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Alternative Conductor Technologies to Mitigate Theft of Power Cables

Anti-Theft Conductors

Anti-Theft Conductors

IT'S A WAR!!

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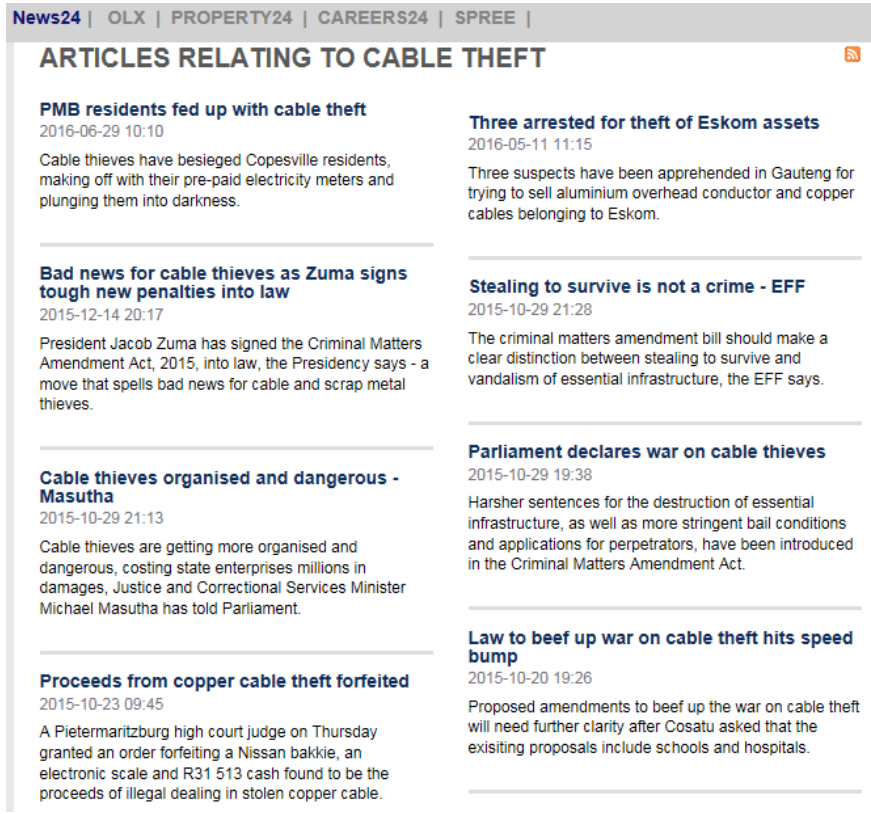
Anti-Theft Conductors

Introduction

Cable theft is an **extremely serious crime** with devastating effects on Society, Industry and Business at large

Often causes irreparable **damage to Utility infrastructure and results in the disruption** of both Essential services and Emergency services and additional loss in revenues due to business's not being able to operate normally.

It is reported that cable theft conservatively costs the **South African Economy about R5bn** a year including both direct and indirect costs (Some Sources report much more). [http://www.combinedpi.co.za]



News24 | OLX | PROPERTY24 | CAREERS24 | SPREE |

ARTICLES RELATING TO CABLE THEFT

PMB residents fed up with cable theft
2016-06-29 10:10
Cable thieves have besieged Copesville residents, making off with their pre-paid electricity meters and plunging them into darkness.

Bad news for cable thieves as Zuma signs tough new penalties into law
2015-12-14 20:17
President Jacob Zuma has signed the Criminal Matters Amendment Act, 2015, into law, the Presidency says - a move that spells bad news for cable and scrap metal thieves.

Cable thieves organised and dangerous - Masutha
2015-10-29 21:13
Cable thieves are getting more organised and dangerous, costing state enterprises millions in damages, Justice and Correctional Services Minister Michael Masutha has told Parliament.

Proceeds from copper cable theft forfeited
2015-10-23 09:45
A Pietermaritzburg high court judge on Thursday granted an order forfeiting a Nissan bakkie, an electronic scale and R31 513 cash found to be the proceeds of illegal dealing in stolen copper cable.

Three arrested for theft of Eskom assets
2016-05-11 11:15
Three suspects have been apprehended in Gauteng for trying to sell aluminium overhead conductor and copper cables belonging to Eskom.

Stealing to survive is not a crime - EFF
2015-10-29 21:28
The criminal matters amendment bill should make a clear distinction between stealing to survive and vandalism of essential infrastructure, the EFF says.

Parliament declares war on cable thieves
2015-10-29 19:38
Harsher sentences for the destruction of essential infrastructure, as well as more stringent bail conditions and applications for perpetrators, have been introduced in the Criminal Matters Amendment Act.

Law to beef up war on cable theft hits speed bump
2015-10-20 19:26
Proposed amendments to beef up the war on cable theft will need further clarity after Cosatu asked that the exisiting proposals include schools and hospitals.

[News24]

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Introduction

2015-12-14 : Johannesburg –**President signed the Criminal Matters Amendment Act, 2015,** into law on Monday, the Presidency said, a move that spells bad news for cable and scrap metal thieves.

The act amends the Criminal Procedure Act, 1977, and introduces **harsher sentences** for the destruction of essential infrastructure and more stringent bail conditions and applications for perpetrators.

"The amendments provide for changes to the law pertaining to infrastructure-related offences by making stricter provisions for the granting of bail, the sentencing of offenders and creating a new offence to criminalise damage to, tampering with or destruction of essential infrastructure which may interfere with the provision of basic services to the public," Presidency spokesperson Bongani Majola said in a statement.

[News24]

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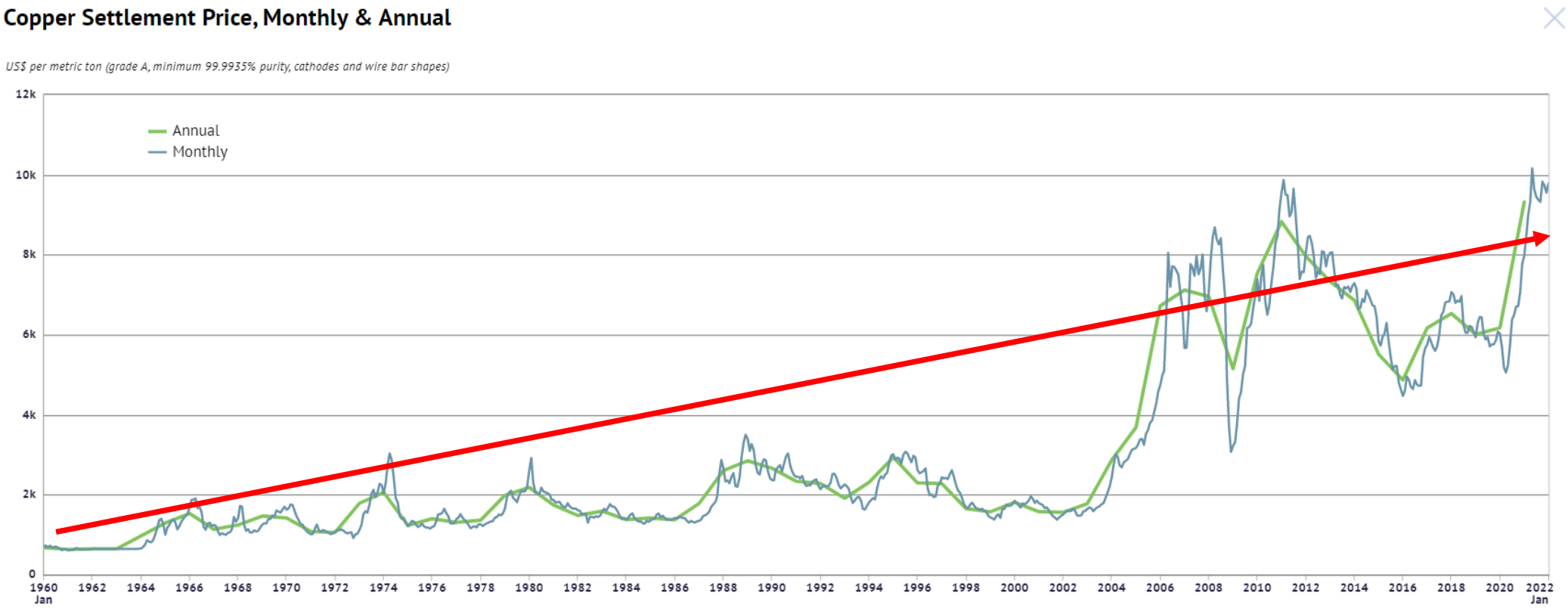
Anti-Theft Conductors

Copper is the **preferred** conductor for electrical power cables and earthing systems

Unfortunately, it's very clear that the **price of copper** and the demand internationally copper theft is on the increase!



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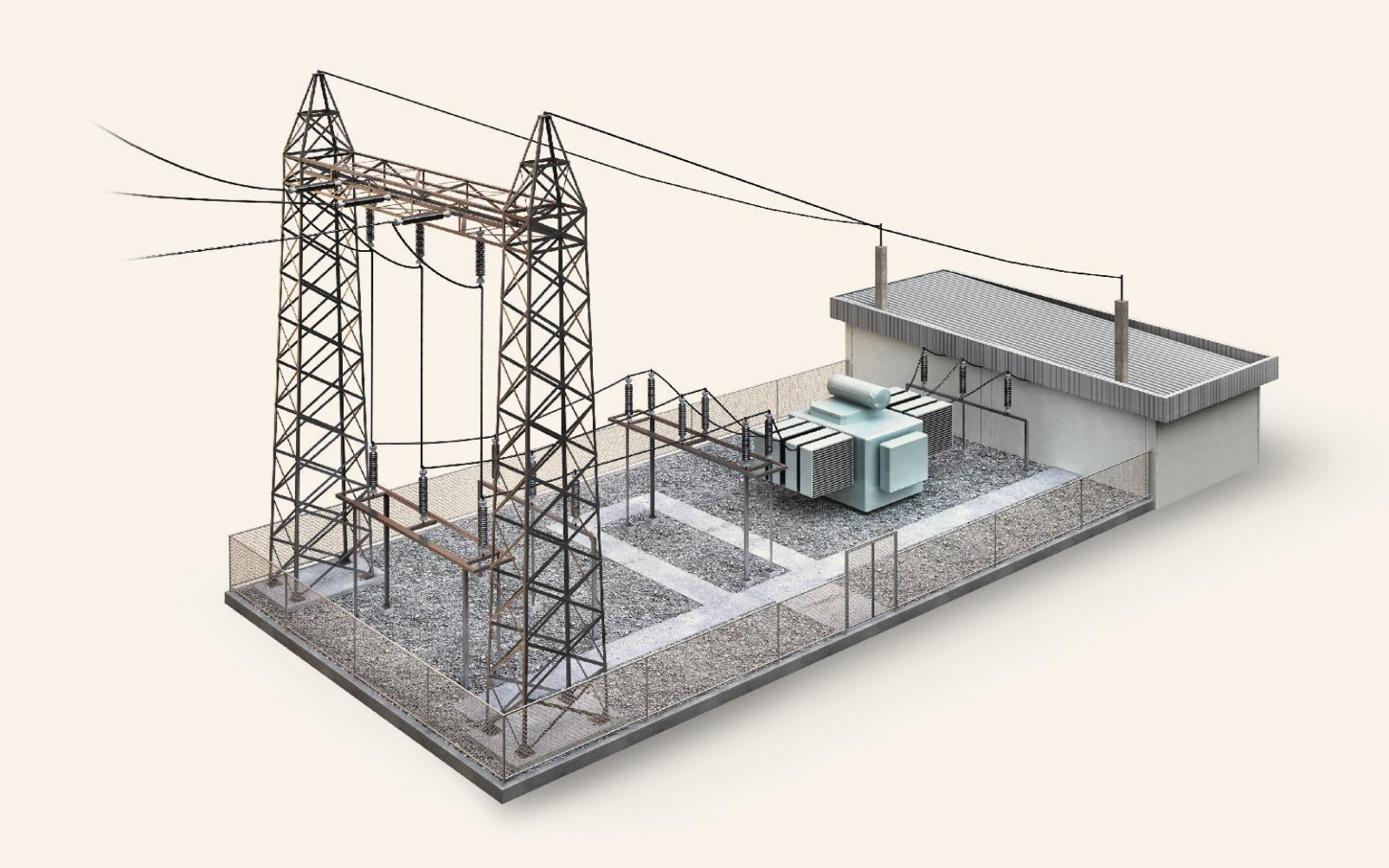
Anti-Theft Conductors

