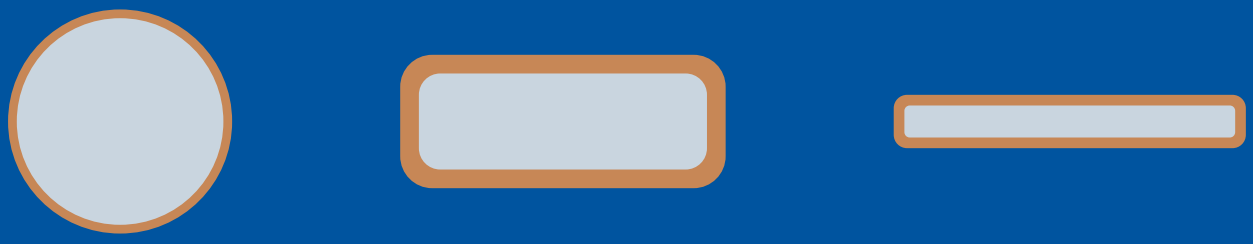
RAYTRON

MATERIAL SELECTION / PROCUREMENT / QUALITY

Copper-Clad Aluminum Buyer's Guide

Specify it. Compare it. Put it to work.

ROUND WIRE / FLAT WIRE / STRIP / FOIL / PV RIBBON



WIRE FLAT WIRE STRIP / FOIL

Construction illustration. Not a material micrograph.

Copper at the surface. A lighter core within.

A practical guide to construction, copper content, resistance, connections, application fit, purchasing cost and incoming inspection. With worked examples, an RFQ checklist and linked references.

Engineering Every Micron.

www.raytron.group

Contents

New to the material? Start with section 01. Preparing an inquiry? Go to section 17.

01 Decide in one minute whether CCA is worth evaluating . . . 3

02 What copper-clad aluminum is . . . 4

03 What CCA can offer . . . 5

04 Always ask what the copper percentage means . . . 5

05 Understand resistivity, conductivity, and ampacity . . . 6

06 Choose the right form of wire, strip, or foil . . . 8

07 Look beyond average copper thickness . . . 9

08 Understand the process and ask for measurable results . . . 9

09 Match the evaluation to the application . . . 10

10 Compare the PV ribbon bill and the module result together . . . 12

11 Follow the applicable route for utility cables and building wire . . . 13

12 Connections and environment determine service performance . . . 14

13 Calculate cost per metre, per part, and per accepted output . . . 15

14 Move from samples to production with a clear trial plan . . . 17

15 Build an incoming-inspection checklist . . . 17

16 Get the documents and delivery terms right for global purchasing . . . 19

17 A ready-to-use RFQ checklist . . . 20

18 Ten statements worth correcting in a purchasing meeting . . . 21

19 Useful formulas and terminology . . . 22

20 Bring your current specification and explore the next option . . . 23

References . . . 24

Understand the material, specify the right product, compare the real cost, and know what to inspect

For copper-clad aluminum round wire, aluminum-alloy-core wire, fine flat wire, strip, foil, and copper-aluminum composite PV ribbon.

The idea behind copper-clad aluminum is straightforward: keep copper where its surface properties are useful, and let lighter aluminum carry part of the electrical load. With the right design, the conductor can weigh less and cost less per metre or per part.

The purchasing decision is about the particular construction your product needs: how much copper, which core material, what shape, which connection, and what service conditions. Those questions matter much more than whether the outside looks like copper.

This guide follows the decisions buyers actually make. New to the material? Start here. Ready to request a quotation? Go straight to the checklist in Section 17.

01 Decide in one minute whether CCA is worth evaluating

If the weight, cost per metre, or supply cost of your copper material is a problem, and your product allows a change in material or section, CCA deserves a place on the shortlist. Answer these six questions before ordering samples.

First establish	Why it matters
What the material does in the product	Carrying current, transmitting signals, soldering, making contact, and shielding have different priorities
Where the product will be sold and which specifications apply	Determines whether the material is permitted and which finished-product tests and approvals are needed
What cannot change	Diameter, thickness, terminals, tooling, resistance, temperature rise, or the customer drawing
How the material will be processed and joined	Drawing, rolling, stamping, bending, coating, soldering, welding, or crimping
Operating conditions	Continuous current, frequency, flexing, temperature, moisture, and chemical exposure
The unit used to compare cost	Per metre, per part, or per accepted module, including yield and associated costs

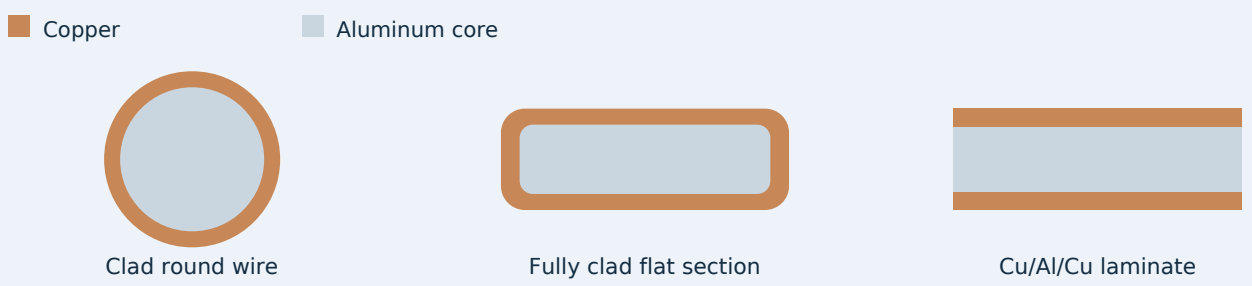
The most productive projects have clear requirements, clear acceptance criteria, and a cost comparison that can be checked after the trial.

02 What copper-clad aluminum is

Copper outside, aluminum inside, both carrying current

Typical CCA wire has an aluminum core surrounded by continuous copper cladding. Copper provides the external contact surface and conducts current. The aluminum core reduces weight and also conducts current. Calling it merely a filler misses a substantial part of its job. [R01][R17]

This is a composite structure: copper and aluminum remain distinct material regions. It is different from melting the two metals together to make an alloy.



Round wire, flat wire and Cu/Al/Cu laminate constructions.

On the market, “alloy ribbon” may refer to an alloy core, a solder formulation, or another material system. When names sound similar, check the cross-section and composition first.

