FLEXFORCE ™

flexible power cables

www.axon-cable.com

axon'
CABLE & INTERCONNECT

Contents

FLEXFORCE ™ flexible power cables

GENERAL INFORMATION

CONSTRUCTION

FLEXIBLE POWER CABLE

© 2011, AXON' CABLE - RELEASED DECEMBER 2011/A
FLEXFORCE™ FLEXIBLE POWER CABLES - www.axon-cable.com

General information

AXON' CABLE has gathered more than 40 years of experience in the design and manufacture of wires, cables and interconnect solutions for advanced technologies.

FLEXFORCE™ cables are intended for applications where high currents have to be carried. Insulated with special AXON' compounds, halogen free or FEP materials FLEXFORCE™ are suited for use in the most severe environments.

Applications

FLEXFORCE™ flexible power cables have been designed for applications where high currents have to be carried, such as :

- Armoured vehicles (power distribution, help start cables, hybrid electric drives, auxiliary power and control systems, engine management, active armour, ...),
- Tanks,
- Remote weapon systems,
- Radar systems : high power radars, airborne radars, ...
- Mast systems,
- Public transport : tramways, metro, ...
- Cars (electric drives, ...)
- Robots,
- Ships, ...

Benefits

Flexibility better than IEC 228 class 6

IEC 228 standard defines flexibility of cables by characterizing the conductor strands. The smallest and most flexible strands are defined as «class 6». AXON' uses strands which diameters are even smaller than the strands defined in «class 6».
In addition to extra-flexible tin plated multi-strand copper conductors and separating tapes under the outer jacket, AXON' uses special assembling techniques, improving the flexibility of FLEXFORCE™.
Flexibility is important to ease installation of FLEXFORCE™ power cables in space reduced environments.
For dynamic applications AXON' has tested a 25 mm² halogen free FLEXFORCE™ cable. With a bend radius of 80 mm and a bending angle of 90° this cable withstands more than 1 million flex cycles.

FLEXFORCE™ CABLE

Big cross section areas

FLEXFORCE™ power cables are available in sections 10/16/25/35/50/70/95/120/150/185 mm².

Increased current carrying capacity

The choice of AXON's flexible conductors and high temperature insulation materials (better than common insulation materials) allow high current carrying capacities. For example 330 Amps for a 50 mm² FLEXFORCE ™ wire FFR 050 at 30°C. According to the cross section of the cable the current carrying capacity will be of 770 Amps maximum.

High and low temperature resistant, flame-retardant and halogen free insulation materials

FLEXFORCE™ power cables are offered with three different high temperature insulation materials :

- Halogen free insulation : -40°C/ +125°C during 3 000 h.
- ASC 15 (AXON' SPECIAL COMPOUND : special high temperature thermoplastic elastomer) : -40°C/+150°C during 3 000 h.
- FEP : -90°C/+200°C during 20 000 h.

Voltage rating

Usually 600 VAC or 1000 VAC.
Cables suited for higher voltage ratings can be proposed on request.

Mechanical resistance

FLEXFORCE™ power cables allow for excellent abrasion and cut-through resistance tested according to SEFT 027.

Chemical resistance

FLEXFORCE™ power cables resist to different engine fluids :

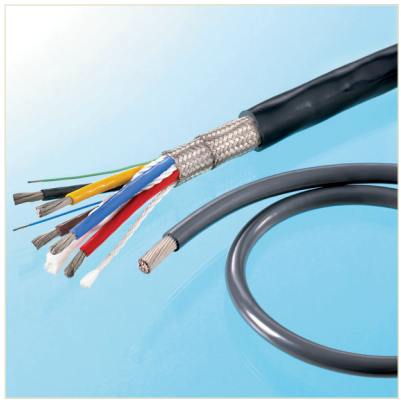
- hydraulic liquid,
- mineral oil,
- gasoline,
- diesel.

Specific marking

AXON ' can identify their cables with a custom marking :
batch number, date, customer name, etc.

