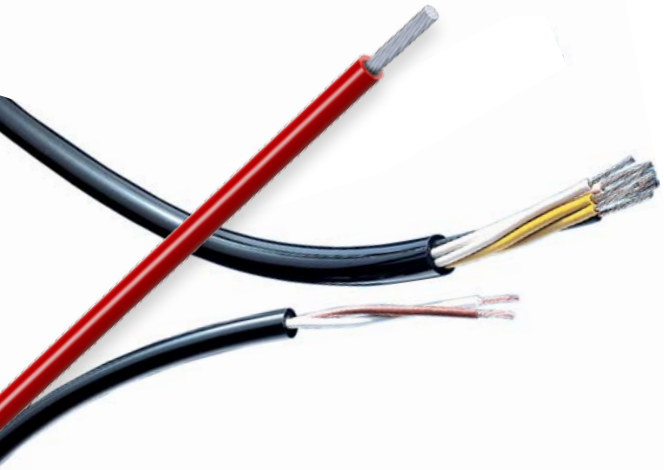
LEONI – Automotive cables for temperatures ≥150°C

The Quality Connection

LEONI

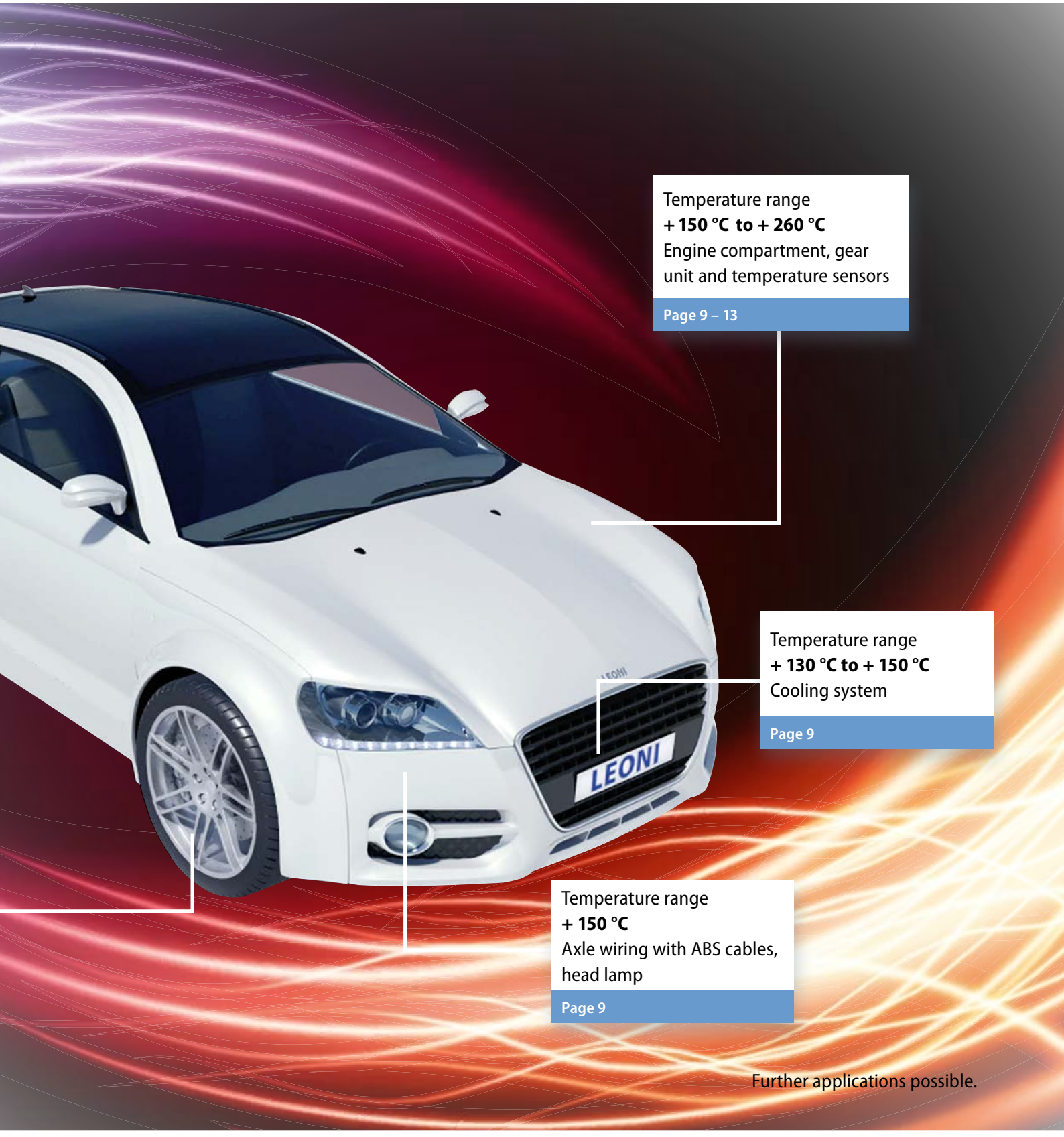
LEONI **Automotive cables**

Typical temperature ranges and applications – Overview



Issue: November 2014

Subject to change and error.



Temperature range
+ 150 °C to + 260 °C
Engine compartment, gear unit and temperature sensors

Page 9 – 13

Temperature range
+ 130 °C to + 150 °C
Cooling system

Page 9

Temperature range
+ 150 °C
Axle wiring with ABS cables, head lamp

Page 9

Further applications possible.

Insulation material properties

LEOMER®

It's all in the mix

LEONI carries its insulation materials for the production of cable under the brand name of LEOMER. With more than 50 of its own formulas developed in-house, LEONI ensures that the requirements arising from the particular applications of our customers are fulfilled in the best possible way. The manufacture of our insulation materials in-house and the close collaboration between our production and materials development guarantee a consistently high standard of quality.

The name LEOMER is composed of the terms LEONI and polymer, and represents the diversity of the materials used at LEONI.