Typical MV/MV substation and associated equipment



Equipment in substations:

- Power transformers (±R15mil)
- HV Switchgear (±R3mil)
- MV switchgear (±R2mil)
- Protection relays (±R1mil)
- Batteries (±R200k)
- MV cables (±R3mil)
- LV control cables (±R600k)
- Structures (±R300k)
- Earthing (±R500k)

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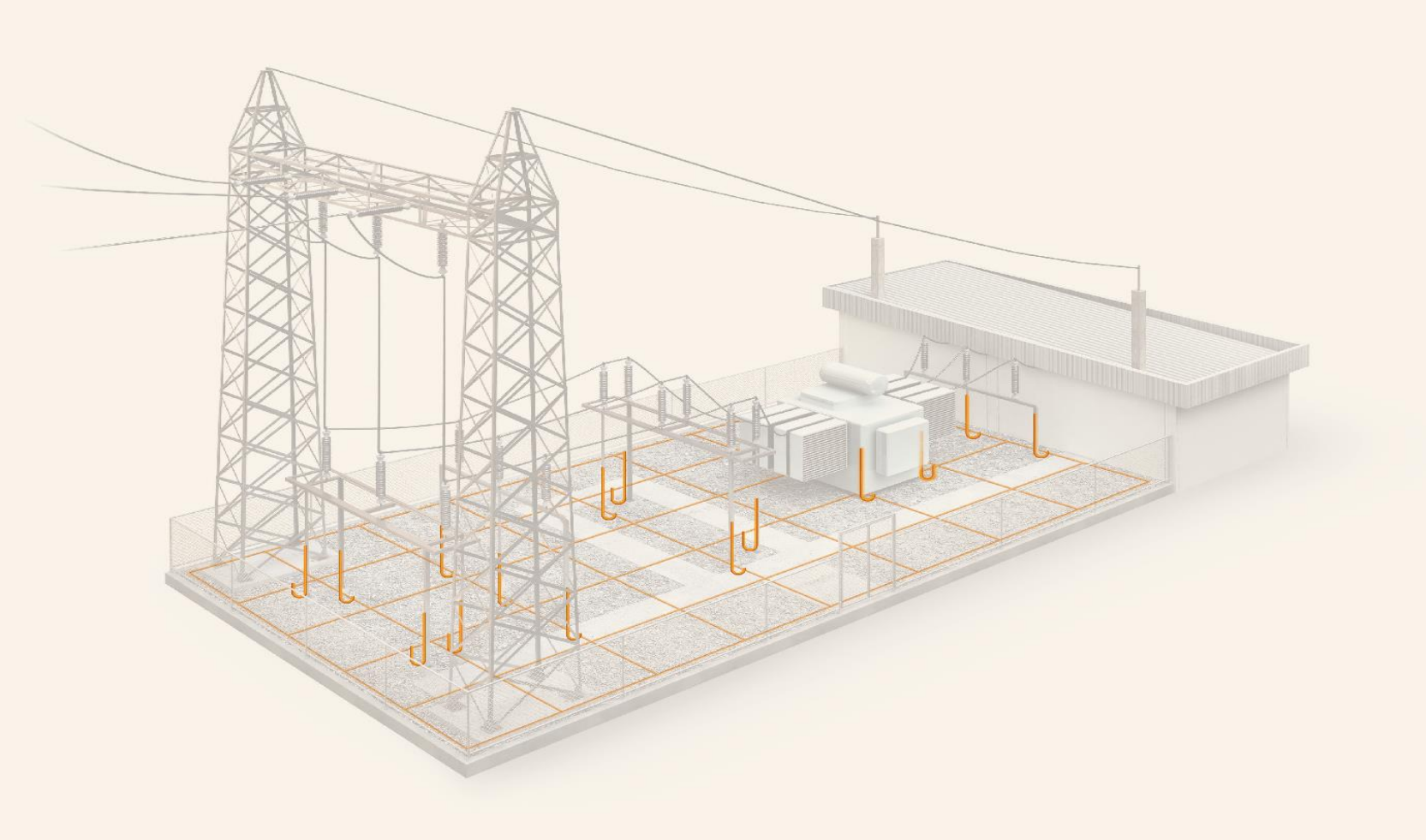
Anti-Theft Conductors

The important earth mat that ensures safety of staff and public



Importance of earthing in substations:

- Safety of staff and public
- Return path for fault currents
- Lighting protection for equipment (dissipate high fault currents)
- Voltage clamping

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Earthing conductors need to be **rated (kA and secs) and connected** correctly otherwise it will fuse under fault conditions

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What can we do as an industry?

What are the means available to the **Industry** to deter cable and conductor theft?

1) **Physically restrain** cables and conductors.

2) **Unique identification** marking in or on cables and conductors (ownership traceability).

3) **Visual means** to identify anti-theft cables at a glance.

4) **Alarm system** with vibration sensors or fiberoptic cable. (Rection time is important)

5) Design cables with **alternative conductor materials**. Rather not install copper conductors.

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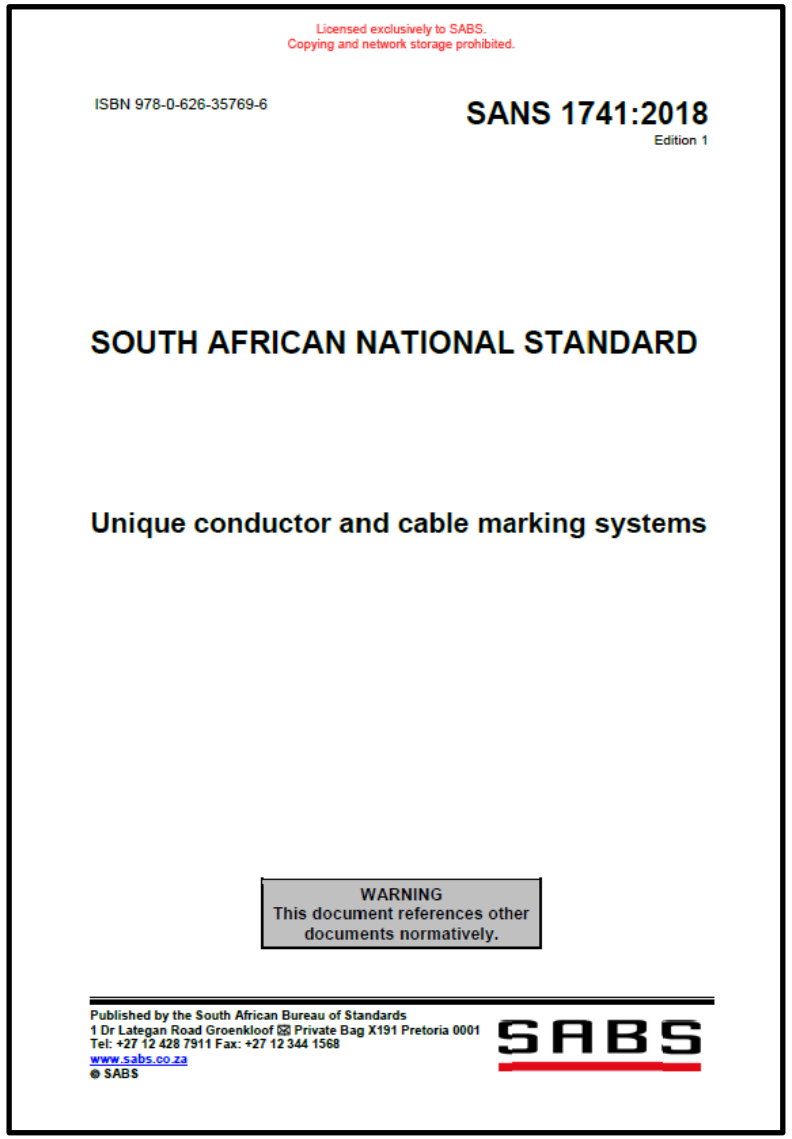
Cable standards for cable marking

SANS 1741: Unique conductor and cable marking systems.

The document deals with conductor and cable marking guideline aspects such as marking techniques (direct marking, batch marking, sequential marking and combination marking), marking location and limitations, data and database requirements.



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SANS 1741:2018
Edition 1

SOUTH AFRICAN NATIONAL STANDARD

Unique conductor and cable marking systems

WARNING
This document references other documents normatively.

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www.sabs.co.za

SABS

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Anti-Theft Conductors

Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copperweld company:

- Pioneers of bimetallic conductor technology and the world's leading brand
- Facilities in USA, UK and Belgium
- Founded in 1915 in Rankin, Pennsylvania as "Copper-Clad Steel Company"
- Headquarters in Nashville, Tennessee (Near to the Jack Daniels factory)
- Current production plant established in 1975 in Fayetteville, Tennessee
- Copper Clad Steel used in the second world war

CAMO™ (CCS) Copperlite™ (CCAA)