A silvery aluminum core visible at the cut end of a round wire is normal. Exposed aluminum, cracked copper, or separation along the outside of a wire specified as fully clad calls for inspection against the agreed requirements. Colour can help identify a construction; it cannot complete an acceptance test.

Turn product names into actual specifications

Name	What it usually describes	What the buyer still needs to establish
CCA	Copper-clad aluminum	Copper fraction, aluminum core grade, temper, dimensions, and resistance
CCAA / HTCCA	Copper cladding over a specified aluminum-alloy core; HTCCA is a Raytron product-family name	Actual core grade and performance; the abbreviation alone does not establish high-temperature capability or an AA-8000-series core
Tinned CCA	A CCA substrate with an additional tin or solder coating	Coating composition and thickness, bare or coated dimensions, and soldering compatibility
CCA flat wire, strip, or foil	Different supplied forms of a copper-aluminum composite	Cross-section, copper-covered faces, edges, and the width-thickness combination
CCS	Copper-clad steel	The steel core's mechanical, electrical, and magnetic properties; CCS and CCA are not interchangeable
Polymer-based composite copper foil	Copper layers combined with a polymer core	A different structure and application from metal-core CCA foil

“High strength,” “high conductivity,” and “extra soft” are useful introductions. Before signing an order, replace them with values, units, and test conditions.

03 What CCA can offer

Less weight and a cost per metre worth calculating

Copper and aluminum have very different densities. The teaching calculations in this guide use 8.96 g/cm³ for copper and 2.70 g/cm³ for aluminum. The density of the delivered material depends on its actual core, copper fraction, and coating. [R04][R05]

At the same section and length, CCA is generally much lighter than copper. Some weight advantage may remain even when the section is increased to reduce resistance. To determine the cost benefit, multiply actual mass by the quoted finished-material price, then account for processing and associated components.

The copper surface is useful, and the whole section matters

A copper surface has practical value for connections, soldering, and certain high-frequency designs. It does not give the underlying aluminum all the properties of solid copper. At equal dimensions, CCA generally has higher DC resistance than copper. Electrical duty, connections, mechanics, and environmental performance belong in the same design review.

Design flexibility has value too

Copper fraction, core material, temper, round or flat geometry, and coating can all be design variables. Where a product allows these to change, there is usually more room to find an economical construction than when every dimension and process must remain fixed.

CCA earns its place through the cost, weight, and manufacturing performance of an accepted product. The material quotation is only the first bill.

04 Always ask what the copper percentage means

“30% copper” is not a complete specification. It could mean copper by mass or by volume. Leaving out a few letters can add three meetings.

This guide primarily uses **copper volume fraction, vol.%**, when comparing materials. For uniform bare material over the same length, copper cross-sectional area fraction equals copper volume fraction. Copper mass fraction is written as wt.%.

Volume fraction and mass fraction are different

The following calculations use copper at 8.96 g/cm³ and aluminum at 2.70 g/cm³, with no coating. They explain the relationship between fractions; they are not an availability table.

Copper volume fraction, vol.%	Corresponding copper mass fraction, wt.%	Calculated density, g/cm³
10	26.94	3.326
15	36.93	3.639

Copper volume fraction, vol.%	Corresponding copper mass fraction, wt.%	Calculated density, g/cm³
30	58.72	4.578
40	68.87	5.204
50	76.84	5.830

Working the other way, 30 wt.% copper is approximately 11.44 vol.%; 40 wt.% is approximately 16.73 vol.%; and 50 wt.% is approximately 23.16 vol.%. **30 wt.% and 30 vol.% describe different compositions.**

Some existing Raytron designations, such as “CCA30,” use copper mass fraction. State the actual fraction and its basis in the purchase specification instead of inferring them from the grade name. For tinned products, also state whether the percentage applies to the substrate or to all metal in the coated product.

More copper is not automatically better value

With the same core material, temper, and substrate dimensions, increasing the copper fraction generally increases conductivity and copper thickness, while also increasing density and material cost. The objective is a suitable composition that meets the resistance, connection, forming, and reliability requirements.

At minimum, specify **the fraction basis, nominal value or limits, core material, treatment of coatings, and inspection method.**

ASTM B566 classes 10A, 15A, 10H, and 15H refer to nominal copper volume fractions of 10% or 15%. A denotes annealed and H denotes hard-drawn. In this context, “10A” does not mean ten amperes. [R01]

05 Understand resistivity, conductivity, and ampacity

Three measurements that answer different questions

Property	Plain-language meaning	How to specify it
Resistivity	How strongly the material resists current; usually lower is better	At 20°C, in Ω·mm²/m, identifying whether the area is bare metal or the finished section
Resistance	The resistance of an actual conductor length; depends on length, section, and temperature	Single conductor or complete circuit, Ω/km or Ω/m, and measurement temperature
Ampacity	Permitted continuous current under defined conditions	Together with insulation, ambient conditions, installation, bundling, connections, and permitted temperature

IACS is a conductivity reference. At 20°C, 100% IACS corresponds to approximately 0.017241 Ω·mm²/m. [R03]

70% IACS does not mean “70% of copper's current rating,” nor does it permit automatic use of copper ampacity tables. Temperature rise depends on the balance between heating and cooling. A connection can become the limiting point before the conductor itself does.

A transparent teaching model

Assume copper at 100% IACS and aluminum at 61% IACS, both metals effectively connected to the current path, a continuous interface, and a uniform section. Compare straight bare conductors of the same length at 20°C. These are calculated values, not measured or guaranteed values for a particular grade. [R03]

Copper volume fraction	Theoretical conductivity, %IACS	Area multiplier for equal resistance	Round-wire diameter multiplier	Mass at equal resistance, relative to copper
10%	64.90	1.541	1.241	57.2%
15%	66.85	1.496	1.223	60.8%
30%	72.70	1.376	1.173	70.3%
40%	76.60	1.305	1.143	75.8%
50%	80.50	1.242	1.115	80.8%

Multipliers and mass ratios use an equal-length copper conductor as the reference. The model shows why CCA generally needs a larger section to achieve similar DC resistance, yet may still weigh less. Alloy cores, material condition, coatings, and actual dimensions affect the result.

Power frequency and high frequency need separate treatment

“The current only travels through the copper skin, so it performs like copper” does not describe DC operation. It is also unsuitable as an explanation for common small-diameter wires at 50/60 Hz.

