Content

I. ABB Cable Accessories Products Introduction
   - MV Product Introduction
   - Overview of MV CA Joint & Termination

II. MV Cable Accessories
   - Technical background of MV Cable Joint & Termination
   - Standard & Type testing MV Cable accessories
   - Field Problem & Solution
   - Products Demo
CA Full Portfolio, 1–420 kV

12 24 36 42 52 72 84 123 145 170 245 300 362 420 kV

Medium Voltage  High Voltage  Extra High Voltage
ABB Cable Accessories 1-420kV

- Medium voltage products 6-42kV
- Reliable junctions in power cable networks.

- Locality Alingsas, Sweden
- Cable accessories 1-420kV
- Manufacture, Design, management, marketing

“We will provide the integrated solution, to make the safe electrical connection”
CA Full Portfolio, 1–420 kV
First in The world HVDC 520 KV-Up to 2,500 MW

Figure 6. Type testing of the 525 kV extruded HVDC cable system.

Figure 5. Extruded HVDC cable termination.
CA Full Portfolio, 1–420 kV
First in The world HVDC 520 KV-Up to 2,500 MW

Figure 2: New HVDC prefabricated joint after installation in a land cable system.

Figure 3: Typical ABB HVDC prefabricated joint design with a FGM layer. The joint can simply slide over the cable.
12-42kV MV CA Portfolio

- Terminal
  - Indoor terminal (CSTI/SOT)
  - Outdoor terminal (CSTO/SOT)

- Joint
  - (CSJ/SOJ)

- Connector
  - Unscreened connector
    - KAP
  - Screened connector
    - CSE-A/B

© ABB Group
March 8, 2016 | Slide 7
CA Application-Cable Termination
Fully Insulated
Terminations installation
CST 12-42 kV

12kV

24kV
Cable Terminations
CST 12-42 kV

- Termination for XLPE-insulated cables with Al- or Cu-conductors, 12-42 kV.
- Indoor and outdoor applications.
- Design
  - Rubber sleeve with integrated electrical field control and top sealing.
  - Good Hydrophobicity and pollution withstand, no electric contact for the high humidity.
  - Integrated sheds of short / long type for extended creeping current distance;
  - Outdoor termination kits for 3-core cables include crutch seal and protective hoses.
  - Supplied in single- or 3-phase kits.

For outdoor terminations: Integrated sheds of short / long type, flat for optimal usage
  - 24 kV: 4 pcs
  - 42 kV: 4 pcs

SOT meets the requirements of:
- SS 424 14 45 Edition 1
- CENELEC HD 628.1 S1 and HD 629 S1
- IEEE 48 1996
- GB12706.4

© ABB Group
March 8, 2016 | Slide 11
Cable Terminations
CST 12-42 kV

1. Seal the cable lug and body with silicone self-adhesive tape.
2. Flexible silicon rubber, anti-UV, anti-aging.
3. Use stress cone to control stress.
4. Seal the gap between the body and cold shrink tube with self-adhesive tape.
Cable Terminations
CST 12-42 kV

Silicone rubber

Refractive stress control

One Piece design with Integrated sheds

© ABB Group
March 8, 2016 | Slide 13
Cold shrink Joint
CSJ structure

- **Outer semi-conductor**: 2mm thick, premoi ded structure, high-quality imported materials, reliable shielding effectiveness.
- **Inner screen**: 3mm thick, enough length to cover the connecting pipe, high-quality imported materials, reliable shielding effectiveness.
- **Stress cone**: Use finite element analysis software to smooth the stress curves, and decrease the electric field intensity.
- **Insulator**: 12mm thick, premoi ded structure, high-quality imported materials, no gas bubble or delamination between the inner and outer layer.
- **Spiral plastic strip**: Self-locking structure. Completely avoid defects such as cracking, dropping of chips, and brittle fracture.
Simple design, simple installation

- One-piece joint design makes easy installation available

- Others joint with stress-control mastic applied over the cable insulation. It leads to a more difficult installation
Simple design, simple installation

- Support core is formed by a spiral tape. It is easy to be installed. (No special tool)

- For plastic cylinder core without spiral tape, the installation would be more difficult (Special tool is needed)
Cold shrink Joint

Water protect test
- GB/T 12706.4 -2008
- IEC 60502
Separable Connector Configurations

250A Elbow

250A Splice

400A / 630A T-Body
Screened Separable Connectors
CSE-B 630

1. Insulating plug in epoxy with brass cover.
2. M16 bolt for connection to bushing.
3. Screw cable lug.
5. Stress grading adapter.
6. Outer conductive layer, UV-, Ozone- and tracking resistant.
100% routine test

$U_m$ 36 kV
- Pd-measurement maximum 5 pC at 31 kV.
- AC-test 81 kV for 1 minute.
- Visual inspection.