Symbol	Name	Code	Density	Halogen content	Hardness Shore A/D	Tensile strength	Elongation at break
	e.g. DIN ISO 1629 and 7728	DIN 76722	ISO 11183		ISO 868	ISO 527	ISO 527 DIN 53504
Fluorpolymers							
			g/cm³	approx. %		MPa	%
ETFE	Ethylen tetrafluoroethylene	7Y	1.70	60	75D	> 30	> 200
FEP	Fluorinated ethylene propylene	6Y	2.14	75	55D	> 15	> 200
PTFE	Polytetrafluoroethylene	5Y	2.12–2.17	75	55D–65D	> 20	> 200
PFA	Perfluoroalkoxy copolymer	51Y	2.15	75	55D	> 20	> 200
Thermoplastic elastomers							
			g/cm³	approx. %		MPa	%
TPE-U	Thermoplastic polyether polyurethane	11Y	1.12	0	75A–54D	> 30	> 400
TPE-S	Thermoplastic polystyrene block copolymer	31Y	1.10–1.30	0–10	50D–65D	> 15	> 200
TPE-E	Thermoplastic polyether ester elastomer	12Y	1.16–1.25	0	40D–82D	> 25	> 400
TPE-A	Thermoplastic polyamide elastomer	41Y	1.01–1.06	0	63D	> 25	> 400
TPE-E	Thermoplastic polyether elastomer	13Y	1.25–1.28	0	55D–62D	> 30	> 300
Crosslinked polymers / silicone							
			g/cm³	approx. %		MPa	%
XLPE	Polyethylene (irradiation, silane, peroxide crosslinked)	2X	1.20–1.50	10	30–60D	> 10	> 200
EVA	Ethylene vinyl acetate	4G	1.30–1.40	0	80A–87A	> 7	> 150
SIR	Silicone rubber	2G	1.20–1.30	0	40A–90A	6–20	> 200

