

Section 2E

Illuminated Armoured Feeder Cables

to AS/NZS 2802:2000

Self-Powered LED | Pliable Steel Armour | High Impact Resistance

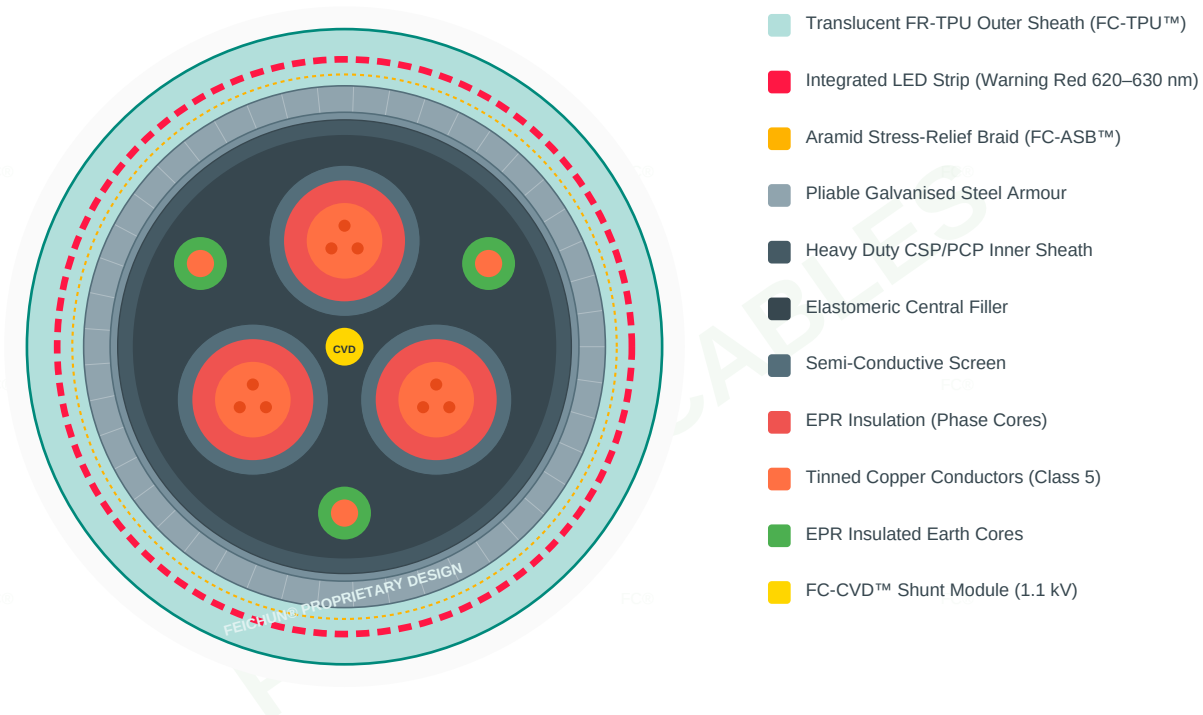
TYPE 412-LED

1.1 kV | Armoured

SELF-POWERED LED VISIBILITY

A pliable armoured cable used as a feeder in areas where high impact resistance is required — longwall gate roads, main headings, panel entries, and surface haul roads — featuring integrated self-powered LED illumination for enhanced cable visibility and personnel safety. The world's first illuminated steel-armoured mining feeder cable.

ILLUMINATED ARMoured FEEDER · SELF-POWERED LED · HIGH IMPACT RESISTANCE · FEICHUN® WORLD FIRST



Cable Construction (Inside → Out)

