
# HIGH VOLTAGE CABLES WITH EXTRUDED CORRUGATED ALUMINIUM SCREEN

Design
Available options
Advantages and disadvantages
Manufacturing process

TELE-FONIKA Kable S.A. PRODUCT BROCHURE

Over the last 20 years TELE-FONIKA Kable S.A. established itself as a global leader in the high voltage systems market - supplying cable to more than 200 projects in over 40 counties around the world.

TELE-FONIKA Kable provide the highest quality and most durable cables, it's advanced designs offer the most efficient solution as part of the overall cable system.

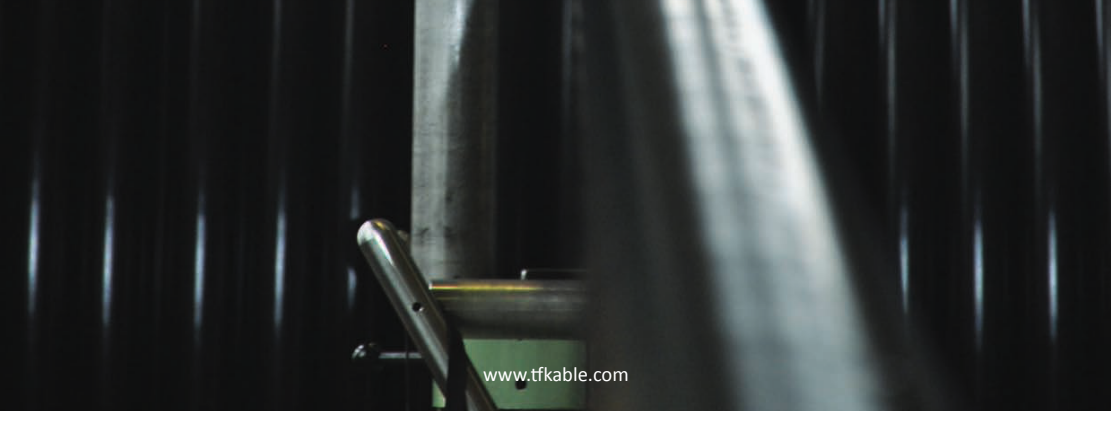
This can only be achieved through a continual process of innovation and development. By combining our knowledge in the field with detailed analysis of current market requirements, we are always one step ahead by investing in the latest manufacturing technology.

It is through this process of innovation that TELE-FONIKA Kable identified a need in the marketplace for a modern alternative to lead sheathed high voltage cables. The use of lead as a screening material has a long history in many countries, but it is a heavy material which adds to installation complexities and it's toxicity has environmental issues.

The aluminium sheathed cables currently marketed as an alternative to lead use the 'Fold and Weld' process, this includes a longitudinal welded join throughout the cable length. Concerns have been raised about the integrity of this weld as no IEC or British Standard protocols exist to prove the strength of the join. TELE-FONIKA Kable realized there was need in the High Voltage market for a more robust alternative to lead.

TELE-FONIKA Kable response to this challenge is the launch of an Extruded Corrugated Aluminium Sheathed high voltage cable utilising SheathEx™ technology. Extruded aluminium sheathed medium voltage utility cables has a proven history of reliability in the UK since the 1970's, TELE-FONIKA Kable have enhanced this process for high voltage cables.

TELE-FONIKA Kable investing in the manufacturing methods of the present and now the energy efficient SheathEx™ Extruded Corrugated Aluminium Sheathing technology of the future!



# EXTRUDED ALUMINIUM SHEATHS - MODEL


**conductor**
High purity compacted stranded copper or aluminium.

**Extruded semi-conducting conductor screen**
Ensures a uniformly stressed interface with the insulation.

**insulation XLPE**
Nitrogen dry cured XLPE dielectric.

**Extruded semi-conducting insulation screen**
Ensures a uniformly stressed interface with the insulation.

**semi-conducting swelling tapes**
Provides a water barrier to prevent the longitudinal propagation of water.

**metallic corrugated sheath: Extruded Aluminium**
Prevents the radial ingress of moisture.

Corrugated sheath profile in combination with the water swellable tapes prevents longitudinal propagation of water.