At higher frequencies, current concentrates closer to the surface, making copper-layer design useful. Performance still depends on frequency, minimum copper thickness, conductor geometry, surface condition, proximity effect, and connections. For ideal nonmagnetic copper, skin depth is approximately 9.35 mm at 50 Hz and 66 µm at 1 MHz. These values indicate scale; they do not guarantee CCA transmission performance.

The skin-depth calculation assumes copper at 20°C and 100% IACS, with relative magnetic permeability approximately 1. The NIST reference provides the relevant formula and order of magnitude. [R27]

For RF products, evaluate insertion loss, return loss, and the complete assembly. Windings also need AC-loss assessment at their operating frequency. **Equal DC resistance answers one question; it does not complete the equipment evaluation.**

06 Choose the right form of wire, strip, or foil

Form	Geometry to specify first	Frequently overlooked details
Round wire	Diameter, tolerance, ovality	Cladding eccentricity, thinnest copper location, continuous reel length
Fine flat wire	Thickness × width, corner radii, permitted cross-sectional area	Copper at rolled edges and corners, bend direction, springback
Strip	Thickness × width, camber, flatness	Slitting burrs, edge coverage, core exposure after stamping
Foil	Total thickness, copper-layer construction, thickness uniformity	Pinholes or defects, winding and unwinding, core dimensions, winding tension
Tinned or solder-coated product	Separate substrate and finished dimensions	Coating composition, local thickness, soldering, and storage requirements

Suppliers and standards may use different thickness boundaries for “strip” and “foil.” A dimension in millimetres or micrometres is more useful on a drawing than a debate over the name.

Reference ranges on Raytron's current product pages

The published reference diameter for round wire is 0.10-4.00 mm. Some flat-wire pages give a reference width limit of 6 mm. Precision CCA strip and foil pages list widths of 0.5-12 mm. [R17][R18][R19]

These are ranges for different product forms. Do not combine the maximum width, minimum thickness, thinnest copper layer, and tightest tolerance into an assumed deliverable specification. Send the actual width-thickness combination or drawing so Raytron can confirm material, temper, surface, reel length, and tolerances together.

Identify every face that needs copper coverage

Flat material rolled from fully clad round wire can have a different edge structure from a two-sided Cu/Al/Cu laminate. Mark the required copper coverage on the upper face, lower face, edges, and joining locations.

Fully clad as delivered does not mean that every new face created by slitting, punching, or cutting will also be copper-covered. Processing exposes new sections. Their connections and environmental exposure need to be considered. [R18][R19]

The words “copper foil” in a product description do not make CCA foil a direct substitute for a solid-copper battery current collector, any width of shielding foil, or PCB copper foil. Confirm construction, width, intended duty, and finished-product requirements first.

Resistance measured after coating, combined with the total coated metal cross-sectional area, gives the finished product's equivalent resistivity. It cannot be treated directly as the bare substrate's resistivity. For coated products such as PV ribbon, prioritise an agreed finished resistance per metre.

07 Look beyond average copper thickness

The same overall copper fraction can be distributed differently around a section. An acceptable average fraction does not establish equal thickness in every direction. Edges, corners, rolling transitions, and contact locations deserve particular attention in flat products.

For an ideal concentric round wire with substrate outside diameter D, excluding any added coating, and copper volume fraction f, radial copper thickness is:

$t = D \div 2 \times [1 - \sqrt{(1 - f)}]$

At a 1.00 mm outside diameter, ideal copper thickness is approximately 25.7 µm at 10 vol.% copper and 39.0 µm at 15 vol.%. At a 0.20 mm diameter, those thicknesses become approximately 5.1 µm and 7.8 µm. The percentage can stay the same while the absolute copper thickness becomes much smaller.

This formula cannot be applied directly to rolled flat material. Determine the actual minimum layer thickness from a real cross-section with a scale, using agreed sampling locations, calculation methods, and acceptance limits.

If a specification says “relative copper-thickness deviation ≤ X%,” ask what the denominator is: average thickness, nominal thickness, or another reference? The same label can conceal different calculations. **Put the formula in the technical agreement so the numbers can be compared.**

08 Understand the process and ask for measurable results

Copper-aluminum composites can be made by different manufacturing routes. Buyers do not need to memorise every process, but they should understand which steps affect the delivered product.

Process stage	Why it matters to your product	Useful evidence to request
Core and copper feedstock	Establishes basic electrical, mechanical, and processing behaviour	Material grades and lot records
Surface preparation and bonding	Affects interface continuity and subsequent deformation	Actual cross-sections and bond tests suited to the product form
Drawing and rolling	Changes dimensions, copper distribution, surface, and material condition	Dimensional and resistance records; sections at critical locations
Heat treatment	Changes temper, elongation, and interface structure	Mechanical, electrical, and downstream-processing results for the actual specification
Coating and winding	Affects joining, storage, and production-line handling	Coating, surface, packaging, and payoff requirements

Raytron's published process information connects material preparation, composite forming, heat treatment, and inspection, with the route and acceptance method established for the particular product. [R21]

Heat treatment must suit the materials and process. Excessive interfacial reaction, defects, and local damage can affect performance. The best temperature reported in one paper is not an annealing recipe for every product. [R24]

Process labels such as “electroplated,” “clad,” or “rolled” do not rank every product by quality. A more useful purchasing question is whether the actual construction meets its specification and continues to do so after your bending, soldering, crimping, or thermal cycling.

09 Match the evaluation to the application

This table identifies selection priorities. It is not a worldwide approval list.