- Conductors** — Annealed tinned copper, flexible Class 5 stranding per AS/NZS 1125.
- Insulation** — EPR (Ethylene Propylene Rubber) per AS/NZS 2802, Cl. 2.4.
- Screening** — Semi-conductive screen over each phase core.
- Earth Cores** — EPR insulated interstitial earth conductors.
- Filler** — Elastomeric central filler.
- Inner Sheath** — Heavy duty CSP or PCP inner sheath (bedding layer for armour).
- Armour** — Pliable galvanised steel wire armour for high mechanical impact protection.
- FC-CVD™ Module** — FeiChun® internal solid-state capacitive voltage divider (all variants 1.1 kV).
- LED Strip** — Industrial-grade flexible LED strip, warning red (620–630 nm), silicone encapsulated. Located *outside* the steel armour within the translucent outer sheath.
- Stress-Relief Layer** — FeiChun® FC-ASB™ aramid braid surrounding LED FPC circuits.
- Outer Sheath** — Heavy duty translucent FR-TPU/PUR (FeiChun® FC-TPU™ proprietary).

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FC-ALC™ Armoured LED Cable Architecture | Patent Pending | FeiChun World First

Note: Conventional armoured cables place all functional layers inside the steel armour, with an opaque outer serving. FeiChun's FC-ALC™ (Armoured LED Cable) architecture is a breakthrough — the LED strip and its aramid-protected FPC driver circuit are positioned **outside the armour but inside the translucent FC-TPU™ outer sheath**. This ensures the LED glow is unobstructed by the steel wires whilst the illumination circuit remains mechanically protected by both the aramid braid and the heavy-duty TPU sheath.

2E.1 TYPE 412-LED — Dimensional & Electrical Data

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Type	Part No.	Voltage	Cond. Size mm ²	Cond. Dia. mm	Screen Area mm ²	Dia. Over Screen mm	LED Power Method	Armour Wire Dia. mm	Sheath Thk. mm	Cable O.D. mm	Wt. kg/ 100 m
412-LED.1	MCO-412L.1-016	1.1kV	16	10.9	5.3	4.2	FC-CVD™	2.5	4.2	43.5	298
	MCO-412L.1-025	1.1kV	25	10.8	5.3	4.2	FC-CVD™	2.5	4.2	43.5	330
	MCO-412L.1-035	1.1kV	35	12.0	5.3	4.2	FC-CVD™	2.5	4.4	49.5	450
	MCO-412L.1-050	1.1kV	50	13.8	8.06	5.3	FC-CVD™	2.5	4.8	53.8	538
	MCO-412L.1-070	1.1kV	70	15.6	12.69	6.3	FC-CVD™	3.15	5.2	60.0	702
	MCO-412L.1-095	1.1kV	95	17.8	15.87	6.8	FC-CVD™	3.15	5.8	66.0	835
	MCO-412L.1-120	1.1kV	120	19.6	20.1	7.9	FC-CVD™	3.15	6.2	74.0	1110
	MCO-412L.1-150	1.1kV	150	21.7	27.15	8.8	FC-CVD™	3.15	6.7	80.5	1330

Dimensions and weights are nominal ± manufacturing tolerances. Cable O.D. includes FeiChun® LED strip, FC-ASB™ aramid braid, and FC-SPM™ surge-protection circuits positioned outside the steel armour. Weights approx. 10–15 % greater than standard Type 412 equivalents due to LED system and additional outer sheath material. All variants use FeiChun® FC-CVD™ capacitive voltage divider as the Type 412 operates exclusively at 1.1 kV. The Type 412-LED has no pilot conductor — consistent with the standard Type 412 feeder cable construction.

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2E.2 FeiChun® FC-ALC™ Armoured LED Cable Architecture

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FC-ALC™ — The Engineering Challenge of Illuminating an Armoured Cable

Armoured feeder cables present a unique engineering challenge for LED illumination. The pliable galvanised steel wire armour — which is the cable's defining feature, providing crush and impact protection that unarmoured trailing cables cannot match — is completely opaque. Placing an LED strip beneath the armour would render it invisible.