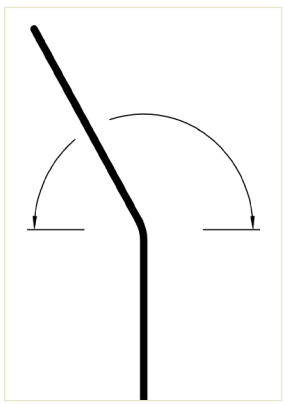
Reduced cable dimensions

As FLEXFORCE™ cables are able to carry higher currents than common standard cables with the same conductor section, you can choose a FLEXFORCE™ cable of smaller dimensions.



HIGH TEMPERATURE INSULATION MATERIALS

MECHANICAL TEST



ALTERNATE MOVEMENT OF THE MECHANICAL TEST

Expertise in conductor

AXON ' manufacture their own single-stranded or multi-stranded precision conductors made with different materials and platings which meet the most stringent electrical and mechanical requirements.

Expertise in primary insulation and jacketing

AXON' master different insulations techniques - thermoplastic extrusion, PTFE extrusion and taping – and are able to insulate their wires and cables with many different materials

- Fluorinated materials (FEP, ETFE, PFA), PEEK, polyimide, ...
- Irradiated insulation (X-ETFE).
- Metal free insulating materials.
- CELLOFLON® (patented expanded PTFE) with a low dielectric constant (1.35).
- Polyimide for radiation resistance.
- VITAX™ fluorinated elastomers for chemical and aggressive environments, including high temperatures (+ 230°C) and abrasion.
- Halogen free insulating materials.
- VIBRAFLAME® insulated composite cables able to withstand extreme temperatures (-196°C/+1050°C).
- Special materials developed by our plastics specialists.

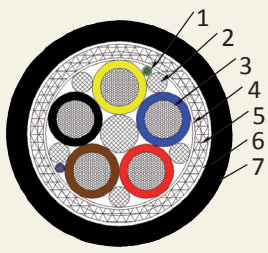
Expertise in hybrid cable construction

Different custom designed cable configurations can be offered including several single power cables, braided tin plated copper shields and an extruded jacket.

In a composite cable, signal wires can be added to power wires. Depending on the type of connection, these wires can be used as pilot wires. They will drive power supply during connection and disconnection to avoid electric damages (e.g. sparks).

Equivalence table AWG / Cross section in mm²

CROSS SECTION mm²	APPROXIMATE AWG
10	7
16	5
25	3
35	2
50	1/0
70	2/0
95	4/0
120	
150	
185	

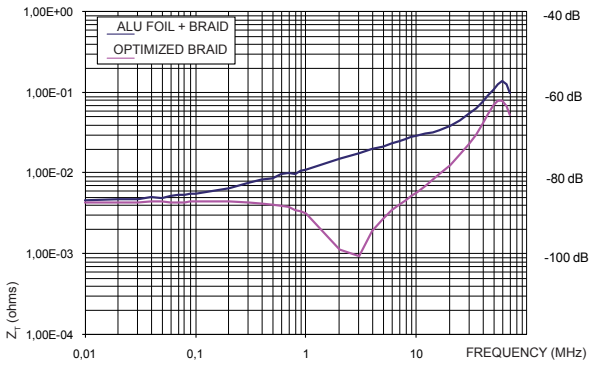


1. Two insulated wires with TPC conductor.
2. Fillers.
3. Five insulated wires with TPC conductor.
4. Maintaining tape.
5. Optimized double braided tin plated copper shield.
6. Separating tape.
7. Extruded outer jacket.

TYPICAL HYBRID CABLE CONSTRUCTION

Electromagnetic protection

AXON's expertise in EMI protection is based on different shielding techniques – helicoidal shielding, shielding braids or tapes.
Shielding efficiency can be improved by optimizing the shielding bundles, diameters of shielding strands as well as braiding angles. The AXON' EMI/EMC laboratory is equipped with comprehensive test benches to control transfer impedance and has been approved by the French Army to carry out EMC measurements.



TRANSFER IMPEDANCE FOR SHIELDED FFR 050

Cable termination

FLEXFORCE™ power cables can be terminated with standard cable lugs and power connectors.