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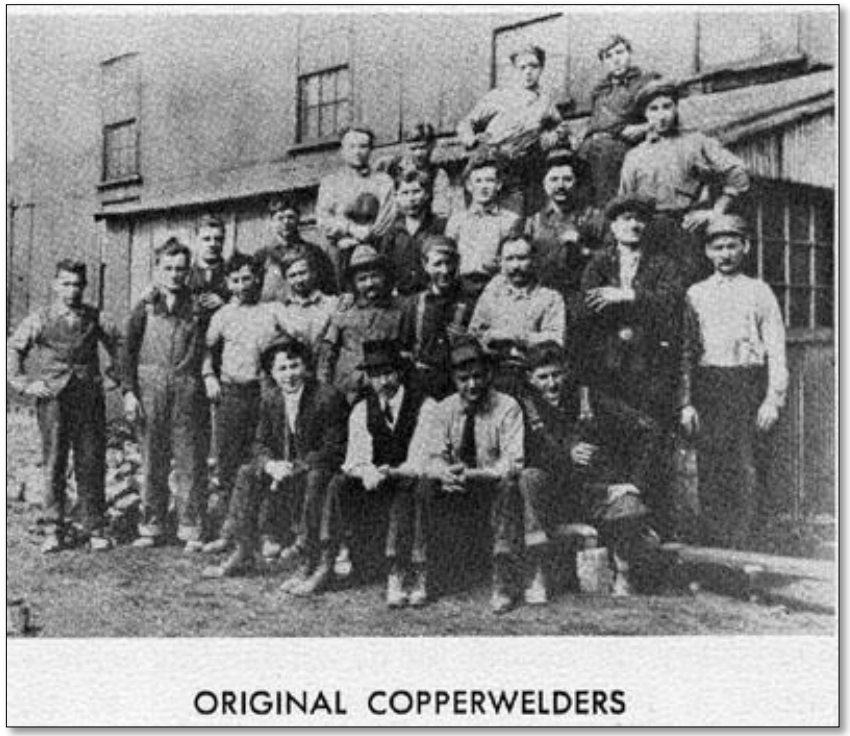
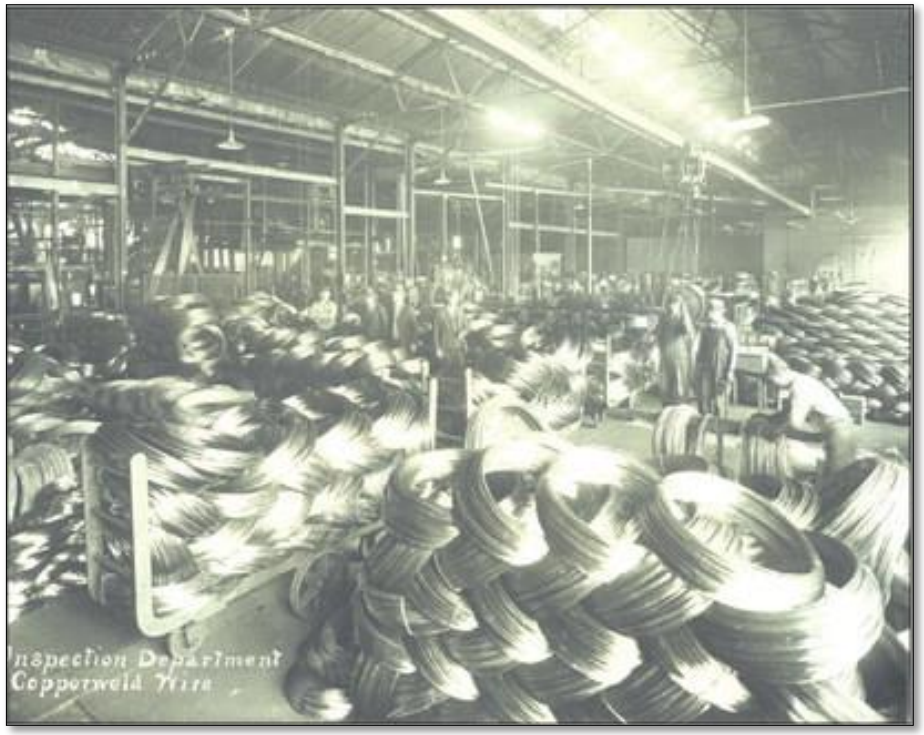
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Inventors of bimetallic wire





Rankin, PA, USA – 1915

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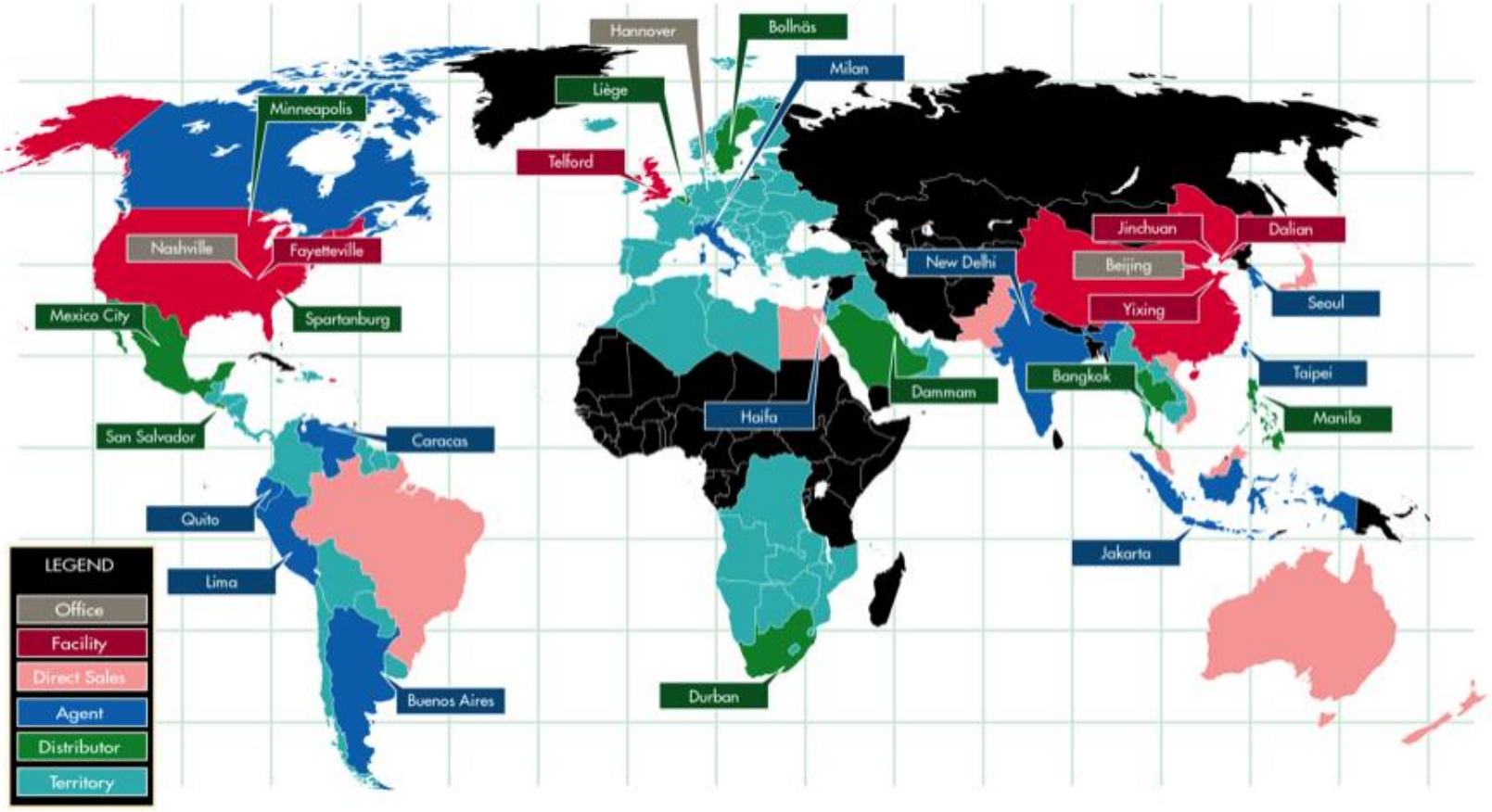
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards



Worldwide presence

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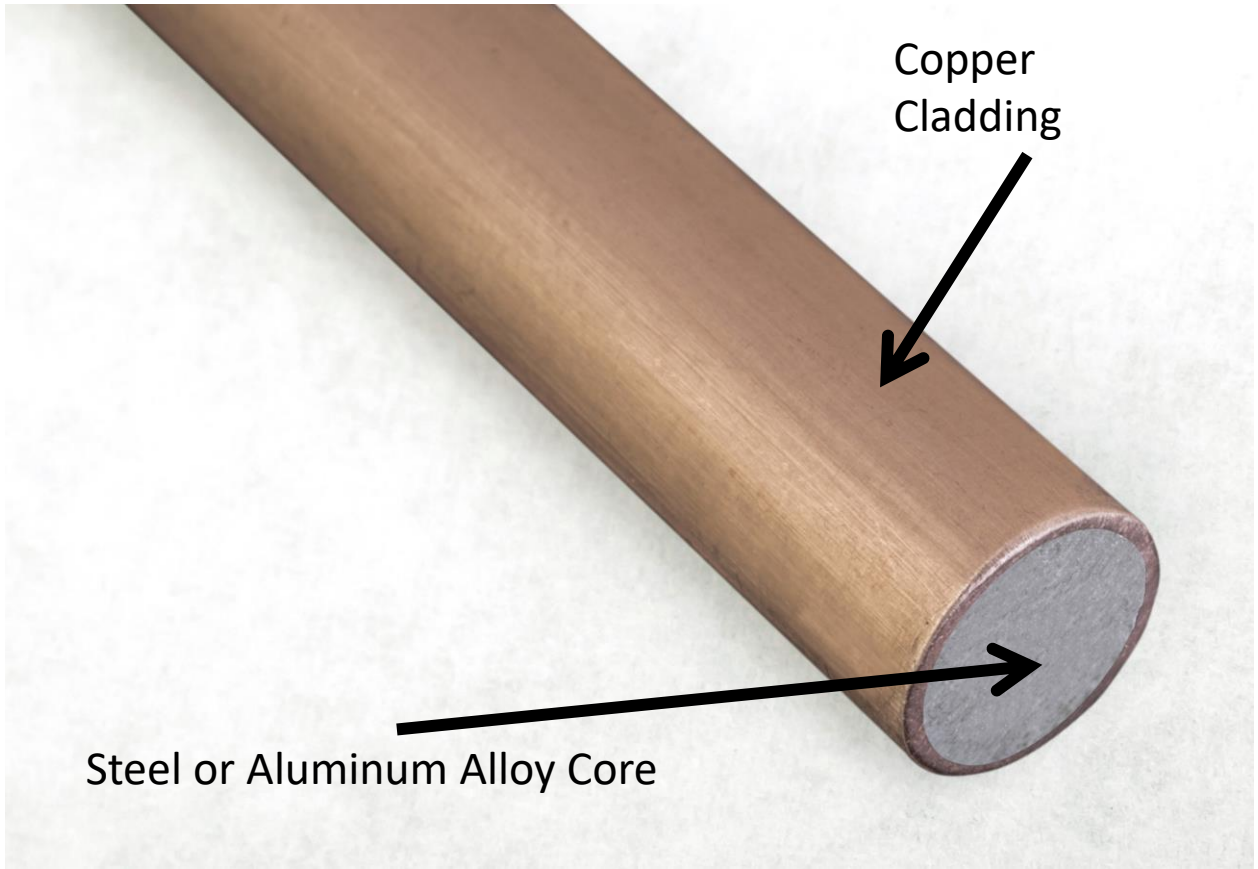
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

CAMO™ (CCS)

ArcAngel™

COPPERWELD BRAND WIRE

Copperlite™ (CCAA)



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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

NRS 102: Theft Deterrent Earthing Materials (cont.)

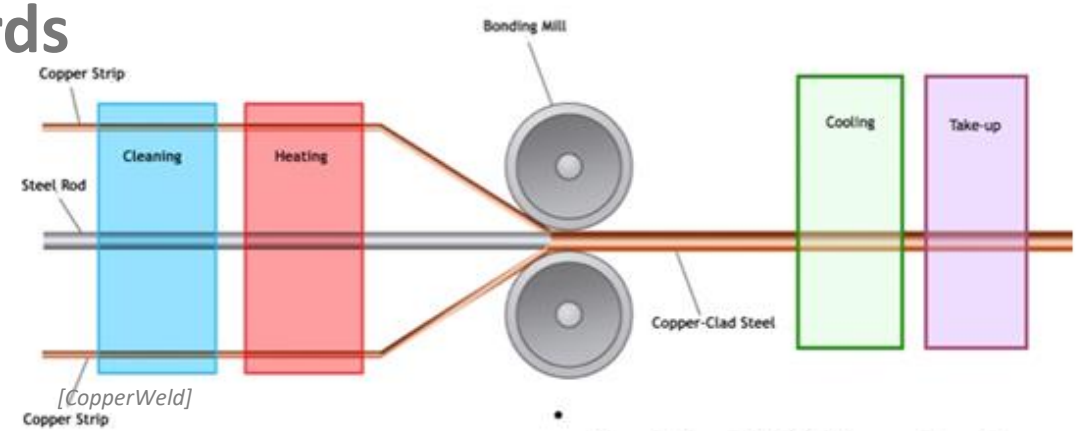
Basic properties for these materials:

- corrosion resistance
- high electrical ampacity
- mechanical robustness and
- limited scrap value

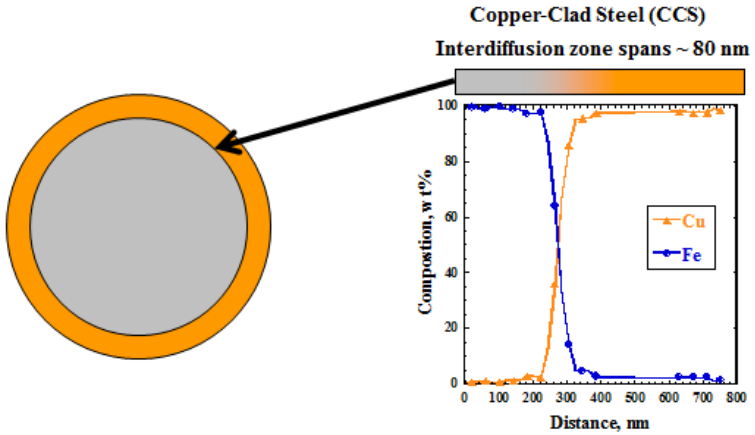
CCS is 40 % IACS (Copper is a 100%)

Further deterrent to theft is to treat the surface so as to **discolour** not to resemble copper.