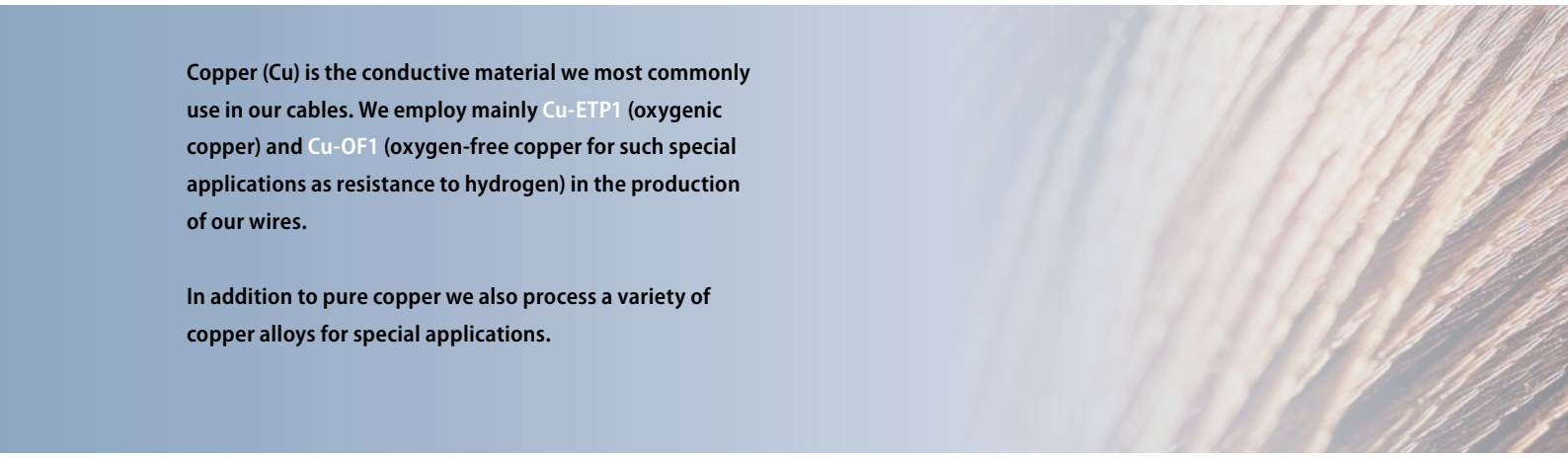
Service temperatures						Resistance to				
Temperature Index	Thermal overload capacity	Cold winding test	Specific volume resistance	Ab-rasion	Flame retardation	Oil	Fuels	Brake fluid	Acids/ alkalis	Organic agents
ISO 6722-1 or ISO 14572			IEC 93 DIN 53482			ISO 6722-1 or ISO 14572				
°C/3,000 h	°C/48 h	°C	Ω · cm							
180	230	–65	> 10^{15}	++	++	++	++	++	++	++
210	260	–65	> 10^{15}	++	++	++	++	++	++	++
260	305	–90	> 10^{18}	++	++	++	++	++	++	++
260	290	–90	> 10^{15}	++	++	++	++	++	++	++
°C/3,000 h	°C/48 h	°C	Ω · cm							
110–150	150	–40	> 10^{9}	++	+	++	++	+	+	+
125	150	–40	> 10^{10}	–	+	+	+	–	+	–
125–150	150	–40	> 10^{9}	++	–	++	++	+	–	+
125–150	120	–40	> 10^{10}	++	–	++	++	+	–	+
125–150	180	–40	> 10^{9}	++	+	++	++	+	+	+
°C/3,000 h	°C/48 h	°C	Ω · cm							
125–150	150	–40	> 10^{14}	+	+	+	+	–	+	+
140	180	–40	> 10^{10}	–	–	–	–	–	–	–
200	225	–80	> 10^{16}	–	+	+	+	++	+	+

++ excellent + good – fair –– poor

Conductor materials

Copper (Cu) is the conductive material we most commonly use in our cables. We employ mainly Cu-ETP1 (oxygenic copper) and Cu-OF1 (oxygen-free copper for such special applications as resistance to hydrogen) in the production of our wires.

In addition to pure copper we also process a variety of copper alloys for special applications.