FeiChun's FC-ALC™ architecture solves this with a **split-sheath, over-armour illumination** design:

- **Over-Armour LED Placement:** The LED flexible strip is positioned in a dedicated annular channel between the outer surface of the steel armour and the inner wall of the translucent FC-TPU™ outer sheath. This ensures unobstructed 360° light output.
- **Armour-to-LED Isolation:** A thin elastomeric bedding layer separates the LED strip from the galvanised steel wires, preventing abrasion of the flexible circuit during cable bending and preventing the steel armour from acting as a heat sink that would reduce LED efficiency.
- **FC-ASB™ Over-Armour Braid:** The aramid stress-isolation braid wraps the LED strip assembly *over* the armour layer. During installation bending and mechanical loading, the aramid prevents any relative movement between the LED FPC and the armour surface.
- **FC-CVD™ Routing:** The capacitive voltage divider module is located inside the armour (in the interstices of the cable core), where it is fully protected by the steel wire layer. A pair of micro flexible conductors pass through a controlled gap between adjacent armour wires to feed the 12 V DC supply to the external LED strip. These conductors are potted at the armour penetration point with FeiChun® FC-POT™ silicone to maintain the armour's mechanical integrity.

2E.3 FeiChun® FC-CVD™ Self-Powered LED Technology

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□ FEICHUN PROPRIETARYFC-CVD™ Capacitive Voltage Divider | All 412-LED Variants | 1.1 kV Optimised

The TYPE 412-LED operates exclusively at 1.1 kV. At this voltage the magnetic field generated by the phase conductors is insufficient for reliable electromagnetic induction harvesting, particularly with the attenuating effect of the steel armour layer. FeiChun therefore employs the **FC-CVD™ capacitive voltage divider** approach for all 412-LED variants:

- FC-CVD™ Module:** An ultra-compact, flexible capacitive voltage divider is integrated within the cable core, inside the steel armour. Through a high-impedance tap it draws only tens of milliamps from the phase conductor — a negligible fraction of rated current.
- Onboard Rectification & Regulation:** Tapped energy passes through FeiChun's flexible-substrate rectifier and LDO regulator, converting to clean 12 V DC.
- Armour Penetration Feed:** Twin micro-conductors (0.5 mm² each, silicone insulated) pass through the armour layer via a controlled gap, delivering DC power to the external LED strip. The penetration point is sealed with FC-POT™ silicone encapsulant.
- Zero Infrastructure Change:** No external DC supply. No switchgear modification. Direct drop-in replacement for standard Type 412 feeder cables.

2E.4 FeiChun® FC-SPM™ Integrated Surge Protection

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Layer	Component	Function & Operating Principle
1	TVS Diodes	Micro TVS suppressors clamp transient spikes in picoseconds. Located inside armour for maximum protection.
2	Zener / LDO	Precision regulation locks LED rail to 12 V DC. Eliminates flicker from load variations on the feeder circuit.
3	PTC Resettable	Polymer PTC in series auto-resets after overcurrent. No replacement required — critical since the module is sealed inside the armour.
4	MOV Backup	Metal-oxide varistors provide additional high-energy surge absorption for the extreme transients typical of feeder circuit switching events (contactor operations, fault clearing at the substation).

Note: The Type 412-LED's FC-SPM™ module includes an additional MOV (metal-oxide varistor) layer not present in the trailing cable variants (440/441/450/455-LED). This reflects the harsher switching transient environment typical of feeder circuits, where contactor operations and upstream fault clearance produce higher-energy surges than trailing cable systems.

FeiChun® Manufacturing Implementation

- FC-FPC™ Construction:** Polyimide flexible circuit hosts all FC-SPM™ and FC-CVD™ components inside the armour. External LED FPC strip runs over the armour.
- FC-POT™ Encapsulation (IP68+):** All internal circuits and armour penetration points fully potted in high-elasticity silicone.
- FC-ASB™ Aramid Braid:** Over-armour aramid isolation layer protects external LED circuit from installation damage and armour wire abrasion.