Rated for **fusing** temperature of 1084 ^{o}C



- *Two Strips C10200 Oxygen-Free Copper*
- *Extreme Pressure & Cleanliness*
- *Verified Metallurgical Bond*



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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

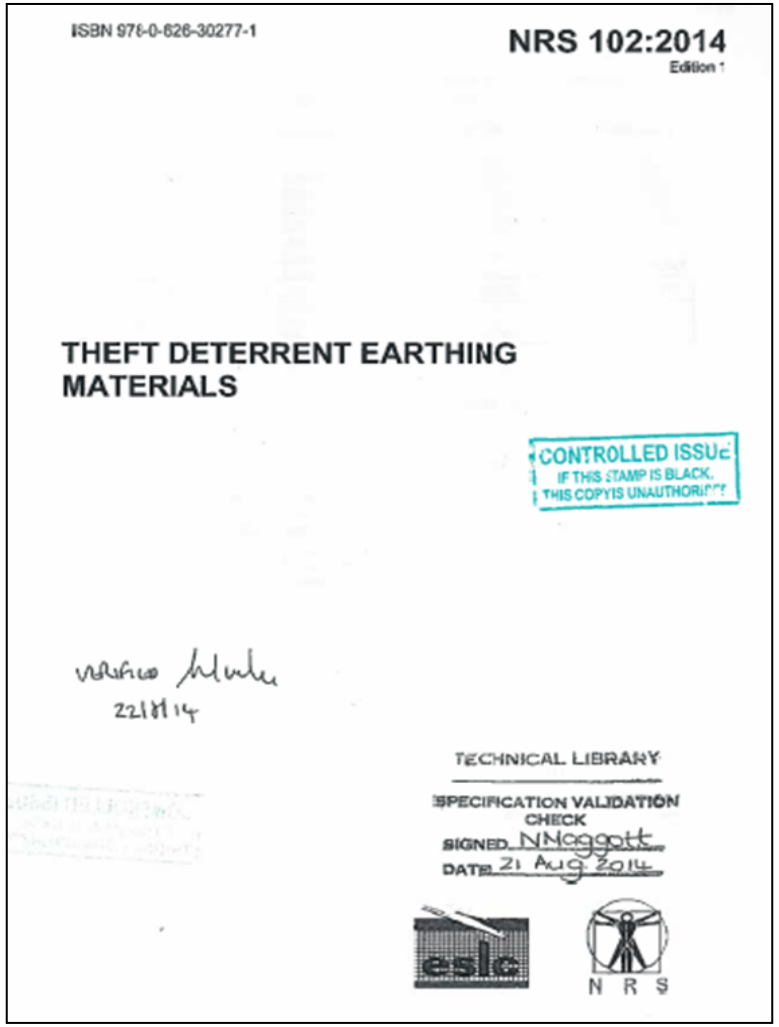
NRS 102: Theft Deterrent Earthing Materials

This standard deals with conductors and connectors and references international standards:

- ASTM B228-04, Standard specification for concentric lay stranded CCS conductors.
- ASTM B910, Standard specification for annealed CCS wire.

Copper Clad Steel (CCS) definition:

Bimetallic conductor that is manufactured by a mechanical bonding process that produces a **metallurgical bond** between a solid oxygen-free copper layer and a steel core.



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Anti-Theft Conductors

BEATS COPPER IN THE GROUND

DSA Copperweld® wire and strand offers so many advantages over solid copper for grounding applications, it's the clear choice for all grounding applications.

- **Conductivity of copper** ...For grounding applications
- **Strength of steel** ...Far superior to solid copper
- **Fatigue resistance** ...Won't break, crack, flake or peel
- **Corrosion resistance** ...Long life under adverse conditions
- **Ample fusing current** ...Exceeds most design requirements
- **Connects like copper** ...Uses standard copper terminations and lugs
- **Low scrap value** ...Excellent theft resistance

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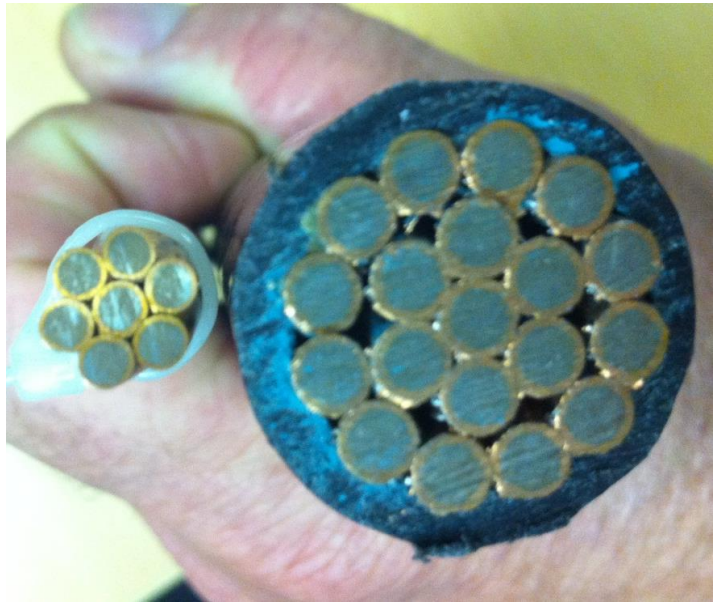
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copper Clad Steel (CCS)

Application for **Earthing/Bonding** Purposes

Mature technology in solid and stranded configurations

No local rod manufacturing capability, but stranding and insulation can be done locally



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DSA COPPERWELD® STRAND FOR GROUNDING APPLICATIONS: PHYSICAL AND ELECTRICAL CHARACTERISTICS

COPPER CONDUCTOR EQUIVALENCY SIZE	DIAMETER (mm)	ACTUAL CROSS-SECTION AREA (mm^2)	MINIMUM BREAK LOADS (kgf)	WEIGHT (kg/km)	APPROXIMATE SHORT-TIME FUSING CURRENT AT 1 SECOND/60 CYCLES (kA)
19-Wire Strand					
150 mm^2 EQ	20.57	252.66	6205	2110	47.70
120 mm^2 EQ	18.33	200.47	4923	1674	37.85
95 mm^2 EQ	16.32	158.97	3904	1327	30.01
70 mm^2 EQ	12.94	99.97	2455	835	18.87
7-Wire Strand					
50 mm^2 EQ	11.00	73.86	1814	614	13.94
35 mm^2 EQ	9.36	53.49	1313	445	10.10
16 mm^2 EQ	6.55	26.23	644	218	4.95

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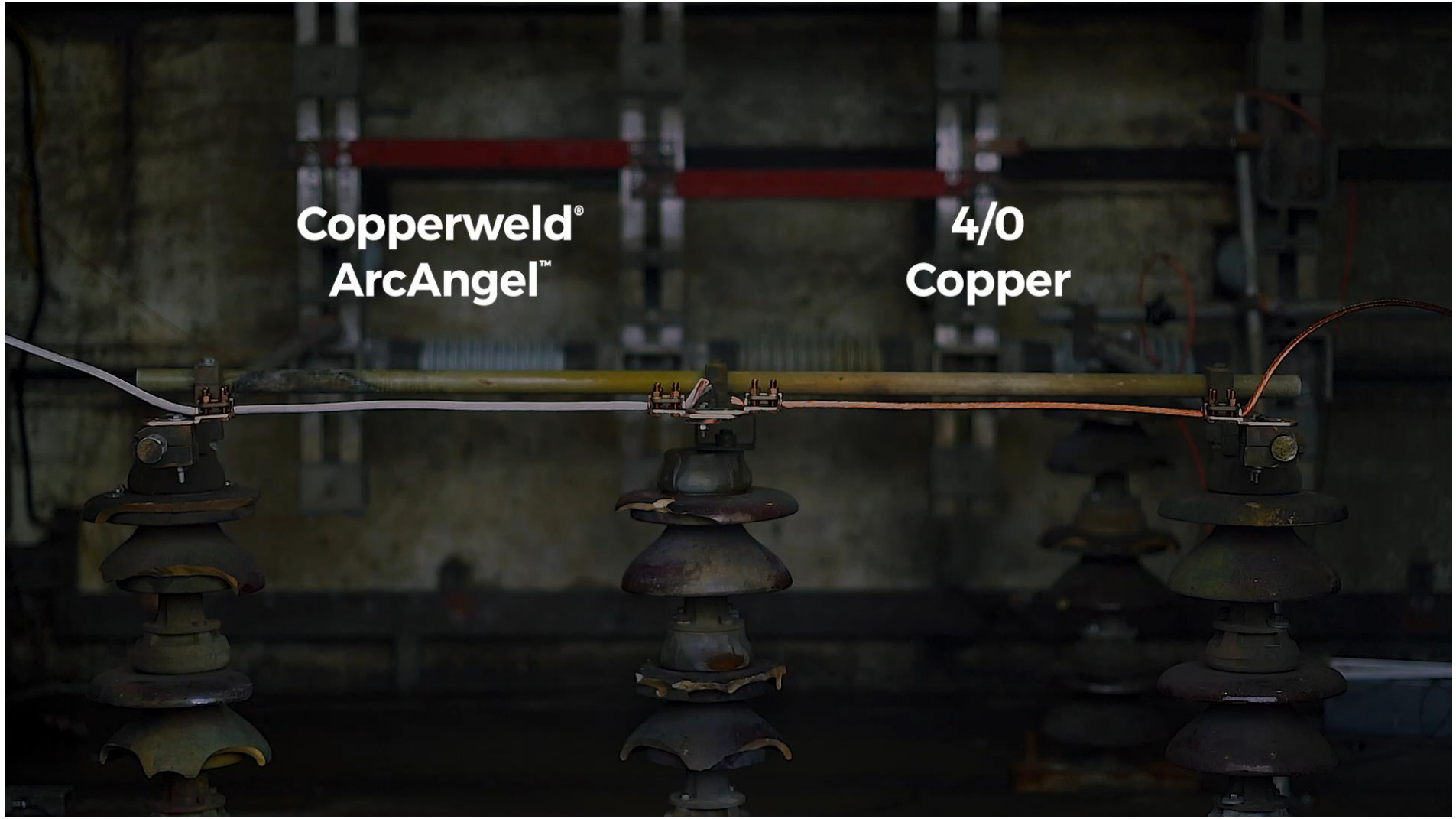
Anti-Theft Conductors

Too good to be true?