FLEXFORCE™ TERMINATION

Quality assurance

Approvals

- ISO 9001,
- ISO 14001,
- TS 16949,
- EN9100,
- OHSAS 18001.

In-house test equipment

- Physical characteristics : full material analysis.
- Chemical characteristics : resistance to oils, solvents, …
- Electrical characteristics : automatic continuity and insulation testing, dielectric strength, current flow, transfer impedance (shield efficiency), …
- Climatic characteristics : resistance to salt spray, thermal shock, flame, accelerated ageing, …
- Mechanical characteristics : resistance to flexion, torsion, winding, vibration, shock, …

Current - carrying capacity

The “current-carrying capacity” is the maximum electrical current a conductor can carry before being deteriorated.
The current – carrying capacity of a cable depends on :

- the temperature rating of the insulation material ;
- the electrical resistance of the different materials used ;
- the frequency of the current, in the case of alternating current ;
- the ability to dissipate heat, which depends on cable geometry and its surroundings ;
- ambient temperature.

All electrical conductors have some resistance to the flow of electricity, and electric current flowing through them causes voltage drop and power dissipation, which heats the cable. Metal materials like copper or aluminum can conduct a large amount of current before melting, but long before the conductors melt, their insulation would be damaged by the heat.

The current carrying capacity of a power cable thus depends on :

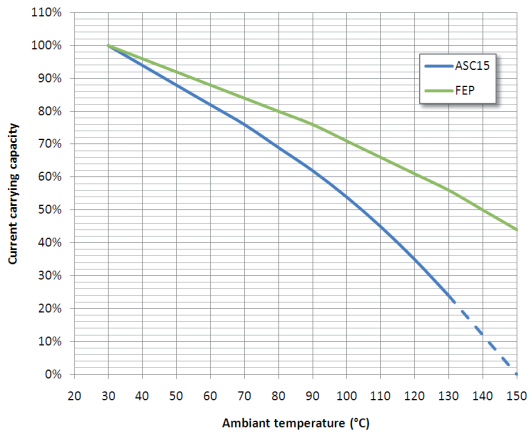
- the physical and electrical properties of the conductor and insulation materials,
- the cable’s construction,
- ambient temperature,
- environmental conditions adjacent to the cable.

Having a large overall surface area may dissipate heat better if the environment can absorb the heat.

The following graphs help to choose the FLEXFORCE™ cable taking into account these criteria.

EXAMPLE 1

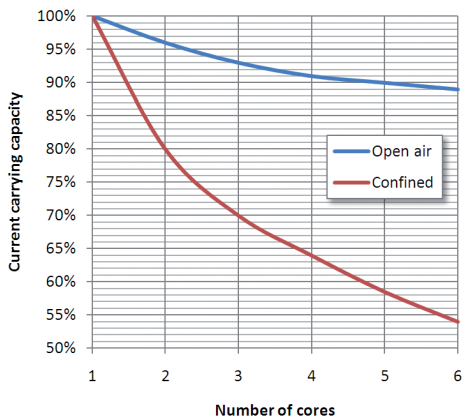
HOW TO CHOOSE A FLEXFORCE™ SINGLE WIRE IN FUNCTION OF THE TEMPERATURE ?



An ASC 15 insulated single FFR wire, has to carry a current of 113A at 100°C. Referring to graph 1, at 100°C the wire can only carry 54% of the current, it would have been able to carry at 30°C.
To be used at 100°C the wire will need to carry around 210A (Calculation : 210 X 0.54 = 113A) and a FFR025 wire will be chosen. ASC 15 insulation has got a temperature resistance up to 150°C. For this application, FEP is also limited to 150°C, due to the use of TPC conductors.

EXAMPLE 2

HOW TO DEFINE THE CURRENT CARRYING CAPACITY OF A FLEXFORCE™ BUNDLE WORKING IN CONFINED SPACE ?