2E.5 FeiChun® FC-TPU™ Outer Sheath for Armoured Construction

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FC-TPU™ Armour-Grade | Formula FC-2026-TPU-A3 | Optimised for Over-Armour Application

The standard Type 412 uses an opaque heavy duty elastomer outer sheath over the steel armour. The TYPE 412-LED replaces this with FeiChun's **FC-TPU™ Armour-Grade** translucent compound (Formula FC-2026-TPU-A3), specifically developed for over-armour application where the sheath must resist the localised point-loading of steel wire tips during bending:

- **High Light Transmittance** — Clear 620–630 nm transmission even at increased armour-grade sheath thickness. Continuous glow visible from all angles.
- **Armour Wire Resistance** — FC-TPU™ A3 formulation includes enhanced point-load resistance to prevent steel armour wire tips from puncturing the sheath during bending. 3–5× abrasion resistance vs conventional elastomer.
- **Flame Retardancy** — Meets AS/NZS 1802 Cl. 13.2 and AS/NZS 2802 Cl. 2.12. Halogen-free; self-extinguishing.
- **Impact Resistance** — The steel armour provides the primary impact barrier; the FC-TPU™ sheath adds a secondary energy-absorbing layer that distributes point loads across the LED strip, preventing LED damage from external impacts.
- **Chemical Resistance** — Resistant to hydraulic fluids, diesel, mine water.

2E.6 Australian & International Standards Compliance

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Standard	Title / Scope	Applicability
AS/NZS 2802:2000	Electric cables — Trailing and reeling — Mining and general use	Primary construction standard. Armour construction per Cl. 2.8.
AS/NZS 1802:2003	Electric cables — Underground coal mining	Underground coal-specific: flame propagation, earth monitoring.
AS/NZS 60079.11	Explosive atmospheres — Intrinsic safety	LED circuit: Ex ia IIC. FC-CVD™ capacitively limited.
AS/NZS 3808:2000	Electrical equipment for coal mines — IS	LED circuit meets Group I (methane) IS requirements.
AS 1429.1	Electric cables — Polymeric insulated — For working voltages up to 1 kV	Armoured cable construction and testing requirements.
IEC 60502-1	Power cables with extruded insulation — Up to 1 kV	EPR insulation, screening, and armouring.
AS/NZS 1125	Conductors in insulated electric cables	Conductor material, stranding, resistivity.
IEC 60079.0	Explosive atmospheres — General	Construction for hazardous zones.
EN 50575 (CPR)	Construction Products Regulation	FC-TPU™ A3 tested to B2ca-s1,d0,a1 (optional).

2E.7 Key Advantages & Operational Benefits

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1 World's First Illuminated Armoured Feeder

The TYPE 412-LED is the world's first steel-armoured mining feeder cable with integrated LED illumination. FeiChun's FC-ALC™ over-armour architecture makes the previously impossible — illuminating a cable through steel armour — a production reality.

2 Uncompromised Impact Protection

The pliable galvanised steel wire armour is fully retained. LED illumination adds no compromise to the Type 412's defining mechanical strength. Impact resistance, crush resistance, and rodent protection are identical to the standard Type 412.

3 Plug-and-Play Deployment

No external DC supplies. No switchgear modifications. Direct drop-in replacement for standard Type 412. Disconnect → connect → energise → glow.

4 Feeder Route Visibility

Illuminated feeders allow personnel to visually trace energised cable routes through longwall gate roads, main headings, and panel entries without portable lighting — critical for cable identification during isolation and re-routing operations.

5 Intrinsically Safe Cold Light

Negligible LED heat. FC-CVD™ capacitive limiting prevents ignition of methane/coal dust. AS/NZS 3808 and AS/NZS 60079.11 compliant.

6 Enhanced FC-SPM™ with MOV

Four-layer surge protection including MOV backup for feeder-circuit switching transients. PTC auto-reset. Zero maintenance for the cable's full service life.

7 Live Cable Indication

Immediate visual confirmation of energisation status — enhancing lock-out/tag-out (LOTO) procedures in complex feeder networks.

8 Full Regulatory Compliance

Derivative of AS/NZS 2802 Type 412. All ratings, earth continuity, armour bonding, and insulation-resistance specs maintained. No derogation from base standard.

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