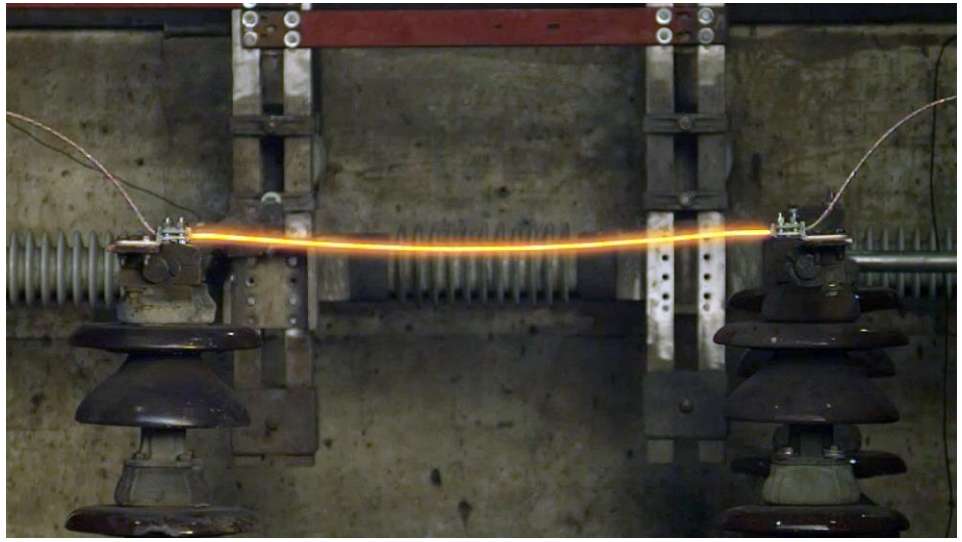
Anti-Theft Conductors

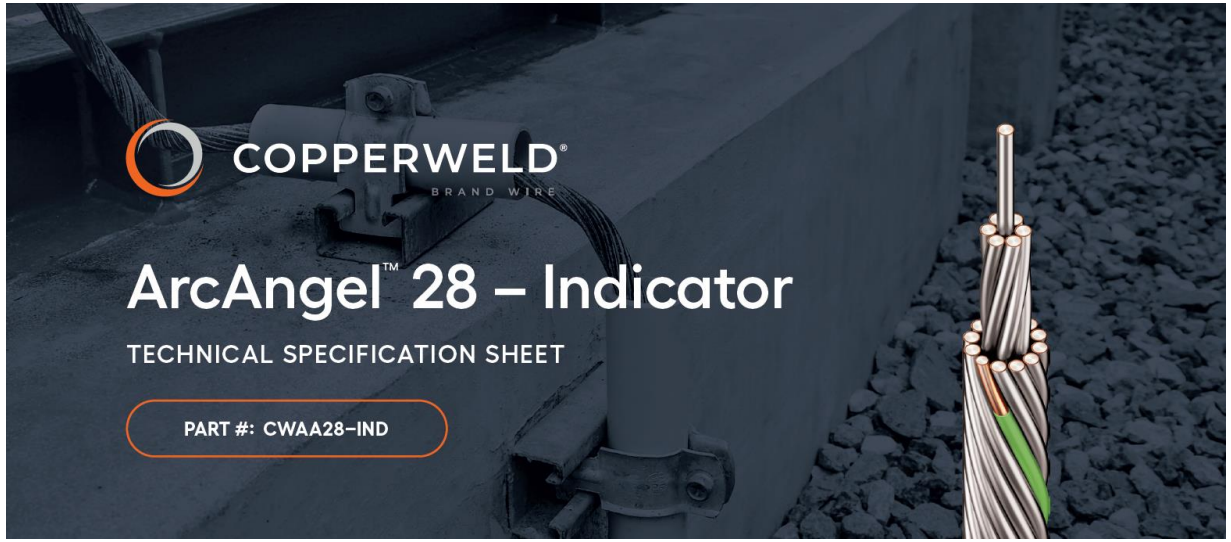
Fault current comparison

ArcAngel™
COPPERWELD BRAND WIRE

Copperweld® Brand Solutions

Part Name	Copperweld Part No.	Isc (Up to 500 ms) (kA)
ArcAngel 101 - Bare	CWAA101	101
500 kcmil Copper	-	97
ArcAngel 73 - Bare	CWAA73	73
350 kcmil Copper	-	68
ArcAngel 44 - Bare	CWAA44	44
4/0 Copper	-	41
ArcAngel 28 - Bare	CWAA28	28
2/0 Copper	-	26





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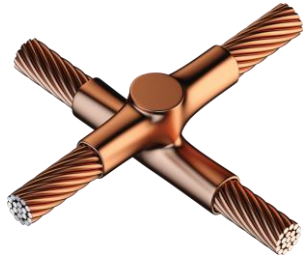
Works with all standard connectors

Compatible connectors:

- Exothermic Weld – 1000ºC
- Swage Crimping – 850ºC
- Compression – 250ºC
- Hard Drawn Copper – 250ºC



Exothermic

Crimp

Compression

Swage

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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductors and cable standards

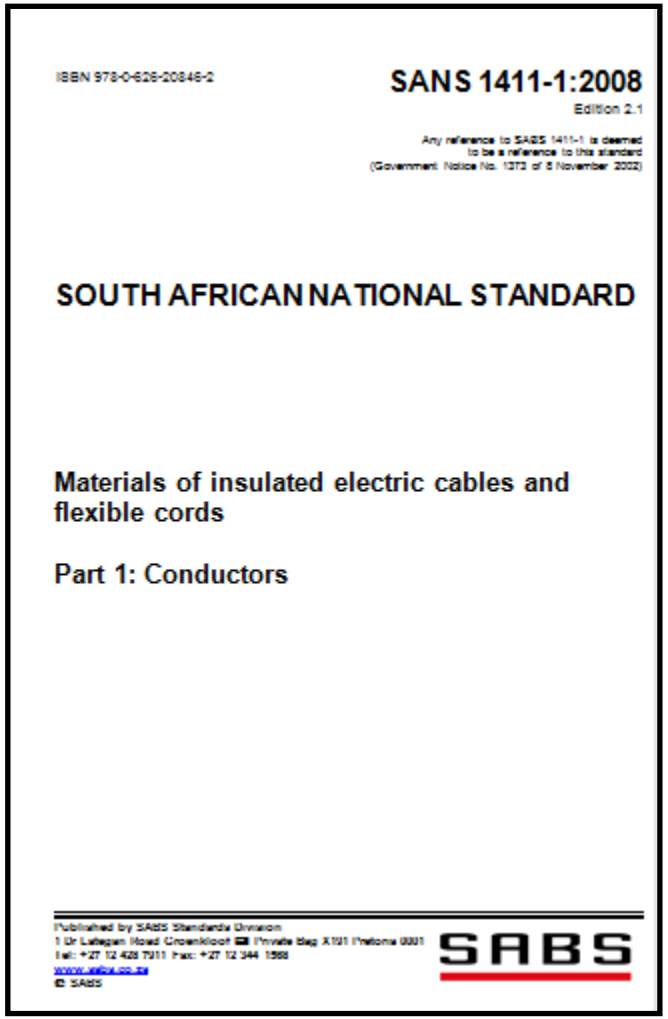
WG - SANS 1411-1: Materials of insulated electric cables and flexible cords - Conductors

A SABS workgroup met a number of times for 3 years and the CD document was completed and circulated at the end of 2016.

The WG considered the inclusion of additional conductor material types specifically intended for **specialized** anti-theft cable types:

- CCS
- CCAA
- Al Alloy
- Mix of metals
- Steel

The revision is however delayed for now and a different approach was agreed to by SABS TC 66



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Anti-Theft Conductors

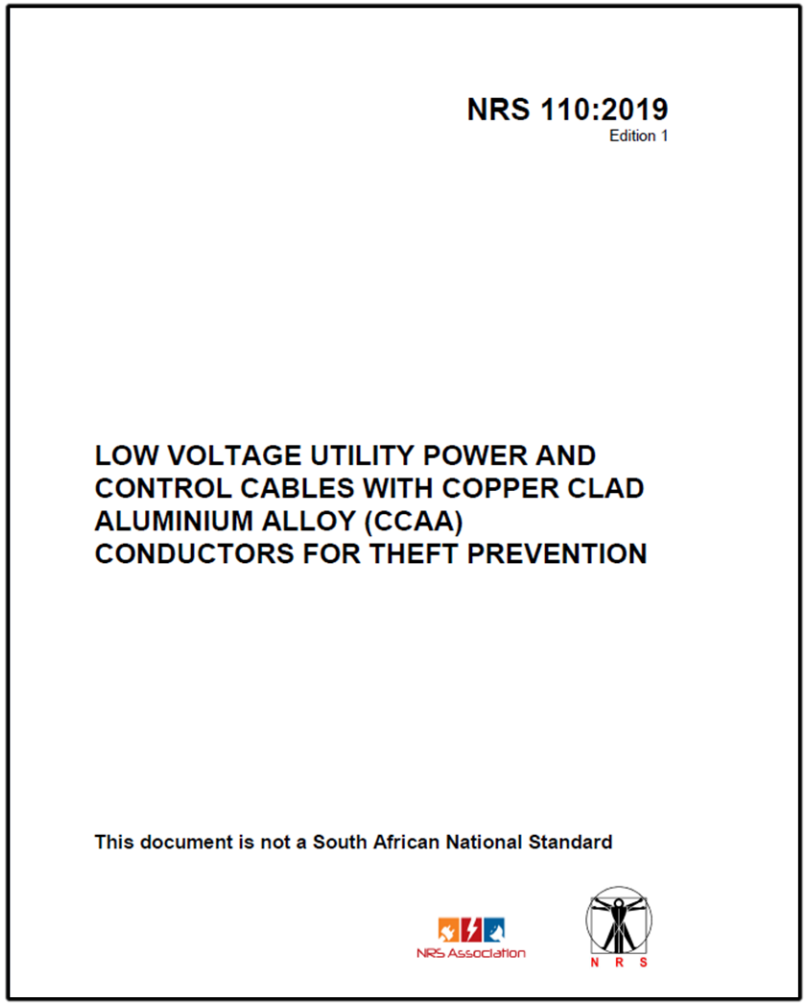
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

NRS 110

LOW VOLTAGE UTILITY POWER AND CONTROL CABLES WITH COPPER CLAD ALUMINIUM ALLOY (CCAA) CONDUCTORS FOR THEFT PREVENTION

The NRS WG considered mainly feasible alternative conductors. A final decision was to start with CCAA and the later to consider Aluminum Alloys

This standard will be published in June 2019 and then exciting cable development can be officially started for utility purposes



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Anti-Theft Conductors

Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

NRS 110 LOW VOLTAGE UTILITY POWER AND CONTROL CABLES WITH COPPER CLAD ALUMINIUM ALLOY (CCAA) CONDUCTORS FOR THEFT PREVENTION

This specification is a guideline and specifies requirements for utility low voltage power and control cables with copper clad aluminium alloy (CCAA) conductors for use in theft deterrent low voltage cable constructions up to 600/1000 V AC.

It covers solid and stranded circular or shaped conductors specified for use in insulated electric power and control cables. These cables are intended for use only up to the point of supply as defined in SANS 10142-1.

This guideline is intended to establish the requirements for research and development of alternate theft deterrent cable types below, which are not covered in the current national standards. All aluminium alloy conductors without copper cladding will be considered for future inclusion. This specification is not intended to be used for conductors intended for bare earthing applications on cable systems (refer to NRS 102 for earthing applications).