In a vehicle, two FFR070 wires with 70 mm² conductor section are routed in a pipe. At 30°C, each of them is able to carry 420A. As the operating temperature is 100°C, the current carrying capacity is only 54% (see graph 1 above).
Calculation : 0.54 x 420 A = 226A
In addition, due to the confined installation, the two wires can only work at 80% of their capacity (see graph 2).
As a consequence, the current should not exceed 180A.
Calculation : 0.80 x 226A = 180A

AXON' reference identification code

SHIELDED JACKETED CABLE

SINGLE WIRE

FFR	010	St	R	1	(0 Hal)

FLEXFORCE = FF

PRIMARY INSULATION MATERIAL
AXON' SPECIAL COMPOUND
ASC 15 - 600 VAC **= R**
AXON' SPECIAL COMPOUND
ASC 15 - 1000 VAC **= RR**
FEP 1000 VAC **= KK**

CONDUCTOR AREA
mm^2

STANDARD BRAID

OUTER JACKET
AXON' SPECIAL COMPOUND
ASC 15 **= R**

SINGLE CORE CABLE

IF «(0 Hal)» SPECIFIED
- Primary insulation is R = halogen free flexible thermoplastic.
- Separating tape is halogen free.

FOR FURTHER INFORMATION,
our sales team is at your disposal for any advice you may require.

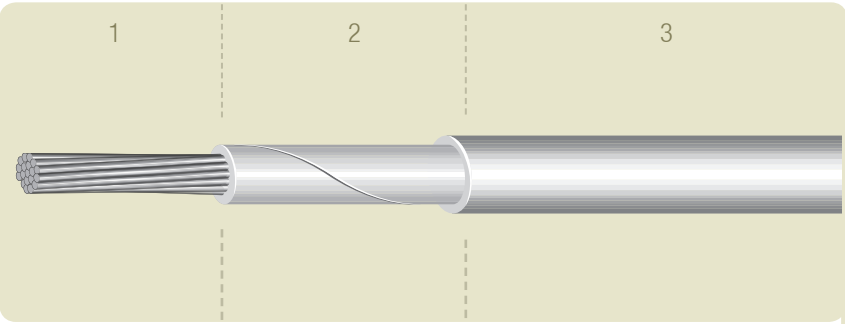
Single wires

TYPE FFR xxx

Insulation : ASC 15

Operating temperature : -40°C up to +150°C

Operating voltage : 600 VAC



Construction

1 - Extra flexible tin plated copper conductor.
2 - Separating tape.
3 - ASC 15 (*) insulation.

Main characteristics

› Flexibility :
bending radius = 4 x outer diameter for static applications.
8 x outer diameter for dynamic applications.

AXON' REFERENCE	CONDUCTOR Ø (mm)	AREA (mm^2)	OHMIC RESISTANCE (Ω/ 100m)	MAXIMUM CURRENT (A) @ 30°C	OUTER Ø (mm)	WEIGHT (g/m)
FFR010	4.59	10	0.202	120	6.50	110
FFR016	6.15	16	0.119	160	8.40	190
FFR025	7.25	25	0.077	210	9.80	280
FFR035	8.68	35	0.054	265	11.50	390
FFR050	10.15	50	0.040	330	13.00	520
FFR070	12.32	70	0.026	420	15.20	760
FFR095	13.50	95	0.021	500	16.50	950
FFR120	15.84	120	0.016	600	19.00	1220
FFR150	18.00	150	0.013	670	21.50	1520
FFR185	20.60	185	0.010	770	24.50	1910