Application	Potential value to evaluate	What to check first
PV module interconnects and busbars	Reduced copper use and ribbon purchasing cost	Finished resistance, stringing, yield, module power, and reliability
Coaxial cables and antennas	Lower weight, with RF performance designed around the copper surface	Frequency, copper thickness, attenuation, impedance, terminations, and complete-cable requirements
CAT 5e / CAT 6 network-cable conductors	Established large-scale use to reduce conductor weight and material cost	Finished-cable transmission performance, DC resistance and unbalance, terminations; voltage drop and temperature rise for PoE
Cable shielding tape	CCA strip is being used to replace copper tape for weight and material-cost reduction	Shield function, copper-layer construction, thickness, width, overlap, continuity, and connections; short-circuit capability where fault current is carried
Metallic screen wire for MV cables	A balance of resistance, weight, and cost in permitted constructions	Screen resistance, fault current and duration, connections, and customer specifications
LV concentric neutrals or service cables	Specific application routes exist in some utility specifications	Installed role, construction, document revision, short-circuit duty, and finished-cable assessment
Building wire	Development where the destination market provides a compliance route	Core material, material and cable certification, wire size, terminals, and locally adopted rules
Track-light and equipment conductors	Section and cost options within a limited envelope	Current, contact pressure, temperature rise, wear, and equipment requirements
Electronic connection strips and narrow foil parts	Weight reduction and material-construction options	Stamping, bending, joining, exposed core edges, and contact stability
Windings and electromagnetic components	Weight and cost options where the design can change	Slot fill, DC and AC losses, insulation, temperature rise, and lead connections

Application	Potential value to evaluate	What to check first
Frequently flexed cables or welding cables	Development around a specific cable construction	Flexibility, strand fatigue, duty cycle, temperature rise, terminals, and product standards

HARADA's official history records the development of a CCA coaxial cable in 2008. This establishes an application history in coaxial products; it does not establish direct substitution in every coaxial construction or indicate that HARADA uses Raytron material. [R23]

CAT 5e / CAT 6 network cable: select the conductor and cable together

CCA conductors are already used at large scale in CAT 5e and CAT 6 network cables. For cable manufacturers, this is an established material-selection route for reducing conductor weight and material cost. [R30]

Select wire diameter, copper volume fraction, core material, and temper together with insulation, pair twist, and terminations. Inspect the conductor for dimensions, DC resistance at 20°C, mechanical properties, and copper cladding. Test the finished cable for insertion loss, return loss, crosstalk, and resistance unbalance at the agreed category, frequency range, and length. The signal needs to get through, and the pairs need to stay out of each other's way.

For PoE, also specify power level, link length, loop voltage drop, bundled-cable temperature rise, and connectors. Data-only service and combined data-and-power service have different acceptance priorities.

State CCA conductors, test methods, limits, and intended use explicitly in the order. Projects requiring compliance with specified TIA, ISO/IEC, or local installation requirements must also address the relevant conductor-material provisions and certification. Record the test category, length, and test items: a statement that a cable passed a 100-metre test should refer to an actual report and does not establish every compliance requirement. [R13]

Cable shielding tape: replacing copper tape with CCA strip

CCA strip is now being used to replace copper tape in cable shields. [R30] This is a copper-aluminum metallic composite; distinguish it from aluminum/polymer and copper/polymer laminates when specifying the construction. A shielding tape and the cable's core conductors are also different components and must be selected for their respective functions.

Start with the shield's job. For signal or electromagnetic shielding, specify the frequency range, helical or longitudinal wrapping method, coverage and overlap, shield continuity, and drain-wire or connection arrangement. Assess shielding performance in the finished cable. If a power-cable metallic screen also carries earth-fault current, assess screen resistance, effective metallic cross-section, fault current and duration, permitted temperatures, and earthing connections. One construction may perform both jobs and must meet both sets of requirements.

Then specify the strip and wrapping conditions. Include thickness × width, tolerances, copper volume fraction or specified layer construction, minimum copper thickness, temper, edge burrs, bond integrity, and overlap width or percentage. Define how overlap percentage is calculated. The drawing should also identify contact and protection requirements at slit edges, joints, and earthing points.

Compare actual tape consumption per kilometre of finished cable, including thickness, width, wrapping pitch, overlap, process losses, and connection costs. Equal tape thickness does not establish equal

shielding performance or equal short-circuit capability. Validate the substitution in the finished cable and calculate cost on the same construction basis.

Resolve these constraints before ordering substitution samples

The customer drawing may require copper without permitting a material change. The material or finished-product specification may provide no applicable route. Dimensions may be fixed while resistance has no remaining margin. Or the connection and environment may be impossible to validate. Resolve the relevant constraint before beginning a replacement trial.

10 Compare the PV ribbon bill and the module result together

Purchasing, process engineering, R&D, and quality look at different aspects of the same ribbon. Purchasing needs lower cost; process engineering needs stable stringing; R&D checks power; quality checks cell damage, connections, and long-term reliability. A useful evaluation brings these measures into one comparison. [R20]

The material-cost opportunity

Some projects reduced ribbon material cost by more than 50% using copper-aluminum composite ribbon instead of copper ribbon. The percentage refers to ribbon material cost. Calculate your project's saving from its specification, purchase price, actual consumption, and yield. [R22]

A saving needs a denominator. A 50% reduction in ribbon cost does not mean a 50% reduction in total module cost. Savings per GW also depend on the corresponding production volume, actual ribbon consumption, and module output.

Raytron's copper-aluminum composite ribbon has been used in more than 50 GW of modules cumulatively. [R29]

Record five groups of results

Data group	Minimum useful records
Material	Substrate and coated dimensions, copper fraction, finished resistance per metre, yield or proof strength, and elongation
Joining	Solder composition, flux, temperature profile, pull or peel method, and joint consistency
Production	Stringing speed, downtime, ribbon breaks, rework, cell breakage, and accepted yield on a consistent measurement basis
Module	Electroluminescence results, power distribution, and relevant contact- and series-resistance behaviour
Reliability	Thermal cycling, damp heat, and other applicable tests selected for the product and certification requirements, including electrical and visual results after testing

Names such as MBB, SMBB, 0BB, BC, and HJT do not define a ribbon specification on their own. Establish the cell construction, interconnection layout, contact locations, process temperature, and equipment before selecting the substrate and coating. Fine-wire and low-temperature processes need particular care when carrying settings over from an earlier product.

“Tinned” does not automatically mean pure tin, lead-free, or compatible with every soldering process. State the actual solder composition, thickness, and environmental requirements. Measure and specify the copper layer separately from the solder coating.

Compare cost per watt on a consistent basis

Ribbon material cost per watt = ribbon material cost attributable to one accepted module ÷ that module's actual output power.

For a complete-module comparison, use the full module cost on the same basis, including yield, process changes, and actual output. A ribbon saving cannot simply be relabelled as a percentage reduction in complete-module cost per watt.

Likewise, a measured power difference in one project is not a fixed wattage loss for every module. A useful comparison uses the same cell batch, module construction, and test conditions.