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Anti-Theft Conductors

Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Specific cable types covered in this specification include the following:

- Single core and multicore control cables with solid class 1 conductors of maximum size 4 mm^2, compliant with either SANS 1507-2, 1507-3, SANS 1507-4 or SANS 1507-5, (conductors compliant with the requirements of this specification);
- Single core and multicore power cables with stranded class 2 circular conductors in sizes 2.5 mm^2 to 240 mm^2, compliant with either SANS 1507-2, SANS 1507-3, SANS 1507-4 or SANS 1507-5 (conductors compliant with the requirements of this specification);
- Multicore power cables with 2 or more stranded class 2 shaped conductors in sizes 16 mm^2 to 240 mm^2, compliant with either SANS 1507-3, SANS 1507-4 or SANS 1507-5 (conductors compliant with the requirements of this specification).
- Concentric service cables in accordance with SANS 1507-6 with span lengths;
- Flexible single-core class 5 cables in accordance with SANS 1507-3 or 1507-4 for minisub applications; and
- Aerial bundled conductors in accordance with SANS 1418.

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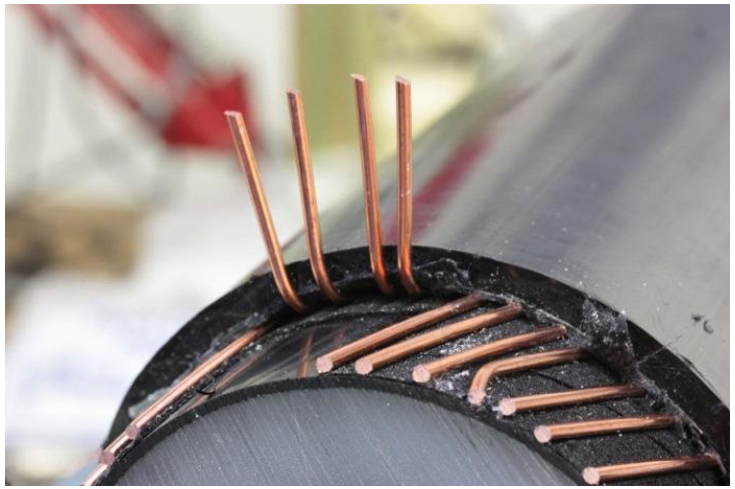
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copperlite™ CCAA applications:

- RF cable center conductor
- Telecom trunk & distribution cable
- Flexible cables; Booster & Jumper Cables
- Data Cables
- Enameled Wire
- Power cable
- Building wire



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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

International CCAA Standards:

- IEC 61196-1: Coaxial Communication Cables
- IEC 60096: Radio Frequency Cables
- UL1581: Electrical Wires, Cables, and Flexible Cords
- UL 1569: Metal Clad Cables
- ASTM B-566: Copper Clad Aluminum Wire
- National Electric Code (USA): 0-2000 Volts power cable

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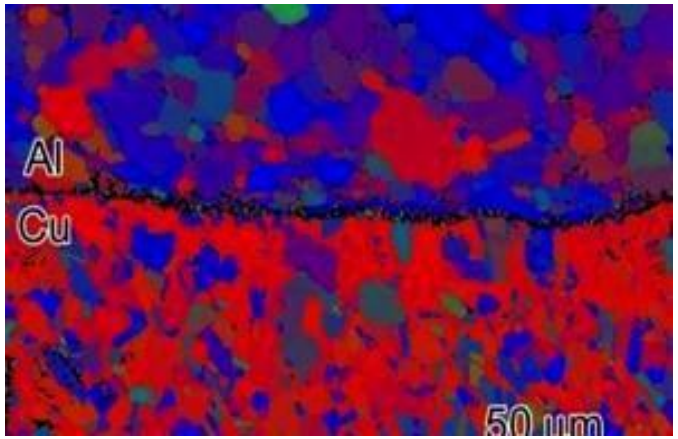
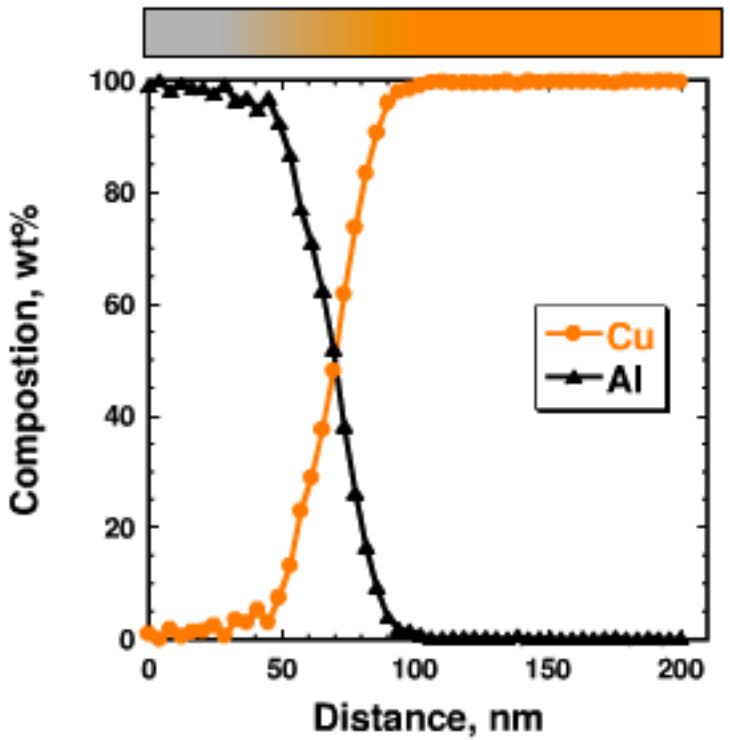
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

CCAA Metallurgical bond

Microstructure at the interface



STEM-HAADF-XEDS with drift correction
CCA Interdiffusion zone spans ~ 50 nm



Research in partnership with the University of Alabama
Department of Metallurgical & Materials Engineering
Tuscaloosa, Alabama

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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copperlite™ brand, copper-clad aluminum alloy (CCAA):

- 10% and 15% Cu by volume:
  - Respectively 63 and 67% IACS conductivity
  - Respectively 28 and 37% Copper by weight
- Key performance factors:
  - Lighter weight
    - For the same weight, Copperlite™ yields 2.7 times the wire as copper
    - Lighter wire yields more effective and energy-efficient products
  - Uses the same insulation and jackets as copper
- Suitable for applications where flexibility and weight are the deciding factors

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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Technical comparison Cu vs CCAA

MATERIAL	DIAMETER	AREA	WEIGHT	RESISTANCE	WEIGHT SAVINGS vs Copper
	mm	mm^2	kg/km	Ω/km	%
Copper	1.129	1.00	8.94	17.149	0
10% CCA	1.428	1.60	5.31	17.149	40

Copper wire replacement with 10% CCA same Resistance requires:

- ✓ 60% higher cross-section
- ✓ 26% higher diameter
- ✓ 40% weight savings

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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

- **Contamination in Scrap Copper Refining**
  Copper-clad aluminum waste wires can create huge losses to scrap copper recycling and refining business since the aluminum content of copper-clad aluminum could contaminate a batch of clean copper wire scraps resulting in a substandard production. Purity of the recycled batch will result to lower value.

Cu

International Copper Association Asia

Copper Alliance

Australia | China | India | Indonesia | Japan | Korea | Malaysia | Philippines | Singapore | Taiwan | Thailand | Vietnam

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Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

CCAA is an **alternative** to Copper and Aluminium conductors for use in LV and MV cables for anti-theft purposes.

The conductor eliminates the serious **corrosion risk** of pure Aluminium conductors

Scrap conductor material has **little** scrap value

Can be drawn to **fine** sizes

Can be used for **small** conductor sizes

CCAA conductor is not produced locally but **drawing down and stranding** will be done in South Africa like Copper and Aluminium

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Anti-Theft Conductors

Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copper-clad aluminum as an alternative to copper flexible conductors for electric power cables: opportunities and challenges

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ABSTRACT

The majority of flexible conductors for LV power cables is today made with Copper. Use of alternative metals for these cables is investigated, under the push of significant cost reduction. Aluminum is an alternative but some technical concerns are considered in terms of mechanical and corrosion resistance properties. Bimetallic conductors like copper-clad aluminium can combine advantages of the 2 metals, with attractive cost. LV flexible cables were produced with Cu, CCA, tinned CCA and Al class 5 conductors; CCA conductors were evaluated in terms of quality and integrity of copper layer; an evaluation of main cable properties was considered.

CONCLUSIONS

Copper clad aluminum is an attractive alternative to copper. It provides a more economical light weight product as compared to copper. The quality of CCA is very critical in several applications. Key components to ensure high quality CCA are the quality of the metals such as copper and aluminum and the integrity of the metallurgical bond.

ARB Electrical Wholesalers

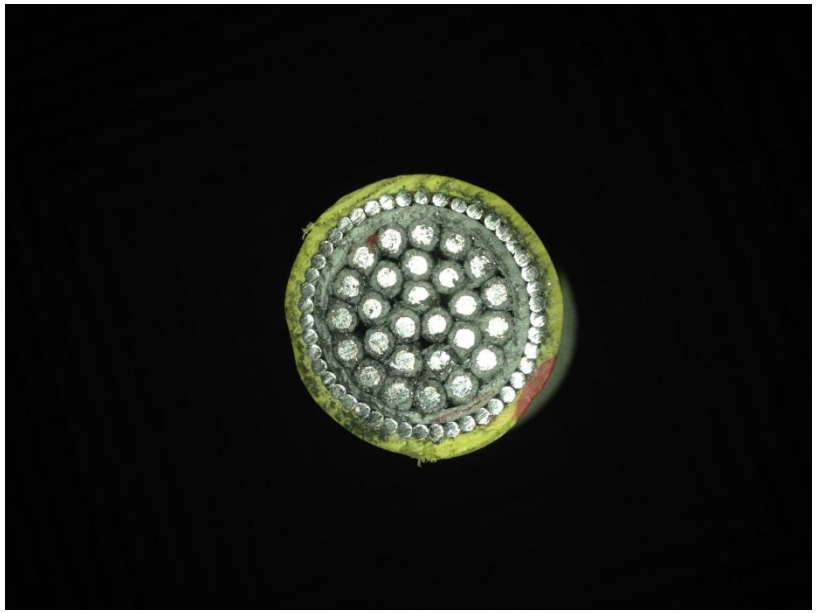
Anti-Theft Conductors

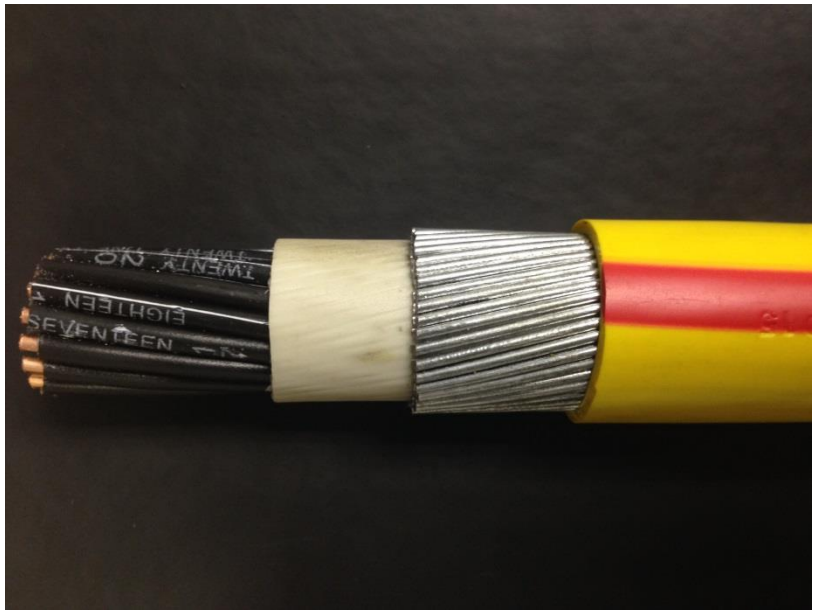
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copper Clad Aluminum Alloy (CCAA)