(*) ASC = AXON' SPECIAL COMPOUND - ALL DATA ARE NOMINAL VALUES

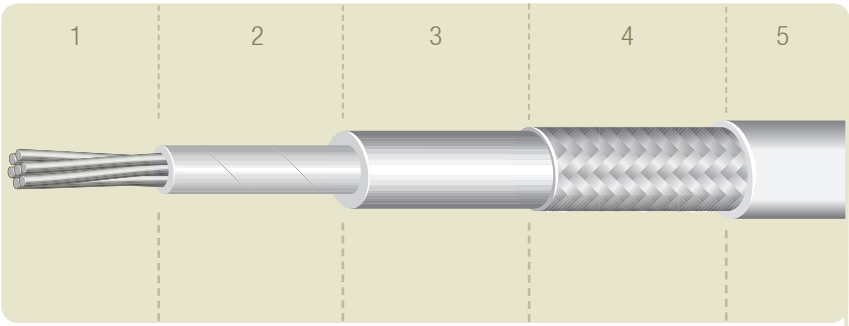
Shielded single wires

TYPE FFR xxx StR 1

Insulation : ASC 15

Operating temperature : -40°C up to +150°C

Operating voltage : 600 VAC



Construction

1 - Extra flexible tin plated copper conductor.
2 - Separating tape.
3 - ASC 15 (*) insulation.
4 - Tin plated copper braid.
5 - ASC 15 (*) jacket.

AXON' REFERENCE	CONDUCTOR Ø (mm)	AREA (mm²)	INSULATED WIRE Ø (mm)	OVER SHIELD Ø (mm)	OVERALL OUTER Ø (mm)	WEIGHT (g/m)
FFR010 StR 1	4.59	10	6.50	7.10	9.10	170
FFR016 StR 1	6.15	16	8.40	9.10	11.50	290
FFR025 StR 1	7.25	25	9.80	10.50	13.10	400
FFR035 StR 1	8.68	35	11.50	12.20	14.80	530
FFR050 StR 1	10.15	50	13.00	13.70	16.50	690
FFR070 StR 1	12.32	70	15.20	15.90	19.10	980
FFR095 StR 1	13.50	95	16.50	17.20	20.40	1190
FFR120 StR 1	15.84	120	19.00	19.90	23.70	1550

(*) ASC = AXON' SPECIAL COMPOUND - ALL DATA ARE NOMINAL VALUES

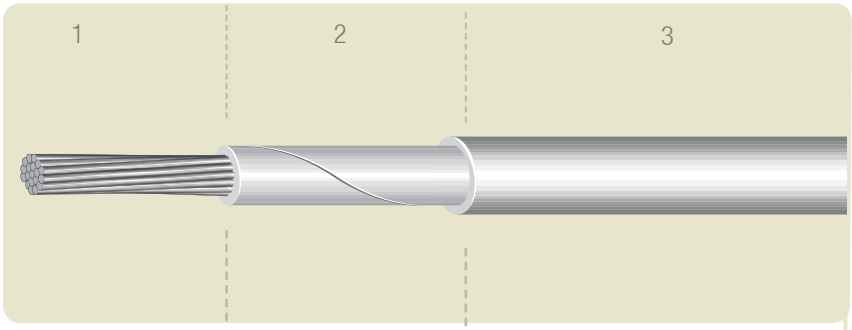
Single wires

TYPE FFRR xxx

Insulation : ASC 15

Operating temperature : -40°C up to +150°C

Operating voltage : 1000 VAC



Construction

1 - Extra flexible tin plated copper conductor.
2 - Separating tape.
3 - ASC 15 (*) insulation.

Main characteristics

› Flexibility :
bending radius = 4 x outer diameter for static applications.
8 x outer diameter for dynamic applications.

AXON' REFERENCE	CONDUCTOR Ø (mm)	AREA (mm²)	OHMIC RESISTANCE (Ω/ 100m)	MAXIMUM CURRENT (A) @ 30°C	OUTER Ø (mm)	WEIGHT (g/m)
FFRR010	4.59	10	0.202	120	7.20	130
FFRR016	6.15	16	0.119	160	9.00	200
FFRR025	7.25	25	0.077	210	10.20	290
FFRR035	8.68	35	0.054	265	12.00	410
FFRR050	10.15	50	0.040	330	13.50	540
FFRR070	12.32	70	0.026	420	15.80	780
FFRR095	13.50	95	0.021	500	17.20	980

