Cable Construction Know How

Conductor classes, stranding, and why it matters in a vehicle installation

The number on the cable tells you one thing

When someone says they need 2.5 mm² cable, they are specifying the cross-sectional area of the conductor. That number determines current carrying capacity and resistance. It tells you almost nothing about how the conductor is built, how flexible the cable is, or how long it will last in a vehicle application. For that, you need to understand conductor class.

Conductor classes — what they mean

IEC 60228 defines conductor classes for copper and aluminium conductors. The class number describes how the conductor is stranded — specifically, how many individual wires make up the conductor and how fine they are. The higher the class number, the finer and more numerous the strands, and the more flexible the finished cable.

Class 1 — solid conductor. A single copper wire. Rigid, inflexible, suitable only for fixed building installations. Not for vehicle use under any circumstances. A solid conductor in a vehicle will work-harden and fracture at vibration points. It is also very difficult to terminate cleanly into crimp ferrules and connector contacts.

Class 2 — stranded conductor. Multiple strands, but relatively few and relatively coarse. Better than Class 1, but still stiff and difficult to work with in tight bends. Used in fixed wiring where some flexibility is needed. Not recommended for vehicle installations where cable is expected to flex or where termination quality matters.

Class 5 — fine stranded flex. The automotive standard. Many fine strands. Genuinely flexible, easy to route, kinder to crimp contacts and connector terminals, and significantly more resistant to vibration fatigue at termination points. This is what OEM automotive harnesses use. This is what Voltforge uses in its assemblies. If you are buying cable for a vehicle installation and the supplier cannot tell you the conductor class, buy from someone who can.

Class 6 — extra fine stranded flex. Even finer strands than Class 5. Used in applications requiring exceptional flexibility — battery leads, welding cable, trailing leads, and applications where the cable is in continuous movement. Also used in some high-end automotive harness work. Overkill for most fixed vehicle installation runs but the right choice for battery interconnects and anything that flexes repeatedly in service.

Why it matters at the termination

The conductor class has a direct effect on termination quality. A crimp contact — whether a bootlace ferrule, a ring terminal, or a Deutsch DT contact — is designed to compress a conductor to a specific cross-sectional geometry. Fine-stranded Class 5 conductor fills the contact barrel evenly, compresses cleanly, and produces a gas-tight cold weld that resists corrosion and vibration loosening. Coarse-stranded or solid conductor does not fill the barrel the same way, leaves voids, and produces a termination that may look acceptable initially but will corrode and loosen over time under vehicle vibration.

This is not theoretical. Intermittent faults at poorly terminated connections are one of the most common and most time-consuming electrical problems in vehicle installations. They are also among the hardest to find. The fix is to use the right cable from the start.

Why vibration kills coarse-stranded cable

Every vehicle vibrates. Every cable in that vehicle flexes, however slightly, with every vibration cycle. Over thousands of hours of use, that flexing causes work hardening in the conductor strands at the point where the cable enters a terminal or passes through a grommet or support. In a solid or coarse-stranded conductor, the individual wires are large enough that the work hardening stress concentrates and the wire fractures. In a fine-stranded conductor, the stress is distributed across many more, thinner wires — any individual wire that fails is a small fraction of the total cross-section and the cable continues to function. Fine stranding is not just about flexibility during installation. It is about fatigue resistance over the life of the vehicle.

How stranding is physically constructed

A stranded conductor is not just a bundle of wires pushed into an insulation tube. The individual strands are twisted together in a controlled way, and the geometry of that twist — the lay — determines the mechanical and electrical behaviour of the finished cable. A consistent, controlled lay is what allows the conductor to flex without the strands working against each other or migrating through the cross-section over time.

Bunched stranding. All strands twisted together in the same operation with no organised geometric arrangement. Simple and economical. The strands do not sit in a fixed relationship to each other, which makes the OD less consistent and the crimp behaviour less predictable.

Concentric stranding. Strands arranged in concentric layers around a central core wire, each layer twisted in the opposite direction to the one below. This is the construction used in quality automotive cable. It produces a consistent cross-section, a predictable OD, better compression behaviour in a crimp, and better fatigue resistance because each layer is mechanically supported by the layer beneath it.

Rope-lay construction. Used in Class 6 extra-flexible cable. Groups of strands are first twisted into small sub-bundles, and those sub-bundles are then twisted together in the opposite direction to form the conductor. The result is exceptionally fine and flexible with very high fatigue resistance. This is the construction found in battery interconnects and welding cable.