Protect cable core against mechanical damage.

Conducts capacitive charging current to ground in normal operation and short circuit currents in the event of a fault.

**Bituminous tapes**
Provides additional corrosion protection of the aluminium layer in the event of localised mechanical damage.

**outer sheath**
Provides protection of the metallic screen. There are options for the composition of the sheath depending on the intended use includes resistance against fire, oils, termites, and rodents.

Also a semiconductive layer can be applied to the outer sheath if required; this can be extruded coating or graphite depending on preference.

# WHAT CABLE SCREEN OPTIONS ARE AVAILABLE

There are various terms used to describe the metallic barrier on a high voltage cable: 'Metallic Sheath', 'Cable Screen', 'Return Conductor'. These terms all describe the metallic layer that concentrically surrounds the cable core.

There are the following types of cable screens:

- Extruded aluminium
- Longitudinally welded aluminium
- Extruded lead
- Laminated foil screen with copper wire bonded to the cable sheath.

The above-types of screens are accepted by the main international standards IEC 60840, HD 632 or British BS 7912.

# ADVANTAGES AND DISADVANTAGES OF DIFFERENT CABLE SCREENS

| | Advantages | disAdvantages |
|---|---|---|
| tFK Corrugated Extruded aluminium | Low cost<br>Proven usage history<br>Good conductivity<br>Low weight<br>Longer pulling in lengths<br>Lower shipping costs<br>Good environmental properties<br>High crush resistance<br>Continuous extrusion- so no weld or overlaps<br>Long lengths | Larger Cable Diameter |
| Aluminium Foil + Copper wire | Good conductivity in copper wires<br>Good environmental properties<br>Possibility of manufacturing long lengths<br>Proven usage history in Europe | Adhesive foil seal can fail<br>Low usage in some countries<br>Short circuit carried by copper wires rather than foil covering |
| Lead screen | Good corrosion resistance<br>Long service history<br>Continuous extrusion- so no weld or overlaps | Very Heavy Material<br>Poor conductivity<br>Bad material for environmental concerns<br>High production costs<br>Can crystallize and crack over time |
| Welded aluminium | Low cost<br>No requirement for hot tooling<br>Lightweight material | No established tests to certify the reliability of weld<br>Weld bead formed on sheath<br>Large bending radius.<br>Increased shipping and installation costs.<br>If welded corrugated-design - the corrugations are added after the weld increasing strain on weld bead.<br>Limited sheath thickness |

# EXTRUDED ALUMINIUM SHEATHS – MANUFACTURING PROCESSES

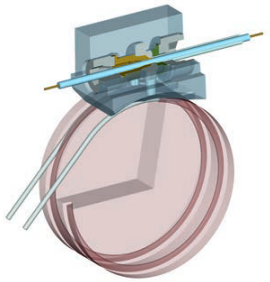
## HYDRAULIC PRESS

In the past, the method of producing extruded aluminium screens was by a hydraulic press. Aluminium ingots were fed into the press, preheated, then huge pressure exerted to extrude flowing aluminium onto the cable.

This was a very expensive process and consumed vast amounts of energy.

There were limitations on cable lengths using this process, also risk of heat damage when process stops to refill with aluminium ingots.

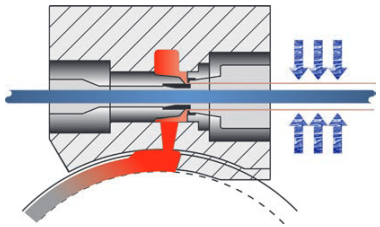
## CONFORM PROCESS



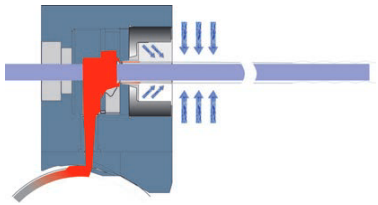
The Conform™ process is a far more efficient method of extruding aluminium sheaths onto cable.