Agree the retesting scope for module design changes with the certification body. IEC TS 62915:2023 provides a retesting framework related to IEC 61215 and IEC 61730. Passing design qualification does not translate directly into a specified number of years of actual service life. [R14][R15][R16]

11 Follow the applicable route for utility cables and building wire

Three documented utility examples

Source	What can be established	How a buyer should use it
ENEL GSCC014, amendment 01/2025	Introduces CCA concentric neutral conductors for certain Type I-III LV concentric cables for Italy; Types II/III still require copper equalising tape	Develop against the specific cable type, installed position, conductor resistance, and project documents
EPM ET-TD-ME01-18 Rev.2, 2018	A historical public specification includes CCA concentric service cables; the CENS directory marks the specification as being updated	Use as an application lead and ask the customer for the current controlled revision
Eskom 240-56063805 Rev.3, 2022	Provides pilot or trial routes for certain CCAA LV service cables and multicore LV control cables	Follow the specified pilot, project dimensions, and approval conditions

Develop each project against the relevant utility's cable type, document revision, and approval procedure. [R09][R10][R11][R12]

MV metallic screen wire must address fault duty

A metallic screen may carry fault current as well as meeting normal resistance requirements. Establish fault current, clearance time, permitted initial and final temperatures, screen construction, and earthing connections. Do not apply copper's short-circuit thermal constant directly to a composite conductor.

For example, if a customer requires resistivity below 0.027 Ω·mm²/m at 20°C, conversion using the 100% IACS reference gives conductivity above approximately 63.86% IACS. This is **a conversion of a stated technical requirement**, not a universal utility limit. Acceptance should still use the original limit, measurement uncertainty, and agreed decision rule.

US building wire requires a complete compliance route

CCA has a compliance route in US building wiring, but adding insulation to ordinary bare CCA does not automatically establish suitability. Core material, cladding, material and finished-cable certification, wire size, protective devices, terminals, and the code edition adopted at the project location must work together. [R07][R08]

Other markets also require a review starting from the finished product. Compliance with a material standard, a satisfactory resistance test, or a quality-management certificate does not replace the destination product's requirements.

12 Connections and environment determine service performance

Crimped and bolted connections

Confirm the connector's permitted conductor material, wire size, solid or stranded construction, temperature rating, tools, dies, and installation settings. Use the specific certification and manufacturer's instructions to establish suitability. A copper surface alone is not enough. [R07][R25]

Beyond initial resistance and pull-out strength, evaluate connection stability after thermal or current cycling as required by the application. If an antioxidant compound is required, follow the connector instructions; do not add an arbitrary grease or paste.

Joining and forming

Identify the surface actually being joined, whether processing leaves the copper layer intact, and how heat input affects the substrate and coating. Making one joint does not establish a stable production window. Butt, lap, ultrasonic, resistance, and laser joining processes should be developed for the actual material combination.

For bending, define radius, direction, number of cycles, speed, and acceptance criteria. Higher elongation in an annealed material does not by itself establish high-cycle flex life.

Moisture and corrosion

Continuous copper cladding changes the exposed surface, but cut ends, punched edges, scratches, and locations where water can enter still need assessment. Where an electrolyte, copper-aluminum contact, and local exposure are present, consider galvanic corrosion and address it through sealing, connection, or protection measures appropriate to the environment. [R26]

Select salt-spray, damp-heat, or immersion tests for the intended service. An isolated number of test hours cannot be converted directly into years outdoors.

13 Calculate cost per metre, per part, and per accepted output

Finance pays by the kilogram. The product works by the metre. Both need to be happy.

Step one is to fix the comparison basis

Comparison route	When it is useful	Main issues to evaluate
Keep the dimensions	Tooling, slots, or the external envelope cannot change	Increased resistance, temperature rise, and operating margin
Keep the DC resistance	A larger section is possible	Dimensions, mass, terminals, insulation, and processing cost
Redesign the component	Material, geometry, or construction can change	Complete-product performance and cost per accepted part

Do not combine the weight saving from the first route with the electrical performance of the second and present them as one product.

Step two is a calculation anyone can check

Compare 1 km of straight bare conductor at 20°C. Assume copper with an area of 2.50 mm², resistivity of 0.017241 Ω·mm²/m, and density of 8.96 g/cm³. Assume CCA with resistivity of 0.027 Ω·mm²/m and density of 3.42 g/cm³. **These are separate teaching inputs, not a grade from the earlier ideal-composition table or guaranteed properties of a Raytron product.**

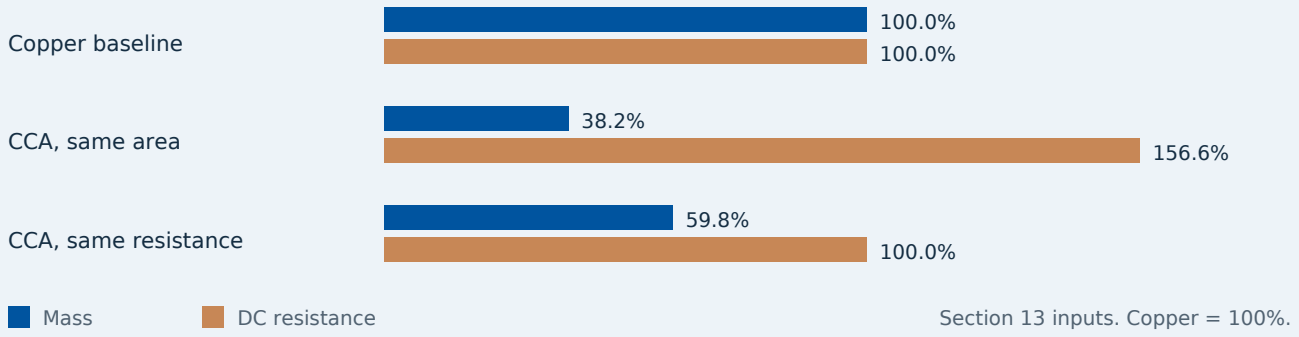
Measure	Copper reference	CCA at equal area	CCA at equal resistance
Metal area, mm²	2.500	2.500	3.915
Single-conductor resistance, Ω/km	6.896	10.800	6.896
Mass, kg/km	22.400	8.550	13.390
Weight reduction versus copper	Reference	61.8%	40.2%
Change in round-wire diameter	Reference	None	Approximately 25.1% larger

Insert the actual finished-material prices: P_Cu for copper and P_CCA for CCA, both in the same currency per kg and on matching tax and delivery terms. Material cost per kilometre is respectively **22.400 × P_Cu, 8.550 × P_CCA, and 13.390 × P_CCA.**

In this example, even at the same price per kilogram, the equal-resistance CCA option reduces conductor material purchasing cost by approximately 40.2% because less mass is required. For a real

project, recalculate using the price and mass of the corresponding specification, then include the associated costs below.