$U_m$ 42 kV
- Pd-measurement maximum 5 pC at 45 kV.
- AC-test 117 kV for 1 minute.
- Visual inspection.
Pre-molded screened separable connector
CSE-B 630

- DESMA injection machine and ABB robotics are involved in production line
Connector Compare of ABB VS Others

Dimension

- ABB has Rear Connector
  - ABB
- Competitors has not rear connector and need middle tube

- Small size
  - Front, Front+Rear, Front+SA
Pre-molded screened separable connector dimension

- CSE-B630
- CSC630
Pre-molded screened separable connector
CSE-SERIES 630

- Front connector
- Rear connector
Screened Separable Connectors
CSE-B 250

1. Pin contact with integrated conductor connection.
2. Bail restrain for fixing to the bushing.
3. Capacitive measuring point covered with a conductive hood - touch proof.
4. Conductive layer creates Faraday´s cage.
5. Outer conductive layer, UV- Ozone- and tracking resistant.
6. Stress grading adapter
Screened Separable Connectors

CSS-B 250

1. Pin contact with integrated conductor connection.
2. Capacitive measuring point covered with a conductive hood - touch proof.
3. Conductive layer creates Faraday’s cage.
4. Bail restrain for fixing to the bushing.
5. Outer conductive layer, UV- Ozone- and tracking resistant.
6. Stress grading adapter.
Cable cabinet with possibilities to joint and T-off 12 / 24 kV XLPE-insulated cable above ground.

- (HDC 250) Kits include material to connect 3 cables.
- (HDC 630) Base kit include material to connect 2 cables.
  - To connect a third (or fourth) cable PC 630 with SOC 630 alternatively PC 630/250 with SOC 250 should be used.
- Possible to disconnect optional cable for earthing or sectional voltage.
- The cables are fastened with universal clamp UKR 90 in anchor bars in the cabinet.

Kabeldon distribution cabinet 12 – 24 kV, HDC
Cable Joint & Termination

LMK Type Test Report

Termination

Cable Joint
Part 2 – MV Cable Accessories

- Technical background of MV Cable Joint & Termination
- Standard & Type testing MV Cable accessories
- Field Problem & Solution
- Products Demo
Technical background of MV Cable Joint & Termination

- Medium Voltage Cable

3 – Core Cable

1 – Core Cable
Main Insulation (material)

- PILC (*Paper Impregnated Lead Covered*)
- PVC (*Polyvinyl Chloride*)
- PE (*Polyethylene*)
- XLPE (*Cross Linked Polyethylene*)
- EPR (*Ethyl Propylene Rubber*)
## Conductor - Materials

### Material properties:

<table>
<thead>
<tr>
<th></th>
<th>Copper</th>
<th>Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Cross section</td>
<td>100%</td>
<td>156%</td>
</tr>
<tr>
<td>Weight</td>
<td>100%</td>
<td>47%</td>
</tr>
<tr>
<td>Conductivity (m/Ohm/mm²)</td>
<td>56</td>
<td>36</td>
</tr>
<tr>
<td>Spec. weight (g/cm³)</td>
<td>8.9</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Technical background of MV Cable Joint & Termination
MV Cable Construction & function
BEDDING Rubber or FILLER

Intended to add **mechanical strength** to the cable
Jacket

Jacket intended to provide physical protection and keep moisture out of the cable

Common Type:
- Thermoplastic (PVC)
- Lead (Neoprene)
- Lead (Timbal)
### Technical background of MV Cable Joint & Termination

### MV Cable Construction & function

**Conductor**
- Material Cu or AL
- To Carry electrical Current

**Inner Semiconductive**
- Prevent Concentration of electric field, prevent partial discharge at the interface between Insulation – Conductor
- Ensure close contact between insulation & conductors

**Main Insulation**
- XLPE, PILC, EPR
- Main Insulation of electrical voltage

**Outer Semiconductive**
- Prevent Concentration of electric field, prevent partial discharge at the interface between Insulation – Metallic Screen

**Metallic Screen**
- Symmetrical radial distribution of Voltage stress within the dielectric, reduce the hazard of shock, return for short circuit current in the event of a cable failure

**Armor**
- Mechanical protection & return current path when faulty

**Outer Jacket**
- Provide Physical protection and keep moisture out of the cable
Technical background of MV Cable Joint & Termination

**MV Cable Termination**

- To Terminate Cable
- Connecting cable to equipment, such as MV SWGR, Transformer, Mv Motor, electric Generator
Technical background of MV Cable Joint & Termination

MV Cable Termination

- Termination Function
  1. Electrical stress Control
  2. External Leakage insulation – HV to Ground
  3. Sealing from environment
I. ELECTRICAL STRESS VOLTAGE CONTROL

Cable with stress control layer

- Stress control layer
- Outer conductive layer
- Equipotential lines
- Field lines
- Cable Insulation
- Conductor
Stress Voltage

**Electrical Stress Control**

Removal of the screen causes a change in the distribution of the electrical potential. Electrical Field will be high at semi-con step.