This process relies on a combination of frictional heat generated by the rotating wheel and a heated die chamber.

Revolving wheel takes aluminium rod into the peripheral grooves.



Aluminium rod is fed into the die chamber by way of peripheral grooves. There is an abutment in the grooves that forces the aluminium to flow plastically into the heated die chamber. The plastic state metal flows into the die chamber and out through an over sized die.



The Extruded tube of aluminium is rapidly cooled immediately after the die to prevent heat damage to the cable.

Extruded aluminium tube is corrugated inline as part of the continuous process.

* Conform and SheathEx graphics reproduced by permission of BWE Ltd.

## COMPARISON OF PHYSICAL AND ELECTRICAL PROPERTIES OF 1000 mm² COPPER CONDUCTOR 76/132 kV CABLE WITH AN EXTRUDED CORRUGATED ALUMINIUM SHEATH, AN ALUMINIUM FOIL WITH COPPER WIRE AND A LEAD SHEATH WITH COPPER WIRE.

| Description | Properties | type of cable metallic screen | | |
|---|---|---|---|---|
| | | Cu wire + AL foil | Cu wire + Extruded Pb | Extruded corrugated AL |
| | | 2Xs(FL)2Y | 2Xs(F)K2Y | 2X(F)KLd2Y |
| Cable details [mm] | Conductor diameter (mm) | 38.2 | | |
| | Insulation thickness (mm) | 15.0 | | |
| | Diameter over insulation (mm) | 70.8 | | |
| | Quantity x diameter of Cu wire (mm) | 90 x 2.20 | 72 x 2.2 | - |
| | Lead layer thickness Pb (mm) | - | 3.0 | - |
| | Aluminium layer thickness Al. (mm) | - | - | 2 |
| | Cross-section of metallic screen (mm²) | 335 + 54Al | 270Cu + 750Pb | 520 |
| | Outhersheath thickness (mm) | 3.8 | 4.0 | 4.2 |
| | Diameter (mm) | 87.5 | 94.0 | 99.6 |
| | Cable weight kg/m | 16.40 | 24.80 | 15.90 |
| | Bending radius | 25 x De | | |
| | Example packing lengths/drum flange | 900m/34<br>1200m/37<br>1500m/40 | 400m/34 | 650m/34<br>850m/37<br>1100m/40 |
| Cable screen properties | Screen short ciruit kA/s | 40.0kA/3s | | |
| | Screen resistance Ω/km | 0.050 | 0.055 | 0.053 |
| | Weight of metalic screen kg/m | 3.31 | 2.80Cu + 9.13Pb | 1.87 |
| Current Rating [A] | Bonding type | Single point bonding / Both end bonding | | |
| | Underground – flat | 1210/760 | 1216/754 | 1159/753 |
| Screen losses $\lambda_1$ | Screen losses $\lambda_1$ | 0/2.200 | 0/2.3600 | 0/2.3600 |
| | Sheath losses | 0/33.27 | 0/34.93 | 0/23.21 |
| | Total losses – per phase | 38.83/48.36 | 39.71/49.74 | 39.90/38.17 |
| sheath loses [W/m] | Induced voltage | 113.6/--- | 117.1/--- | 146.0/--- |
| | Sheath current | ---/667 | ---/467 | ---/620 |
| | Underground - trefoil | 1083/830 | 1085/829 | 999/822 |
| total loses [W/m] | Screen losses $\lambda_1$ | 0/0.900 | 0/0.963 | 0/0.9850 |
| | Sheath losses | 0/17.05 | 0/18.02 | 0/18.00 |
| | Total losses - per phase | 33.21/36.00 | 33.88/36.73 | 34.25/36.49 |
| induce voltage [v/km] | Induced voltage | 54.9/--- | 57.1/--- | 54.8/--- |
| | Sheath current | ---/536 | ---/513 | ---/516 |
| | Air - flat | 1656/1176 | 1675/1181 | 1568/1155 |
| sheath current [A] | Screen losses $\lambda_1$ | 0/2.1700 | 0/2.3200 | 0/2.3100 |
| | Sheath losses | 0/78.38 | 0/84.45 | 0/53.84 |
| | Total losses - per phase | 72.88/114.5 | 75.38/120.8 | 72.58/115.27 |
| | Induced voltage | 155.6/--- | 161.2/--- | 196.9/--- |
| | Sheath current | ---/1030 | ---/731 | ---/958 |
| | Air - trefoil | 1423/1166 | 1443/1182 | 1333/1158 |
| | Screen losses $\lambda_1$ | 0/0.9040 | 0/0.9680 | 0/0.9900 |
| | Sheath losses | 0/33.79 | 0/36.84 | 0/35.91 |
| | Total losses - per phase | 57.35/71.17 | 59.97/74.90 | 61.00/72.38 |
| | Induced voltage | 71.8/--- | 76.1/--- | 72.7/--- |
| | Sheath current | ---/760 | ---/732 | ---/738 |

