is applied with low disturbances. As such a screen covers the cable 100 % in case of an appropriate production they are very effective with high frequencies (GHz). In case of mechanical stress however, this construction type is prone to wear.

Metal wire shields are braided around the cable by counter rotation with the help of special machines and multiple wire bundles, the so called folding. The resulting cable section shows the highest conductivity compared to all screening types and therefore, is especially appropriate for high disturbance energy. At the intersections of the wire bundles (folding) gaps occur that limit the effectiveness with high frequencies (>100 MHz). Equally high torsional stress causes restrictions for the braiding of the folding.

Wrapping with metal wires is simply a “half braiding”. The copper wires are wrapped in one direction around the cable. In this way only a smaller section results compared with a metal braiding. As there is no overlapping, there is a higher flexibility for torsional applications. In case of high alternating bending stress however, gaps between the wires may occur more easily than the intersections of a braiding allow.

A f**iller** as wire or strand is a conductor that is in electric contact with the screen along the cable core. First of all it is used to contact the screen more easily as it is more difficult to contact foil screens with the help of usual connection techniques and second it is used if the wrapping or braiding shall be connected to a pin contact of a plug.

Furthermore, there are still other screening types that are used less frequently: foils made of magnetic materials (µ-metal) are especially effective with strong magnetic fields. Metallised nonwoven tapes reduce the wear of foils but have a small conductivity themselves. Most of the mentioned measures can be combined. Moreover, all of them offer adjustment options with regard to construction details or production processes to the required shielding effects and mechanical stress.

Smoke density

In case that cables burn smoke develops that may for example impede the rescue of persons in the fire zone. The smoke density is tested acc. to standard IEC 61034 (DIN EN 61034, VDE 0482-1034). The test is executed in a defined room size by fixing the cables over a tub filled with burning alcohol. The light transmission between the lamp and a photocell is not allowed to be subdued more than a prescribed value during the test period.

Voltage

An important value for the application of a cable is the voltage rating. Depending on the cable application however, there are different voltage ratings that are not always interchangeable among each other.

For classic applications at an AC voltage source mostly the **effective value** (U_{eff}) is indicated. Due to the alternating voltage curve this value corresponds to the load that a constant direct voltage would apply. The max. **peak voltage** is almost 50 % higher. The English term for the effective value is “RMS” for “Root-Mean-Square” that indicates the calculation of the mean value.

Peak operating voltages are mostly indicated for not periodical applications as for example data cables -analogue or digital-. For cables that are only short term highly loaded so that the indication of the effective value or regularly occurring peak voltages do not make sense, either application-related indications are made (for example the **“ignition voltage”** of cables for gas discharge lamps) or the **“test voltage”** used during production in order categorize the performance capability of a cable. Both indications reflect only short term load in the service life of a cable and therefore, are mostly higher with the same insulation than the indications of permanent load as for example peak voltage or RMS value (root mean square).

Another important aspect is the voltage towards environment (“earth”, “mass”) or towards other conductors. Towards environment there is only one effective insulation layer, against the second conductor, however, two layers. Therefore, the indication core/core (U) is mostly higher than core/mass (U_0). The classical examples are here three phase current systems for which the phase shift of voltage on the conductor of 120° leads to the fact that an alternating voltage between the cores occurs that is exactly the factor √3 higher than the voltage of the conductor against mass.

Terms from the world of cables

Acc. to standard VDE 0298-3 the following interrelations result for “the highest permanently allowed **operating voltage** $U_{b,max}$” under consideration of load reserves:

nominal voltage	highest permanently allowed operating voltage $U_{b,max}$			
U_0/U [V]	AC conductor/ earth [V]	AC conductor/conductor [V]	DC conductor/ earth [V]	DC conductor/conductor [V]
230/400	254	440	330	660
300/500	318	550	413	825
450/750	476	825	619	1238
[kV]	[kV]	[kV]	[kV]	[kV]
0,6/1	0,7	1,2	0,9	1,8
1,8/3	2,1	3,6	2,7	5,4

UL voltage alues always refer to the highest effective system voltage. In DC and AC systems this is U_0, in three phase current systems U.

The following diagrams shall give an impression of the different indications:

Three phase current systems