(*) ASC = AXON' SPECIAL COMPOUND - ALL DATA ARE NOMINAL VALUES

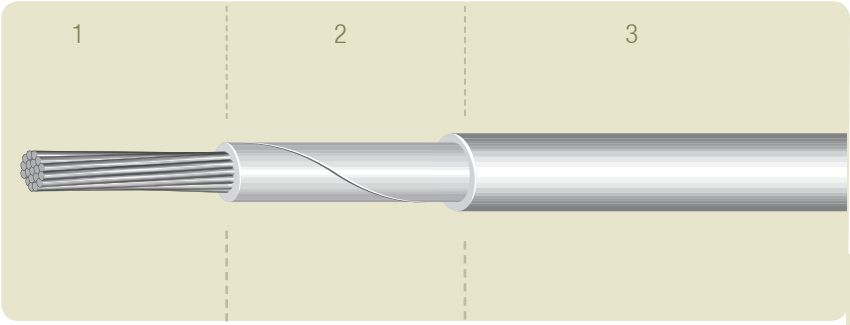
Single wires

TYPE FFKK xxx

Insulation : FEP

Operating temperature : -90°C up to +150°C (*)

Operating voltage : 1000 VAC



Construction

1 - Extra flexible tin plated copper conductor.
2 - Separating tape.
3 - FEP insulation.

(*) due to the use of tin plated copper conductor.

AXON' REFERENCE	CONDUCTOR Ø (mm)	AREA (mm²)	OHMIC RESISTANCE (Ω/ 100m)	MAXIMUM CURRENT (A) @ 30°C	OUTER Ø (mm)	WEIGHT (g/m)
FFKK010	4.59	10	0.202	120	6.50	120
FFKK016	6.15	16	0.119	160	8.40	200
FFKK025	7.25	25	0.077	210	9.80	290
FFKK035	8.68	35	0.054	265	11.50	410
FFKK050	10.15	50	0.040	330	13.00	540
FFKK070	12.32	70	0.026	420	15.20	780
FFKK095	13.50	95	0.021	500	16.50	970
FFKK120	15.84	120	0.016	600	19.00	1250
FFKK150	18.00	150	0.013	670	21.50	1560
FFKK185	20.60	185	0.010	770	24.50	1970

ALL DATA ARE NOMINAL VALUES

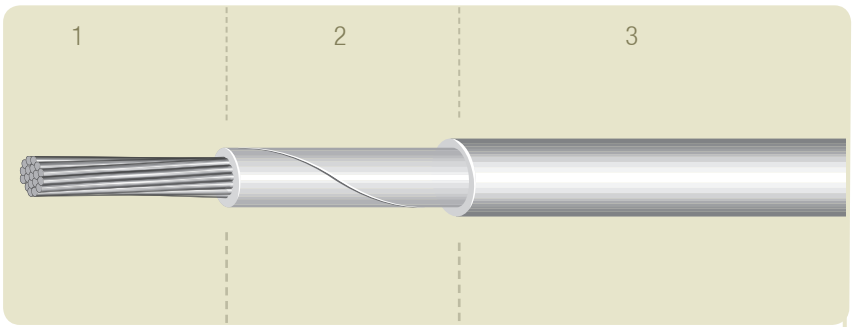
Single wires

TYPE FFR xxx (0 hal)

Insulation : HALOGEN FREE FLEXIBLE THERMOPLASTIC

Operating temperature : -40°C up to +125°C

Operating voltage : 600 VAC



Construction

1 - Extra flexible tin plated copper conductor.
2 - Halogen free separating tape.
3 - Halogen free flexible thermoplastic insulation.

AXON' REFERENCE	CONDUCTOR Ø (mm)	AREA (mm^2)	OHMIC RESISTANCE (Ω/ 100m)	MAXIMUM CURRENT (A) @ 30°C	OUTER Ø (mm)	WEIGHT (g/m)
FFR010 (0 Hal)	4.59	10	0.202	120	7.00	120
FFR016 (0 Hal)	6.15	16	0.119	160	8.60	190
FFR025 (0 Hal)	7.25	25	0.077	210	9.80	280
FFR035 (0 Hal)	8.68	35	0.054	265	11.50	390
FFR050 (0 Hal)	10.15	50	0.040	330	13.00	520
FFR070 (0 Hal)	12.32	70	0.026	420	15.20	760
FFR095 (0 Hal)	13.50	95	0.021	500	16.50	950
FFR120 (0 Hal)	15.84	120	0.016	600	19.00	1220
FFR150 (0 Hal)	18.00	150	0.013	670	21.50	1520
FFR185 (0 Hal)	20.60	185	0.010	770	24.50	1910