Calculated with CymCap 5.3 based on IEC Pub. 60287 and the following conditions: Ground temperature 20°C, Ground thermal resistivity 1.0 K*m/W, Laying depth 1.2m, Air temperature 35°C

## WHY CHOOSE AN EXTRUDED CORRUGATED ALUMINIUM SCREENED CABLE?

- LIGHTWEIGHT – HV cables with extruded corrugated aluminium screens are less weight compared to other types of metal screens, this reduces transportation costs and makes the cable easier to install.
- ELECTRICAL PERFORMANCE - extruded corrugated aluminium screen is characterised by high electrical conductivity capable of carrying higher short circuit currents.
- NO NEED FOR COPPER WIRES – due to the superior electrical performance of extruded corrugated aluminium screens it is not necessary to add copper wires under the screen to carry high fault current requirements. Even the highest UK short circuit requirement of 40 kA for 3 seconds can be easily carried by an aluminium screen of 2 mm thickness. (see table above)
- BENDING RADIUS - The corrugations in the extruded aluminum sheath offer a tighter bending (typically 25 x cable diameter) compared to smooth welded aluminium cable (35 x cable diameter).
- DURABILITY - Aluminium has excellent mechanical properties including hardness and fatigue resistance compared to lead sheath cables. Aluminium offers superior resistance to vibration and movement caused by mechanical thrust and thermal cycles encountered during current loading transients.
- LESS ENVIRONMENTAL IMPACT – Aluminium is a clean metal, both in the manufacturing process and for continued installation, whereas lead is considered a hazardous substance by the EU's RoHS directive 20002/95/EC.
- PROVEN RELIABILITY – Extruded aluminium sheathed medium voltage cables were produced in the UK from the 1970's until the early 21st Century. Promoted as the latest sheathing solution, thousands of kilometers are still in continuous service, proving the long term reliability of the design.
- LATEST TECHNOLOGY - The closure of many UK manufacturers meant extruded aluminium sheathed cables disappeared from the market... until now!
  TFK are offering the same proven reliability but with an improved and more efficient method of production.

## ACCEPT NO IMITATIONS!

Some manufacturers are offering an aluminium sheathed cable that have been corrugated after welding. This is not the same product. TELE-FONIKA Kable S.A. offer a SEAMLESS aluminium sheath where the corrugations are formed as part of the extrusion process whilst the aluminium is in a molten state.

**A STRESS FREE DESIGN FOR A STRESS FREE INSTALLATION!**

www.tfkable.com

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Edition II