What the numbers mean on a datasheet

Automotive cable datasheets express conductor construction in two ways: as a class number (Class 5, Class 6) or as a strand count and strand diameter notation. Both tell you the same thing in different ways.

The strand count / diameter notation looks like this: **32 × 0.20** — meaning 32 individual strands each 0.20 mm in diameter, giving a nominal cross-sectional area of approximately 1.0 mm². A Class 2 conductor of the same nominal CSA might be expressed as **7 × 0.43** — the same total copper area but seven coarse strands that will behave entirely differently in a crimp and under vibration. If a supplier cannot give you the strand count and diameter, ask why not.

Typical strand count and diameter combinations for Class 5 automotive flex: 0.5 mm² — 16 × 0.20 mm; 1.0 mm² — 32 × 0.20 mm; 2.5 mm² — 50 × 0.25 mm; 4.0 mm² — 56 × 0.30 mm; 6.0 mm² — 84 × 0.30 mm; 10.0 mm² — 80 × 0.40 mm. The difference compared to a Class 2 conductor of the same nominal CSA is visible to the naked eye once you know what you are looking for.

How to identify fine vs coarse stranded cable by eye

Strip back about 20 mm of insulation and look at the conductor end-on. Fine-stranded Class 5 cable has a conductor that looks almost smooth — the individual strands are so small that the cross-section appears almost solid until you look closely. A coarse-stranded or Class 2 conductor will show clearly visible individual wires, often arranged in a recognisable hexagonal pattern of concentric rings.

You can also flex a short stripped length between your fingers. Fine-stranded cable moves easily and springs back without any tendency to kink. Coarse-stranded cable feels stiffer and will hold a bend rather than returning to its original shape. If it feels like bending a coat hanger, do not put it in a vehicle.

BS 6004 flat twin and earth is immediately identifiable — flat grey profile, two or three cores with visible bare earth, rigid enough to hold its shape. There is no circumstance in which this belongs in a vehicle DC installation.

Never use fixed installation cable (BS 6004 / BS 6231) in a vehicle

Twin and earth, alarm cable, bell wire, speaker cable, and other building or domestic wiring products are not automotive cable. They may carry the correct current for the job. They will not survive vehicle life. Building wiring is typically Class 1 or Class 2, designed for a fixed installation in a wall or ceiling where it will never move. It uses PVC insulation compounds formulated for ambient indoor temperatures, not the thermal cycling, UV exposure, oil, moisture and vibration that a vehicle environment delivers. It is also not designed for the crimp terminations used in automotive connectors — attempts to crimp fixed installation cable into automotive contacts produce poor-quality joints that will fail.

The cost difference between building wire and proper automotive cable is small. The cost of re-doing a poor installation — in time, materials and diagnostic frustration — is not.

What to look for when buying cable

A reputable automotive cable supplier will be able to tell you the conductor class, the insulation type and temperature rating, the insulation wall thickness, and the overall cable OD. The cable itself should be marked with its cross-sectional area, voltage rating and insulation type at regular intervals along the jacket. If a cable has no markings, or the markings are vague, that tells you something about how it was made.

For leisure vehicle and campervan work, specify Class 5 fine-stranded automotive flex with 105°C PVC insulation as a minimum. For under-bonnet, engine bay or high ambient temperature applications, specify 125°C XLPE or XLPO insulated Class 5 or Class 6 cable. See our Ampacity Reference Document and Heat Shrink Ready Reckoner at voltforge.co.uk for cable OD data and current ratings across insulation types.

Tri-rated cable — a legitimate choice with conditions

Tri-rated cable is a single-core, fine-stranded flexible cable carrying three approvals: BS EN 60228 Class 5, UL 508 and CSA 22.2. It takes its name from those three approvals, not from any particular construction characteristic. The conductor is Class 5 fine-stranded copper, typically with 105°C PVC insulation, and it is manufactured to a consistent standard with good dimensional tolerances.

It is widely used in control panel wiring, switchgear, and industrial electrical work, and it turns up regularly in automotive and leisure vehicle installations — partly because it is available from electrical wholesalers in an extensive colour range that genuine automotive cable often is not, and partly because it is a quality product that is genuinely easy to work with. The Class 5 conductor construction means it terminates well, routes easily, and handles vehicle vibration without the fatigue problems associated with coarser-stranded cable. It is a legitimate choice for interior, protected DC runs in a vehicle where the cable will not be exposed to fuel, oil, UV radiation or extreme heat.