Mass and resistance in the same worked example



Step three is to include the rest of the bill

Cost item	Use these inputs
Material purchasing	Finished-material price × actual purchased mass, with consistent currency, tax, and delivery terms
Yield and scrap	Actual trial input, accepted output, and recoverable scrap value
Customer processing	Speed, wire breaks, downtime, labour, joining, and rework
Associated materials	Changes in insulation, sheath, terminals, solder, adhesive, seals, and other parts
One-time investment	Tooling, equipment changes, qualification, and certification, spread over expected usable production volume
Logistics and financing	Actual changes in freight, packaging, inventory, and payment terms
Service phase	Where relevant, electrical losses, maintenance, and replacement under the same conditions and period

Net material cost per accepted part = (input material cost - recoverable scrap value) ÷ number of accepted parts.

Leave an unknown cost as an open item. “Unknown” and “zero” are different numbers.

Read a metal-price-plus-conversion-charge quotation correctly

When a quote uses copper and aluminum metal prices plus a conversion charge, weight the metal prices by **mass fraction**. Establish the metal-price source, date or price-fixing rule, currency, tax basis, losses, and items included in the conversion charge. Volume fractions cannot be multiplied directly by metal prices per tonne.

Confirm whether coatings, special packaging, and additional processing are included. A valid comparison brings finished prices on the same basis together with actual consumption.

14 Move from samples to production with a clear trial plan

First record the baseline

Document the existing copper specification, drawing, actual resistance, processing settings, accepted yield, and current cost. Without a baseline, an equipment change can easily be mistaken for a material effect.

Then work through four steps

1. **Screen the options on paper.** Confirm permitted materials, available space, resistance target, connection method, and destination market. Select a small number of meaningfully different candidates.

2. **Inspect material samples.** Check dimensions, resistance, copper layers, and mechanical properties. Match each sample lot to its inspection report.

3. **Run the real production process.** Use the intended equipment, terminals, solder, and operating conditions. Record speed, defects, yield, and product performance.

4. **Approve and scale up.** Complete the applicable reliability work and approvals. Freeze the drawing, inspection requirements, packaging, and change-notification requirements before production supply.

Agree pass criteria before the trial. Results should identify which requirements were met and which need adjustment, rather than ending with “seems fine.”

A supplier's free sample is useful, but it is still a sample. What you ultimately buy is the ability to deliver the agreed result again, lot after lot.

15 Build an incoming-inspection checklist

The following is a framework for an acceptance agreement. Limits, sampling, and frequency should come from applicable standards and mutually agreed requirements. This example is not a universal mandatory test specification.

Item	How to check	Minimum report content
Identity and traceability	Cross-check labels, order, reel identity, and lot number	Material, specification, temper, lot, and delivered quantity
Dimensions	Measure diameter or width and thickness at agreed locations	Actual values, tolerances, bare or coated condition, instrument, and sampling
DC resistance	Suitable four-wire or specified method, with controlled length and temperature	Original resistance, length, temperature, conversion basis, and units
Copper fraction and layers	Metallographic section analysis, with agreed composition methods where needed	Fraction basis, scale, location, minimum thickness, and average
Interface and continuity	Sections, bending, torsion, peel, or shear tests suited to the product form	Method, load or geometry, acceptance criteria, and results

Item	How to check	Minimum report content
Mechanical properties	Tensile and applicable forming tests	Tensile strength, elongation, gauge length, and Rp0.2 where needed
Coating	Composition, thickness, and coverage checks	Substrate and coating identified separately; local or average thickness
Surface and edges	Inspect scratches, cracks, burrs, contamination, and exposed core	Defect position, size, and agreed permitted conditions
Actual connection	Make joints using the production joining method	Initial and specified post-ageing resistance, strength, or temperature rise
Packaging and quantity	Check mass, length, core dimensions, and payoff	Net mass, tare, length, joints, and winding direction

Common inspection traps

A handheld instrument identifying copper at the surface does not establish that the entire conductor is copper or determine its overall copper fraction. Surface composition and cross-sectional composition are different questions.

Mass alone cannot establish copper content. Length, section, coating, reel tare, and core material all affect the result. Weighing is useful as a cross-check.

A magnet generally cannot distinguish copper from CCA. A lack of magnetic attraction does not prove a conductor is solid copper.

An attractive cross-section image represents the sampled location. Agree representative sampling for new suppliers, changed products, and important lots. Whether samples come from the beginning, middle, or end of a reel, or from different reels, should reflect the process and relevant risks.

Qualification testing and routine release inspection can be separate. Every reel need not repeat every long-duration test, but production inspection must detect changes that affect delivery.

Control temperature when measuring resistance. Conversion to 20°C requires a correction appropriate to the material and method; copper's temperature coefficient cannot be applied indiscriminately to every composite. ASTM B193-25 provides a method for measuring the resistivity of metallic conductors. [R28]

A surface eddy-current conductivity reading and the longitudinal DC resistance of a conductor length are different measurements. Establish the method's suitability before applying it to a layered composite.

16 Get the documents and delivery terms right for global purchasing

Separate four levels of requirements

Level	The question it answers
Material standard or technical agreement	What must this lot of wire, strip, or foil meet?
Finished-product standard and certification	What must the resulting cable, module, or component meet?
Market and installation rules	How may the product be sold, installed, and used at its destination?
Customer or project specification	Which model, revision, and acceptance requirements apply to this customer?

ASTM B566 applies to the bare round-wire classes within its scope. China's GB/T 29197-2012, Copper-clad aluminum wire, is listed as current on the official platform. The public scope of IEC 60228:2023 identifies requirements for conductors including copper, aluminum, and aluminum alloy. Meeting one resistance limit with CCA is not enough to claim compliance of the whole product with that standard. [R01][R02][R06]

For standards, association standards, and patents, check the formal identifier, revision, scope, and document status. A consultation draft is not a published standard. A patent is not product certification. A quality-system certificate does not establish that a particular grade has passed a customer's application qualification.