Extract from EN 1977 – copper

Symbol	Material number	Composition	Density	Melting point	% IACS min.	Notes on properties and use
		in % by weight	g/cm³		ISO 868	ISO 527
Oxygenic copper						
Cu-ETP1 (E-Cu)	CW 003 A	Cu ≥ 99.90 oxygen max. 0.040	8.9	1,083 °C	80A–60D	Oxygenic (tough-pitch) copper with an electrical conductivity in soft condition of ≥ 58.58 m/Ωmm² at 20 °C.
Oxygen-free copper, non-deoxidized						
Cu-OF1 (OF-Cu)	CW 007 A	Cu 99.95	8.9	1,083 °C	101	High-purity copper, largely free of elements that evaporate in vacuum, with an electrical conductivity in soft condition ≥ 58.58 m/Ωmm² at 20 °C. Intermediate material meeting high requirements on hydrogen resistance; welding and hard soldering capability. For vacuum systems and electronics.

International **A**nnealed **C**opper **S**tandard = **IACS**

Electrical conductivity of copper = min. 58 m/Ωmm² = 100 % IACS

Excerpt from DIN CEN/TS 13388 and EN 1977 – Alloys

Symbol	Material number	Composition	Density	Melting point	% IACS min.	Information regarding properties and use
		in % by weight	g/cm³			
CuAg 0.1	CW 013 A	Ag min. 0.08 max. 0.12	8.9	1,083 °C	98	Copper alloys with high tensile strength electrical conductivity of ≥ 57 m/Ωmm² at 20 °C in soft condition.
CuMg 0.2	CW 127 C	Mg* min. 0.14 max. 0.26	8.9	1,078 °C	75	Copper alloys with high tensile strength electrical conductivity of ≥ 44 m/Ωmm² at 20 °C in soft condition.
CuSn 0.3**	CW 129 C	Sn* min. 0.25 max. 0.35	8.9	1,065 °C	72	Copper alloys with high tensile strength electrical conductivity of ≥ 42 m/Ωmm² at 20 °C in soft condition.

* Tolerance deviating from DIN CEN/TS 13388
** Symbol deviating from DIN CEN/TS 13388

Excerpt from EN 573 – Aluminium

Symbol	Material number	Composition	Density	Melting point	% IACS min.	Information regarding properties and use
		in % by weight	g/cm³			
EAl 99.7	1370	Al 99.7	2.7	659 °C	62	Aluminium with electrical conductivity of ≥ 35.5 m/Ωmm² at 20 °C in soft condition.

Galvanic coatings: The metal materials used for galvanically refined copper wires are tin, silver or nickel, depending on the requirements.

Tin	
Designation	Tin 99.90
Density	7.29 g/cm³
Melting point	232 °C
Symbol	Sn

Silver	
Designation	Fine silver 99.97
Density	10.5 g/cm³
Melting point	960 °C
Symbol	Ag

Nickel	
Designation	Nickel 99.90
Density	8.9 g/cm³
Melting point	1450 °C
Symbol	Ni

Criteria for use

- Good solderability
- Effective protection against corrosion

- High temperature resistance
- Good surface conductivity (skin effect)

- High resistance to corrosion and temperature

Temperature limits for the use of conductor materials.
Directive CSA-C22.2 No. 210.2 assigns conductor materials to the following temperature limits:

Temperature range max. 150 °C*

- Bare and tin-plated copper with single wire Ø ≤0.38 mm
- Copper-plated steel wire (e.g. Staku) with single wire Ø ≤ 0.38 mm

Temperature range max. 200 °C*

- Bare and tin-plated copper with single wire Ø ≥0.38 mm
- Copper-plated steel wire (e.g. Staku) with single wire Ø ≥0.38 mm bare and tin-plated
- Silver-plated copper
- Copper alloy