The caveats are straightforward. Tri-rated cable is not formulated or tested to automotive insulation standards — the PVC compound is designed for switchgear and panel environments, not engine bays, wheel arches or external runs where fuel, oil, UV and temperature cycling are normal. For under-bonnet runs, external runs or any location where the cable is exposed to the full automotive environment rather than protected behind a panel, use cable specified and tested to SAE J1128 or ISO 6722 with an appropriate temperature rating. For those applications, tri-rated is the wrong tool.

Used in the right place — interior protected DC runs in a campervan or leisure vehicle, control wiring in a panel or enclosure, low-voltage signalling in a protected loom — tri-rated cable is a sound and practical choice.

230V AC cable in leisure vehicles — not the same conversation

Everything above applies to DC wiring. The 230V AC system in a leisure vehicle is a different discipline with different standards, different cable types and a different regulatory framework. This section is a brief orientation, not a complete guide — 230V work in leisure vehicles should always be carried out by a competent person with a working understanding of BS 7671.

Fixed wiring — flexible twin and earth. Where 230V cable is run as fixed wiring between consumer units, sockets and permanently connected equipment, use flexible twin and earth — 3183Y or 3092Y. Not solid flat twin and earth (BS 6004 flat grey T&E) as used in domestic building wiring. BS 6004 flat T&E is a Class 1 or Class 2 conductor designed for a fixed installation in a wall or ceiling. It will work-harden at vibration points, crack at bends, and is not fit for a vehicle. The minimum size for a leisure vehicle 230V circuit is **1.5 mm² flexible twin and earth (3183Y)**. Size up for higher current circuits — electric water heaters, air conditioning units, inverter outputs — in accordance with BS 7671 and the load.

Flexible connections — rubber or thermoplastic flex. For portable appliances, trailing leads, and any connection that flexes in use, use appropriately rated rubber or thermoplastic flexible cord — HO5VV-F for indoor protected use, HO7RN-F for external, damp or exposed locations. Minimum 1.5 mm² for general circuits; 2.5 mm² for higher current loads.

Never use solid flat twin and earth (BS 6004 T&E) in a vehicle under any circumstances. It is a Class 1 or 2 conductor in a PVC compound designed for a wall or ceiling. It will work-harden and fracture at vibration points, and it is simply not fit for a vehicle installation regardless of how convenient it is to source.

230V AC work in a leisure vehicle is subject to BS 7671 (the IET Wiring Regulations) and, for leisure vehicles specifically, BS EN 1648. New installation work should be accompanied by an Electrical Installation Certificate issued by a registered competent person. If you have any concerns about an existing 230V installation, stop and get it checked before connecting to shore power.

Quick reference — conductor class summary

Class	Stranding	Flexibility	Typical use	Vehicle use
1	Solid — single wire	None	Fixed building installations only	**Never**
2	Stranded — few, coarse wires	Low	Fixed building and industrial wiring	**Not recommended**
5	Fine stranded flex — many thin wires	High	Automotive, leisure vehicle, marine, OEM harnesses	**Yes — specify this**
6	Extra fine stranded flex	Very high	Battery leads, welding cable, continuously flexing applications	**Yes — for battery leads and flex applications**

About Voltforge

Voltforge is the retail brand of Zeromachine Ltd, an engineering business based in Blyth, Northumberland. Zeromachine's longer-term programme is the development of a hydrogen fuel cell hybrid electric powertrain for off-highway machinery — serious engineering work that needs a serious commercial foundation underneath it. Voltforge is that foundation, and the live sandbox for it: a place where low-voltage DC system design principles, documentation standards and product development thinking get tested in the real world before they scale.

The engineering background behind Voltforge spans over 30 years of low-voltage DC and high-voltage DC electrical experience across automotive, OEM leisure vehicle, EV, and off-highway and construction machinery applications. We build connector assemblies, pigtail kits and cable harnesses with the same thinking we apply to much larger and more complex work: correct materials, correct process, and a clear understanding of how a product will actually be used once it leaves the bench. Every assembly we make comes with a full bill of materials citing OEM part numbers, because you should always know exactly what you've got. All Voltforge-built assemblies carry a 2-year warranty.

For larger and more complex work, Zeromachine Works Studio offers bespoke harness design and production, low-voltage DC system design, B2B engineering services, and consultancy for trade and commercial customers. We also offer specialist repair, diagnosis and electrical design services for leisure vehicles, campervans, overlanders and 4x4s across the North East of England.

If you know what you need, you can go straight to the shop. If the job is bigger or less straightforward, talk to us. **Tell us what you're building and where you're stuck.**

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