2.5 mm^2 x 27 and 15 core for traffic signal application

Reported cost to repair a vandalized traffic intersection > R100k





ARB Electrical Wholesalers

Anti-Theft Conductors

Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copper Clad Aluminum Alloy (CCAA)

Traffic signal application in Johannesburg

ARB Electrical Wholesalers

Anti-Theft Conductors

Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copper Clad Aluminum Alloy (CCAA)

50 mm^2 x 4 CCAA core for power distribution cable designs

CCAA
7 wire
conductor

CU wires

CCAA wire

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Electrical Wholesalers

Anti-Theft Conductors

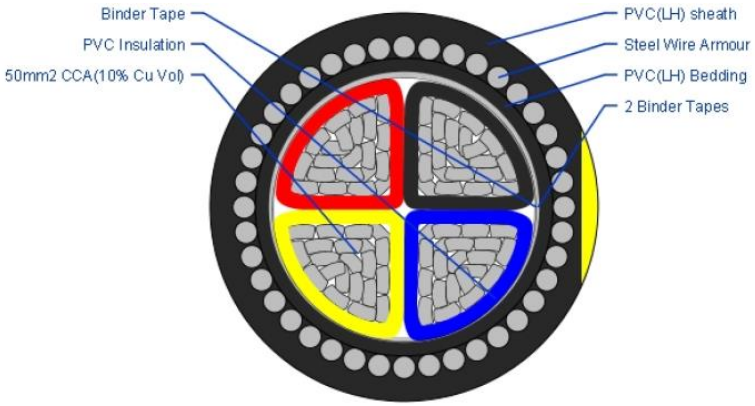
Copperweld Bimetallic Copper Clad technologies (CCS and CCAA) and associated conductor and cable standards

Copper Clad Aluminum Alloy (CCAA)

50 mm^2 CCAA x 4 core

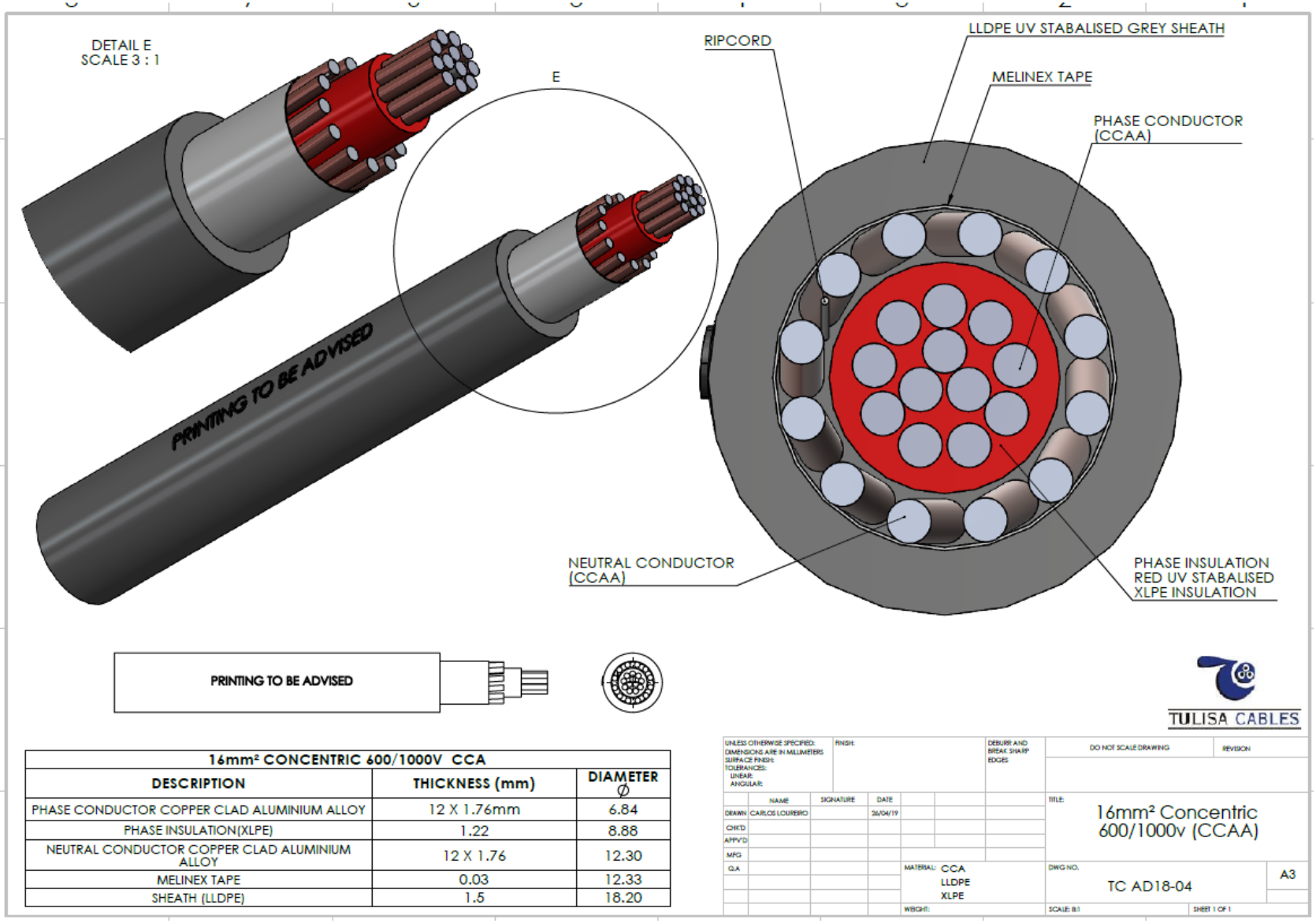
Max. Conductor Resistance (D.C. at 20°C)			0,5486	Ω/km
Max. Conductor Resistance (A.C. at 70 °C)			0,6594	Ω/km
Conductor Inductance			0,266	mH/km
Inductive Reactance			0,084	Ω/km
Impedance/phase			0,665	Ω/km
Capacitance			862	nF/km
Charging Current			[illegible]	A/km
Ground Current Rating			145	A
Single way Duct Current Rating			[illegible]	A
Air Current Rating (in Shade)			139	A
Air Current Rating (in Direct Sunlight)			105	A
Losses Calculated at	145A	Conductor Losses	13864	W/ph/km
		Dielectric Losses	9,749	W/ph/km
		Armour/Sheath Losse	33,324	W/ph/km
Inter-layer Temperatures at	145A	Conductor	70	°C
		Armour	62	°C
		Serving	57,42	°C
Zero Sequence Impedance/phase			3,9537 + j0,1141	Ω/km
Positive and Negative Sequence Impedance/phase			0,6594 + j0,084	Ω/km
Shunt Susceptance			271	µS/km

35mm² Copper is ±140A



ARB Electrical Wholesalers

Anti-Theft Conductors



16mm² CONCENTRIC 600/1000V CCA		
DESCRIPTION	**THICKNESS (mm)**	**DIAMETER Ø**
PHASE CONDUCTOR COPPER CLAD ALUMINIUM ALLOY	12 X 1.76mm	6.84
PHASE INSULATION(XLPE)	1.22	8.88
NEUTRAL CONDUCTOR COPPER CLAD ALUMINIUM ALLOY	12 X 1.76	12.30
MELINEX TAPE	0.03	12.33
SHEATH (LLDPE)	1.5	18.20

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:
FINISH:
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION

	NAME	SIGNATURE	DATE
DRAWN	CARLOS LOUREIRO		26/04/19
CHK'D			
APPV'D			
MFG			
Q.A			

MATERIAL: CCA
LLDPE
XLPE
WEIGHT:

TITLE: 16mm² Concentric 600/1000v (CCAA)
DWG NO. TC AD18-04
A3
SCALE: 8:1
SHEET 1 OF 1

ARB Electrical Wholesalers

Anti-Theft Conductors

Size Code		Unit	6.0 mm² ESKOM 240-61704085	8.0 mm² ESKOM 240-61704085	10 mm² SANS 1507	16 mm² SANS 1507	10 mm² CCAA	16 mm² CCAA
PHASE CORE								
Conductor Size		mm²	6.00	8.00	10.00	16.00	16.00	25.00
Conductor Condition			Stranded, uncompacted	Stranded, uncompacted	Stranded, uncompacted	Stranded, uncompacted	Stranded, uncompacted	Stranded, uncompacted
TIN COPPER	Conductor Diameter	mm	1.14	1.30	-	-	-	-
	Strands Quantity	qty	6.00	6.00	-	-	-	-
GSW	Conductor Diameter	mm	1.27	1.27	-	-	-	-
	Strand Quantity	qty	1.00	1.00	-	-	-	-
CU	Conductor Diameter	mm	-	-	1.36	1.68	-	-
	Strand Quantity	qty	-	-	7.00	7.00	-	-
CCAA	Conductor Diameter	mm	-	-	-	-	1.70	1.70
	Strand Quantity	qty	-	-	-	-	7.00	12.00
Overall Conductor Diameter		mm	3.55	3.92	4.08	5.04	5.10	6.80
Insulation Thickness (± 0.05)		mm	0.80	0.90	0.80	0.80	0.82	1.02
Insulation Diameter		mm	5.15	5.72	5.68	6.64	6.74	8.84
Insulation Material			UV Red XLPE	UV Red XLPE	UV Red XLPE	UV Red XLPE	UV Red XLPE	UV Red XLPE
CONCENTRIC CONDUCTOR								
Conductor Size		mm²	6.00	8.00	10.00	16.00	16.00	25.00
Conductor Condition			Solid, S/Z *	Solid, S/Z *	Solid, S/Z *	Solid, S/Z *	Solid, S/Z *	Solid, S/Z *
TIN COPPER	Conductor Diameter	mm	1.05	1.30	-	-	-	-
	Strands Quantity	qty	7.00	6.00	-	-	-	-
GSW	Conductor Diameter	mm	1.25	1.26	-	-	-	-
	Strand Quantity	qty	6.00	7.00	-	-	-	-
CU	Conductor Diameter	mm	-	-	1.06	1.36	-	-
	Strand Quantity	qty	-	-	12	12	-	-
CCAA	Conductor Diameter	mm	-	-	-	-	1.70	1.70
	Strand Quantity	qty	-	-	-	-	7.00	12.00
Nominal Diameter Under Sheath		mm	7.65	8.24	7.80	9.36	10.14	12.24
COMMUNICATION CORES *(ONE WHITE AND ONE BLUE)*								
Conductor Size		mm²	0.50	0.50	0.50	0.50	-	-
Conductor Condition			Solid,Annealed, S/Z *	Solid,Annealed, S/Z *	Solid,Annealed, S/Z *	Solid,Annealed, S/Z *	-	-
Conductor Diameter		mm	2 x 0.80mm	2 x 0.80mm	2 x 0.80mm	2 x 0.80mm	-	-
Insulation Diameter		mm	2.00	2.00	2.00	2.00	-	-
Insulation Thickness and Tolerance		mm	0.60 (± 0.05)	0.60 (± 0.05)	0.60 (± 0.05)	0.60 (± 0.05)	-	-
Insulation Material			Blue core LLDPE /White core	Blue core LLDPE /White core	Blue core LLDPE /White core	Blue core LLDPE /White core	-	-
COMPLETE CABLE								
Sheath Thickness (±0.05)		mm	2.00	1.60	1.9	1.95	1.65	2.92
Sheath Diameter		mm	11.65	11.44	11.58	13.14	13.47	18.11
Sheath Material			Black/Orange LLDPE/UV	Black/Orange LLDPE/UV	Black LLDPE	Black LLDPE	Orange LLDPE	Orange LLDPE
Tape Between Sheath And Cores			30.00	30.00	melinex 40 mm	melinex 40 mm	Melinex 35 mm	Melinex 40 mm
Ripcord			Polyester yarn	Polyester yarn	polyester yarn	polyester yarn	Polyester yarn	Polyester yarn
Approximate Cable weight		kg/km	227 - 229	285 - 290	240 - 250	355 - 365	167 - 180	326 - 340
CURRENT RATING								
In Air (Continuous full load) @ 30°C		A	60	70	80	100	60	90
In ground (Continuous full load) @ 25°C		A	60	70	130	160	75	105
RESISTANCE								
Phase core	dc @ 20°C	Ω/km (max)	3.020	2.400	1.88	1.18	1.88	1.18
	ac @ 90°C	Ω/km (max)	3.851	3.060	2.397	1.505	2.397	1.505
Conductor	ac @ 90°C	Ω/km (max)	3.812	3.060	2.333	1.466	2.333	1.466
COMMS	dc @ 20°C	Ω/km (max)	35.000	35.000	35	35	-	-
	ac @ 90°C	Ω/km (max)	44.625	44.625	44.625	44.625	-	-
Dielectric resistance		MΩ/km	>100	>100	>100	>100	>100	>100
Impedance		Ω/km	3.700	2.900	2.335	1.47	2.19	1.47
Short circuit ratings								
Symmetrical		kA (1 sec)	0.85	1.10	1.40	2.2	1.35	2.16