ALL DATA ARE NOMINAL VALUES

>> CHINA

AXON' INTERCONNECT LIMITED
HIGH TECH INDUSTRIAL PARK
CHANG BAO XI ROAD
RONGGUI, 528306
SHUNDE, GUANGDONG
TEL : + 86 757 2838 7200
FAX : + 86 757 2838 7212
e-mail : sales@axon-interconnect.com

AXON' INTERCONNECT LIMITED
SHANGHAI REPRESENTATIVE OFFICE
1258, YU YUAN ROAD. 15A/FLOOR ROOM 09-10
SHANGHAI, 200050
TEL : +86 21 6225 3951
FAX : +86 21 6225 3961
e-mail : sales@axon-interconnect.com

>> GERMANY

AXON' KABEL GmbH
POSTFACH 1131 D - 71201 LEONBERG
HERTICHSTR. 23 D - 71229 LEONBERG
TEL : +49 7152-97992-0
FAX : +49 7152-97992-7
e-mail : sales@axon-cable.de

>> HUNGARY

AXON' KÁBELGYÁRTÓ KFT.
H-6000 KECSKEMÉT,
WÉBER EDE U. 10/A
TEL : +36 76 508 195
FAX : +36 76 508 196
e-mail : axon@axon-cable.hu

>> INDIA

AXON'INTERCONNECTORS
AND WIRES PVT LTD
NO: 118, SUITE 4 E, NEIL RAO TOWERS,
ROAD NO:3, EPIP, WHITEFIELD
BANGALORE 560066
TEL : +91 80 40918186
FAX : +91 80 40918185
e-mail : sales@axon-cable.in

>> JAPAN

AXON' CABLE JAPAN OFFICE
PMR 1410043
3-23-3, MINAMI-OI, SHINAGAWA -KU
TOKYO 140-0013 JAPAN
TEL /FAX : +81 26 244 2261
e-mail : axon-japan@nifty.com

>> LATVIA

AXON' CABLE SIA
VIŠKU IELA, 21 C - LV-5410 DAUGAVPILS
TEL : +371 6540 78 91
FAX : +371 6540 78 93
e-mail : axon@axoncable.lv

>> MEXICO

AXON' INTERCONEX, S.A. de C.V
AV. PEÑUELAS 26 A.
INDUSTRIAL SAN PEDRITO PEÑUELAS
QUERÉTARO, QRO. C.P.76148 MÉXICO
TEL / FAX : +52 442 220 6464
TEL : +52 442 215 2713
e-mail : n.rodriguez@axoncable.com

>> SPAIN

AXON' CABLE SPANISH OFFICE
C/CAPITÁN HAYA, N°1, PLANTA 15
28020 MADRID
TEL : +34 91 418 43 46
FAX : +34 91 556 28 80
e-mail : sales@axon-cable.com

>> UNITED KINGDOM

AXON' CABLE Ltd
AXON' AGORA
ADMIRALTY PARK - ROSYTH - FIFE
KY11 2YW - UK
TEL : +44 1383 421500
FAX : +44 8715 282 789
e-mail : sales@axon-cable.co.uk

>> USA

AXON' CABLE INC.
1314 PLUM GROVE ROAD
SCHAUMBURG, IL. 60173
TEL : +1 847 230 7800
FAX : +1 847 230 7849
e-mail : sales@axoncable.com

HEADQUARTERS
>> France

>> AXON' CABLE S.A.S.

ROUTE DE CHALONS EN CHAMPAGNE - 51210 MONTMIRAIL
TEL : +33 3 26 81 70 00 - FAX : +33 3 26 81 28 83
e-mail : sales@axon-cable.com - http://www.axon-cable.com

axon'
CABLE & INTERCONNECT