Air breaks down. The critical value for air is approximately 2.5kV/mm. Partial discharges occur at semi-con step.
Stress grading
Electric field control

Refractive
Stress grading

Electric field control

Resistive
Stress grading

Electric field control

Geometric field control
II. EXTERNAL LEAKAGE INSULATION
Between Conductor & Ground

FLASHOVER PROTECTION

THE INSULATOR

TRACKING PROTECTION
TRACKING

Three Conditions Must Exist:

- **CONTAMINATION**
  - Dust
  - Chemicals
  - Salt
  - Other Airborne Particles

- **MOISTURE**
  - Humidity
  - Fog
  - Condensation
  - Mist
  - Snow
  - Rain

- **VOLTAGE**
  - Surface Stress (V/mil)
DISCHARGE FORMATION

DRY BANDS
(Areas of Higher Surface Resistance)
& Concentrated Voltage Gradient

Surface Resistance Reduced When Wet

ELECTRICAL DISCHARGES
(Generated in Dry Band Areas)
Ways To CONTROL TRACKING

1. Increase Distance from HV to Ground

2. Rain Shed *(Insulator Skirts)*

3. Track Resistant Materials
   - Porcelain
   - Inorganic Fillers in Rubber
   - Inorganic Fillers in EVA *(Heat Shrink)*
   - Silicone Rubber
Silicone Rubber for Termination
INSULATOR MATERIAL

1. Silicone is *Hydrophobic*

2. Silicone Can *Recover Its Hydrophobicity*

3. Silicone is Inherently *UV-Stable*

4. Silicone is Mostly *Inorganic* -- *(No Conducting Carbon Path)*

5. Silicone Has a *Smooth Surface*
Examples
HYDROPHOBIC & HYDROPHILIC

SILICONE RUBBER
Hydrophobic
(Water “Balls-up”)

PORCELAIN
Hydrophilic
(Surface “Wets”)
III. SEAL

To the External Environment

Top Seal
(Conductor Seal)

Bottom Seal
(Jacket Seal)

Silicon Rubber

Potting Compound

Porcelain
“Why Splice a Shielded Power Cable?”

- Supplied length is not long enough *(reel end)*
- Length is limited due to pulling distance and bends
  - Cable failure
- Cable damaged after installation *(e.g. dig-in)*
- Tap into an existing cable *(Tee or wye splice)*
A *Splice* can be defined as two or more conductors joined with a suitable connector re-insulated re-shielded and re-jacketed with compatible materials.
FUNCTION OF MEDIUM VOLTAGE SPLICES

- Control Electrical Stress in Connector Area
- Insulate Between Voltage and Ground
- Maintain Metallic Shield Continuity
- Provide Protection from Impact and Moisture
- Provide Resistance to Acidic & Alkaline Soil
CABLE SPLICING/JOINTING

Common Steps for POWER CABLE SPLICING

- Properly Prepare Surface
- Join Conductors with a Connector
- ReInsulate Main Insulation
- Re-Establish Shield system Continuity
- Re Jacketing
FIELD PROBLEM

Faulty connection of copper tape screen
FIELD PROBLEM

Crossing of cores - Discharge

\[ U_0 \]
FIELD PROBLEM

Problem in parallel connections

- Use the same length of Terminations!
Simplify Design Construction

Comparison Installation method

Simply installation - Reduce faulty, caused by field installation
MV Cable preparation tools

Bonded Semiconductive Peeler

Cable Jacket Cutter

Peel-able Semiconductive Peeler

Cablefield limitation cutter
Mechanical stop
Safe removal of insulation screen
Good quality stripping tools.
Manual Crimping Tool

HPI130-C – Manual Hydraulic Compression Tool 130kN (300mm²)

Designed to crimp terminals and connectors up to a maximum of 300 mm² cable cross sections.

Technical Characteristics:
- Light and compact structure
- C head for easily positioning the dies, rotates 270°
- Quick feed with double hydraulic cylinder
- Single hand use by innerside handle
- Pressure limiter
- Manual return in any position
- Compression force: 130kN
- Max. stroke: 30mm
- Head opening: 28mm
- Operating pressure: 700bar (70MPa)

<table>
<thead>
<tr>
<th>Sector of use</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexagon crimping dies to DIN 46083 Cu</td>
<td>240mm²</td>
</tr>
<tr>
<td>Hexagon crimping dies to DIN 46083 Al</td>
<td>300mm²</td>
</tr>
<tr>
<td>Hexagon crimping dies to DIN 46083 Al/St.</td>
<td>150/25mm²</td>
</tr>
<tr>
<td>Hexagon crimping dies for fork terminal similar to DIN</td>
<td>300mm²</td>
</tr>
<tr>
<td>Round die for Al and Cu sector-shaped conductor</td>
<td>300mm²</td>
</tr>
<tr>
<td>Oval crimping dies for Ø branch terminals</td>
<td>50mm²</td>
</tr>
<tr>
<td>Thomb crimping dies for cable shoe to DIN 46234</td>
<td>70mm²</td>
</tr>
<tr>
<td>Trapezoid crimping dies for wire end sleeve</td>
<td>150mm²</td>
</tr>
<tr>
<td>Oval crimping dies for indent-connector to DIN 48217</td>
<td>70mm²</td>
</tr>
</tbody>
</table>

Crimping dies see Page 228
POWER CABLE ACCESSORIES

- SUMMARY

• Read Instructions *First!*
  • Good Cable Preparation is *Necessary!*

  - Training
  - Practice
  - Craftsmanship

• More Simple Products

**WORK SAFELY !!**
Power and productivity for a better world™