Put the commercial details in the order

Specify the drawing and technical-document revisions, quantity measurement basis, net mass or continuous length per reel, whether joints are permitted and how they must be marked, packaging, lead time, currency, taxes, price validity, and metal-price fixing rules.

Joint requirements must first satisfy the applicable standard. Finished bare round wire supplied to ASTM B566 must contain no joints or splices. Other product forms follow their applicable standards and technical agreements; an order note permitting joints cannot override the relevant delivery requirements. [R01]

International orders should also identify the delivery term and named place, responsibilities for freight and insurance, destination requirements, required documents, and the evidence and process for handling quality claims. Prices on different delivery terms are not directly comparable.

Where metric and imperial dimensions are both used, identify the controlling unit and conversion. AWG defines a geometric wire size; it does not establish resistance equivalence. “CuEq” must state the property and reference being matched. Lowercase mΩ and uppercase MΩ differ by a billion. Small letters, large consequences.

Receiving and storage

Check for wet or damaged packaging and distorted reels. Store in clean, dry conditions away from corrosive substances, and protect the copper layer from scratches. When cold material enters a warm, humid workshop, manage condensation according to the packaging and process requirements.

For soldering applications, follow supplier instructions for storage conditions, opened-pack management, and usable storage period. Do not try to restore oxidised or contaminated material with unvalidated acid cleaning, abrasion, or aggressive chemicals; these can damage thin cladding or coatings.

Keep labels linked to their lots. If a problem occurs, isolate the relevant reels and retain original packaging, samples, and processing records for the investigation.

Copper reduction, weight reduction, and carbon reduction need separate evidence

CCA can reduce copper consumption through material design. The percentage of copper saved is not the percentage of carbon emissions saved. Carbon footprint also depends on raw-material sources, recycled content, smelting electricity, processing, transport, and use. An environmental comparison needs actual data and consistent life-cycle boundaries.

Identify scrap as copper-aluminum composite and manage it separately from copper and aluminum scrap. Use the recycler's quotation for the actual material, rather than assuming a solid-copper scrap value.

17 A ready-to-use RFQ checklist

You do not need every field completed to start a conversation. **Send the application, current specification or drawing, destination market, and approximate demand.** The details below can be completed during selection.

Field	Information to provide
Application and installed position	Finished product and the function of the material
Destination and customer requirements	Country, project, applicable standards, and revisions
Existing material	Copper, aluminum, or an existing composite; current grade and temper
Current dimensions	Round-wire diameter or thickness × width; tolerances, corners, and edges
Conditions that cannot change	Space, terminals, tooling, resistance, temperature rise, or other limits
Candidate material	CCA or a specified alloy core; Raytron can help compare options if undecided
Copper fraction	Prefer vol.%; identify wt.% explicitly if used, and state substrate or coated-product basis
Electrical requirements	Resistance or resistivity at 20°C; operating current, frequency, and length
Mechanical properties and processing	Temper, tensile requirements, bending, stamping, drawing, or other operations
Surface and joining	Bare material or coating composition and thickness; soldering, welding, crimping, or contact method
Environment and qualification	Temperature, moisture, media, motion, and test requirements

Field	Information to provide
Quantity and packaging	Sample quantity, monthly demand, continuous reel length, reel dimensions, and permitted joints
Commercial terms	Delivery location, currency, delivery basis, and timing
Required documents	Data sheet, lot report, conformity documents, and other customer requirements

Example enquiry

We currently use 0.20 × 2.00 mm copper strip for an internal equipment connection, stamped and then crimped. Width cannot increase, but thickness can change. Please compare CCA options that meet our existing DC-resistance requirement. The equipment will be sold in Germany; we will provide the applicable finished-product standard with the drawing. Expected demand is 300,000 m per month. Please propose the construction and sample plan, with finished dimensions, resistance, copper-layer and edge details, packaging, and a quotation on matching delivery terms.

This is an example of an enquiry, not an approved material substitution.

18 Ten statements worth correcting in a purchasing meeting

Common statement	A more useful interpretation
The outside is copper, so it performs like copper	The surface, complete section, and connection have different roles; compare the relevant properties
Everyone knows what 30% copper means	State wt.% or vol.% first
It is lighter, so it must be cheaper	Calculate actual cost per metre or per accepted part
Equal resistance means equal ampacity	Cooling, insulation, installation, and connections also matter
The copper fraction passes, so the cladding is uniform	Minimum thickness and edges need separate confirmation
Annealed wire bends easily, so it will survive repeated flexing	Formability and fatigue life are different properties
Tinned means lead-free	Check the actual coating composition and applicable requirements
The tester passed it, so it is certified	Check test scope, material requirements, finished-product compliance, and installation separately
One utility uses it, so it can be used worldwide	Check the particular region, installed position, construction, and project documents
Material cost falls 50%, so product cost falls 50%	State the cost denominator and include processing, yield, and associated components

19 Useful formulas and terminology

Calculation reference

These formulas support preliminary engineering calculations. Round-wire and rectangular approximations must fit the actual construction. Account for stranding, coatings, corner radii, conductor paths, and temperature as appropriate.

Purpose	Formula and units
Round-wire area	$A = \pi D^2/4$; D in mm gives A in mm²
Approximate rectangular area	$A \approx W \times T$; use actual area for significant corner radii or shaped profiles
Single-conductor DC resistance	$R = \rho_e L/A$; ρ_e in Ω·mm²/m, L in m, R in Ω
Mass per kilometre	$M = d_m A$; d_m in g/cm³, A in mm², M in kg/km
Material cost per metre	$C = pM/1000$; p in currency units/kg
Area for equal resistance	$A_{new} = A_{copper} \times \rho_{e,new}/\rho_{e,copper}$; same length and temperature
Two-wire DC circuit voltage drop	$\Delta U \approx 2IL\rho_e/A$; L is one-way length, with identical outgoing and return conductors
Conductor heating	$P = I^2R$; use conductor or circuit resistance at the actual operating temperature
Conductivity conversion	$\%IACS = 0.017241/\rho_{20} \times 100$

Copper volume fraction f and mass fraction w are decimals: enter 15% as 0.15. dCu and dAl are mass densities.