ARB Electrical Wholesalers

Anti-Theft Busbars

New Bimetallic Copper Clad technologies (CCA busbars)

CCA busbars can now **replace** Copper busbars in MV and LV applications:

- MV AIS switchgear
- LV side of MSS
- BMK
- MV outdoor CB (Dog boxes)
- LV Pillar boxes
- Earth bars

Produced in lengths up to 6m

Can be drilled, punched and bent

Busbar cross sectional sizes **slightly** larger than Copper busbars
(Skin effect with in conductors)

Can be tinned if required

No international standards exist yet. NRS standard may be required to ensure quality

ARB Electrical Wholesalers

Anti-Theft Busbars

New Bimetallic Copper Clad technologies (CCA busbars)

ARB Electrical Wholesalers

Anti-Theft Busbars

INTENSITÉS NOMINALES DU COURRANT AC/DC / AC/DC CURRENT RATINGS

Taille Size	Rayon extérieur Corner radius	Domaine Area	Poids Weight	Résistance DC à DC Resistance to 20ºC	Résistance DC à DC Resistance to 65ºC	n=1		n=2		n=3		n=4	
mm	mm	mm²	g/m	µOhm/m	µOhm/m	DC	AC	DC	AC	DC	AC	DC	AC
10x3	0,5	29,79	0,108	890	1050	99	99	188	188	277	277	366	365
20x3	0,5	59,79	0,247	443	523	175	175	322	322	469	466	615	611
25x3	0,5	74,79	0,271	354	418	211	211	386	385	560	557	733	728
10x4	0,5	39,79	0,144	666	786	119	119	229	229	338	337	448	447
16x4	1,5	62,07	0,225	427	504	169	169	319	318	468	466	617	614
20x4	1	79,14	0,287	335	395	205	205	382	382	559	556	736	730
25x4	1	99,14	0,36	267	316	247	247	457	455	665	660	873	863
30x4	1	119,14	0,432	222	26	289	289	529	527	768	761	1007	991
40x4*	1	159,14	0,627	164	194	373	372	676	670	977	961	1277	1242
10x5	0,5	49,79	0,181	532	628	137	137	266	266	395	394	525	522
12x5	0,5	59,79	0,217	443	523	157	157	304	304	451	449	597	594
15x5	sq	75	0,272	353	417	187	187	358	357	528	525	698	693
20x5	1,5	98,07	0,356	270	319	233	233	439	437	644	639	849	840
20x5	sq	100	0,363	265	313	235	235	443	441	650	646	858	848
25x5	1,5	123,07	0,447	215	254	280	280	522	519	763	755	1004	987
30x5	1,5	158,07	0,537	179	211	327	326	604	599	879	867	1154	1127
30x5	sq	150	0,545	177	209	329	328	607	603	885	872	1162	1134
40x5	1,5	198,07	0,719	134	158	418	416	762	752	1105	1079	1446	1388
40x5	sq	200	0,726	133	156	420	418	766	756	1110	1084	1453	1395
50x5*	1,5	248,07	0,977	105	124	511	508	924	905	1334	1285	1743	1637
60x5*	1,5	298,07	1,174	88	103	599	594	1077	1047	1550	1471	2022	1856
80x5*	1,5	398,07	1,568	66	77	773	762	1376	1320	1971	1809	2565	2248
20x6	2	116,57	0,423	227	268	259	259	492	489	725	18	958	943
25x6	2	146,57	0,532	181	213	311	311	584	579	856	845	1128	1103
28x6	2	164,57	0,597	161	190	341	341	638	632	933	918	1228	1194
30x6	2	176,57	0,641	150	177	362	361	673	666	984	965	1294	1252
40x6	2	236,57	0,859	112	132	461	459	848	833	1232	1192	1615	1527
50x6	2	396,57	1077	89	105	559	555	1018	991	1473	1400	1927	1774
60x6	2,5	354,63	1287	75	88	653	646	1181	1140	1703	1590	2225	1995
75x6*	2	446,57	1759	58	69	803	789	1440	1370	2069	1867	2696	2311
80x6*	2	476,57	1878	55	65	851	834	1521	1441	2183	1950	2844	2406
120x6	2	716,57	2823	36	43	1222	1179	2155	1979	3075	2538	3990	3103
12x6,3	2	72,17	0,262	367	433	179	179	348	348	517	515	686	681
16x6,3	2	97,37	0,353	272	321	224	224	431	430	639	634	846	837
20x6,3	2	122,57	0,445	216	255	267	267	509	506	750	743	992	975
25x6,3	2	154,07	0,559	172	203	320	320	603	598	885	872	1167	1138
28x6,3	2	172,97	0,628	153	181	352	351	658	651	964	947	1269	1230
32x6,3	2	198,17	0,719	134	158	393	392	731	721	1068	1043	1404	1348
38x6,3	2	235,97	0,857	112	133	454	452	838	824	1220	1181	1602	1515
40x6,3	2	248,57	0,902	107	126	474	472	874	857	1270	1225	1667	1568
50x6,3	2	311,57	1131	85	100	575	569	1048	1018	1517	1436	1986	1816
63x6,3	2	393,47	1428	67	80	702	693	1269	1218	1830	1686	2390	2104
65x6,3*	2	406,07	1600	64	76	727	717	1312	1256	1892	1732	2470	2156
80x6,3*	2	500,57	1972	52	62	873	855	1563	1476	2246	1989	2926	2451
82x6,3*	2	513,17	2022	51	60	893	873	1596	1504	2292	2021	2986	2488
100X6,3*	2	626,57	2469	42	49	1065	1034	1891	1755	2707	2297	3520	2813
120X6,3*	2	752,57	2965	35	41	1254	1207	2213	2022	3159	2580	4101	3157
16x8	0,25	127,95	0,464	207	244	266	266	517	514	768	760	1019	1001
20x8	2	156,57	0,568	169	200	312	311	601	596	891	877	1180	1149
25x8	2	196,57	0,714	135	159	371	370	708	698	1044	1020	1380	1326

Taille Size	Rayon extérieur Corner radius	Domaine Area	Poids Weight	Résistance DC à DC Resistance to 20ºC	Résistance DC à DC Resistance to 65ºC	n=1		n=2		n=3		n=4	
mm	mm	mm²	g/m	µOhm/m	µOhm/m	DC	AC	DC	AC	DC	AC	DC	AC
30x8	2	236,57	0,859	112	132	430	428	812	797	1193	1154	1573	1487
34x8	2	268,57	0,975	99	116	476	473	894	874	1309	1256	1725	1608
40x8	2	316,57	1149	84	99	545	540	1014	985	1481	1399	1947	1777
50x8	2	396,57	1440	67	79	658	649	1211	1161	1760	1620	2309	2030
60x8	2	476,57	1730	56	66	769	755	1403	1328	2033	1820	2661	2259
75x8	2	596,57	2166	44	52	933	908	1686	1568	2432	2090	2177	2573
80x8	2	636,57	2311	42	49	987	958	1779	1644	2564	2175	3346	2674
90x8	2	716,57	2601	37	44	1094	1057	1963	1795	2824	2338	3681	2871
100x8	2	796,57	2892	33	39	1201	1154	2146	1942	3080	2494	4012	3061
10x10	sq	100	0,363	265	313	225	225	439	438	654	649	869	859
12x10	1	119,14	0,432	222	263	253	252	493	491	734	727	975	959
12x12	sq	144	0,523	184	217	290	289	568	563	845	834	1123	1098
15x10	1	149,14	0,541	178	210	295	294	575	570	855	843	1134	1108
15x10	sq	150	0,545	177	209	296	295	577	572	857	845	1138	1111
20x10	3	192,27	0,698	138	163	357	356	695	686	1032	1009	1369	1317
20x10	sq	200	0,726	133	156	365	363	709	699	1052	1027	1396	1340
25x10	3	242,27	0,879	109	129	425	422	820	804	1214	1173	1609	1518
25x10	sq	250	0,908	106	125	431	429	833	816	1234	1189	1634	1536
30x10	3	292,27	1061	91	107	491	487	937	913	1383	1317	1829	1687
30x10	sq	300	1089	88	104	497	493	949	923	1401	1331	1853	1703
40x10	3	392,27	1424	68	80	619	611	1165	1116	1708	1575	2251	1984
50x10	3	492,27	1787	54	64	746	731	1385	1306	2023	1801	2659	2242
50x10	sq	500	1815	53	63	751	736	1396	1314	2038	1810	2680	2252
60x10	3	592,27	2150	45	53	870	848	1601	1484	2329	2004	3055	2478
60x10	sq	600	2178	44	52	875	853	1612	1492	2344	2012	3075	2488
75x10	3	742,27	2694	36	42	1053	1015	1918	1737	2778	2282	3635	2814
80x10	3	792,27	2876	33	39	1114	1070	2023	1819	2925	2371	3825	2921
80x10	sq	800	2904	33	39	1119	1074	2033	1825	2939	2378	3843	2930
100x10	3	992,27	3602	27	32	1353	1282	2434	2135	3504	2711	4571	3330
100x10	sq	1000	3630	27	31	1358	1287	2443	2141	3518	2718	4589	3338
120x10	3	1192,27	4328	22	26	1589	1488	2837	2439	4071	3032	5301	3713
18x12	sq	216	0,784	123	145	383	381	746	734	1108	1078	1471	1401
20x12	3	232,27	0,843	114	135	406	404	790	776	1174	1137	1558	1476
24x12	sq	288	1045	92	109	471	468	916	893	1361	1298	1806	1670
30x12	sq	360	1307	74	87	558	552	1077	1038	1596	1487	2114	1890
40x12	3	472,27	1714	56	66	693	681	1316	1243	1938	1737	2559	2176
50x12	3	592,27	2150	45	53	831	809	1559	1440	2284	1966	3009	2440
60x12	3	712,27	2586	37	44	961	934	1796	1625	2621	2173	3445	2690
120x12	3	1432,27	5199	19	22	1755	1617	3151	2625	4534	3248	5912	3981
63x12,5	3	779,77	2831	34	40	1032	992	1915	1711	2795	2273	3673	2814
24x15	sq	360	1307	74	87	548	542	1069	1031	1589	1480	2109	1885
50x15	3	742,27	2694	36	42	953	918	1809	1618	2663	2188	3517	2723
60x15	3	892,27	3239	30	35	1105	1052	2075	1806	3043	2407	4010	2988
32x16	3	504,27	1831	53	62	702	688	1365	1283	2029	1799	2692	2258

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Electrical Wholesalers