$d_{composite} = f \times d_{Cu} + (1 - f) \times d_{Al}$

$w = f \times d_{Cu} \div [f \times d_{Cu} + (1 - f) \times d_{Al}]$

$f = (w/d_{Cu}) \div [(w/d_{Cu}) + (1 - w)/d_{Al}]$

For the ideal axial-conduction model under the assumptions stated earlier:

$\sigma_{composite} = f \times \sigma_{Cu} + (1 - f) \times \sigma_{Al}$

Resistivity is therefore the reciprocal of the weighted conductivity. Do not calculate it by taking a simple volume-weighted arithmetic average of the two metal resistivities.

These simple expressions describe uniform straight material. Strands in a stranded conductor follow longer paths, which must be accounted for. Calculate resistance from the actual conducting paths; do not apply an arbitrary average lay factor to every construction.

Common terms

Chinese	English
铜包铝	Copper-clad aluminum / aluminium, CCA
铜包铝合金	Copper-clad aluminum alloy, CCAA
铜体积分数 / 质量分数	Copper volume fraction / mass fraction
基材 / 镀后成品	Substrate / coated finished product
退火态 / 硬拉态	Annealed / hard-drawn
铜层最小厚度	Minimum copper-cladding thickness
电阻率 / 电阻	Resistivity / resistance
导电率 / 载流量	Conductivity / ampacity
屈服 / 规定塑性延伸强度	Yield strength / proof strength
绞合 / 紧压	Stranded / compacted
材料数据表 / 批次检验报告	Technical data sheet / lot inspection report
询价 / 变更批准	Request for quotation, RFQ / change approval

20 Bring your current specification and explore the next option

Raytron supplies CCA and specified alloy-core clad conductors, precision flat wire, strip, foil, and copper-aluminum composite PV ribbon. Selection starts with your product: define the performance it must meet, then compare construction, weight, processing, and cost. [R17][R18][R19][R20]

Bring a drawing, a wire sample, or a specific problem: too much weight, too much cost per metre, too little space, or inconsistent joining and forming. We can turn those questions into parameters that can be measured, calculated, and tested.

Send Raytron your application, current specification or drawing, destination market, and approximate demand.

Website: www.raytron.group

Contact: Material selection and enquiries

Engineering Every Micron.

References

Standards and public web sources checked on 5 November 2026. Relevant revisions and scopes are identified in the text. Orders should use the controlled technical documents agreed by both parties.

[R01] ASTM International. ASTM B566-04a(2025). Official abstract and scope for bare round copper-clad aluminum wire.

[R02] China's National Standard Full-Text Disclosure System. GB/T 29197-2012 Copper-clad aluminum wire. Official standard status.

[R03] Copper Information Center. How does copper set the standard for electrical conductivity. IACS reference and reference aluminum conductivity.

[R04] NIST. Material composition Copper. Reference copper density.

[R05] NIST. Material composition Aluminum. Reference aluminum density.

[R06] IEC. IEC 60228:2023. Public scope of the cable-conductor standard.

[R07] UL Solutions. Wire and Cable Application Guide. Product categories, markings, and application scope.

[R08] NFPA. NFPA 70 National Electrical Code. Standard-edition entry point; projects must verify the locally adopted edition and full requirements.

[R09] ENEL. GSCC014 Rev.00 and amendment 01/2025. Amendment notes and §5.5 for specified Italian LV concentric constructions.

[R10] EPM. ET-TD-ME01-18 Rev.2. Historical public specification for concentric service cables, 2018.

[R11] CENS. Especificaciones técnicas. Public directory and update status.

[R12] Eskom. 240-56063805 Rev.3. 2022, §3.2.1(c), specified pilot or trial routes.

[R13] Fluke Networks. Application Note Copper Clad Aluminum Cables. Communications-cable testing and material compliance; historical standard identifiers in the note are not cited as current editions.

[R14] IEC. IEC 61215-1:2021. PV module design qualification and type approval.

[R15] IEC. IEC 61730-1:2023. PV module safety requirements.

[R16] IEC. IEC TS 62915:2023. Module modification retesting; the page includes information on the 2024 corrigendum.

[R17] Raytron. Copper-Clad Aluminum Conductors. Current public product forms and reference ranges.

[R18] Raytron. Precision Copper-Clad Aluminum Strip. Strip widths, delivered sections, and edge requirements.

[R19] Raytron. Precision Copper-Clad Aluminum Foil. Narrow-foil range and material construction.

[R20] Raytron. Copper-Aluminum Composite PV Ribbon. PV interconnection material and selection inputs.

[R21] Raytron. How Raytron Produces Clad Conductors. Manufacturing routes and inspection priorities.

[R22] Raytron. Solarbe. Composite ribbon and non-silicon module cost reduction in 2026. 10 June 2026.

[R23] HARADA. History. Record of CCA coaxial-cable development in 2008.

[R24] Chen and Hwang. Effect of Annealing on the Interfacial Structure of Aluminum-Copper Joints. Materials Transactions 2007, 48(7), 1938-1947. Research on thermal-history effects at copper-aluminum interfaces, not a universal production setting.

[R25] UL Standards & Engagement. UL 486A-486B Wire Connectors. Connector suitability depends on the specific standard, certification, and manufacturer's instructions.

[R26] U.S. Department of Energy. Managing and Mitigating Solar PV Corrosion. Dissimilar metals, electrolytes, and galvanic corrosion mechanisms; not used to predict CCA product service life.

[R27] Kopanski et al., NIST. Scanning Probe Microscopes for Subsurface Imaging. ECS Transactions 2014. Skin-depth formula and order-of-magnitude reference.

[R28] ASTM International. ASTM B193-25. Public description and scope for measuring resistivity of metallic conductor materials.

[R29] Raytron. Copper-aluminum composite PV ribbon application data, November 2026. Cumulative use in more than 50 GW of modules.

[R30] Raytron. CCA network-cable conductor and cable-shielding tape application data, 5 November 2026. Large-scale use of CCA conductors in CAT 5e / CAT 6 network cables, and the introduction of CCA strip as a replacement for copper cable-shielding tape. Individual projects require acceptance against agreed specifications and finished-cable requirements.

The fraction, geometry, and cost tables are independently calculated teaching examples using the stated inputs. Application trials, acceptance practices, and purchasing procedures are engineering guidance.