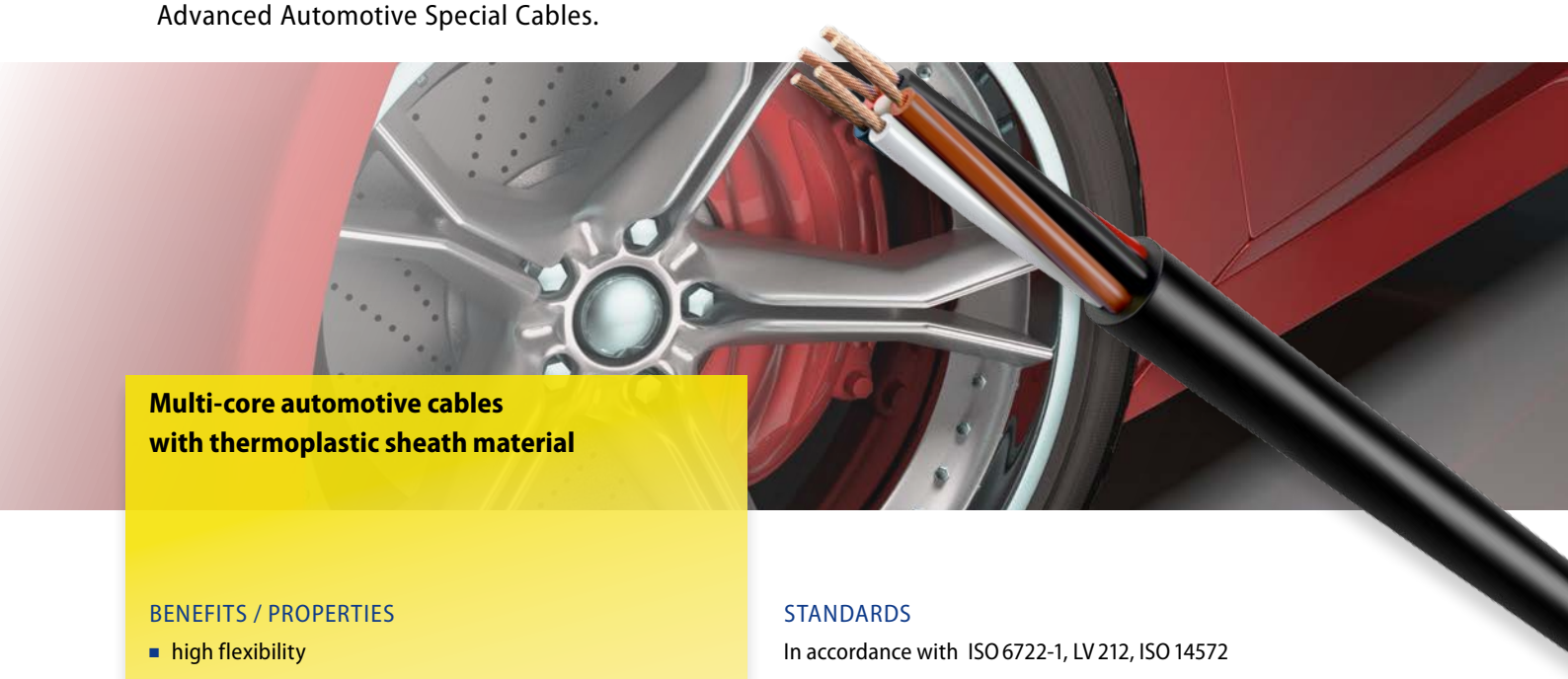
Temperature range max. 250 °C*

- Nickel-plated copper
- Silver-plated alloys of cadmium chrome-copper
- Nickel-plated steel wires
- Pure nickel wires for flexible applications and nickel alloys

* Similar to ISO 6722-1 temperature classes

LEONI **Adascar® Standard cables**

Advanced Automotive Special Cables.



Multi-core automotive cables with thermoplastic sheath material

BENEFITS / PROPERTIES

- high flexibility
- good insert moulding
- cold resistance
- resistance to hydrolysis
- good media resistance
- bending strength
- non crosslinked sheath material
- abrasion resistance

APPLICATIONS

- ABS applications
- wiring harness
- sensor technology
- cooling system

STANDARDS

In accordance with ISO 6722-1, LV 212, ISO 14572

INSULATION

- Thermoplastic elastomer on polyether ester basis (TPE-E)
- Polyethylene (irradiation, silane, peroxide crosslinked) (XLPE)
- Ethylene/vinyl acetate (EVA), crosslinked

SHEATH

- Thermoplastic elastomer on polyurethane basis (TPE-U)

OPERATING VOLTAGE

≤ 60 V

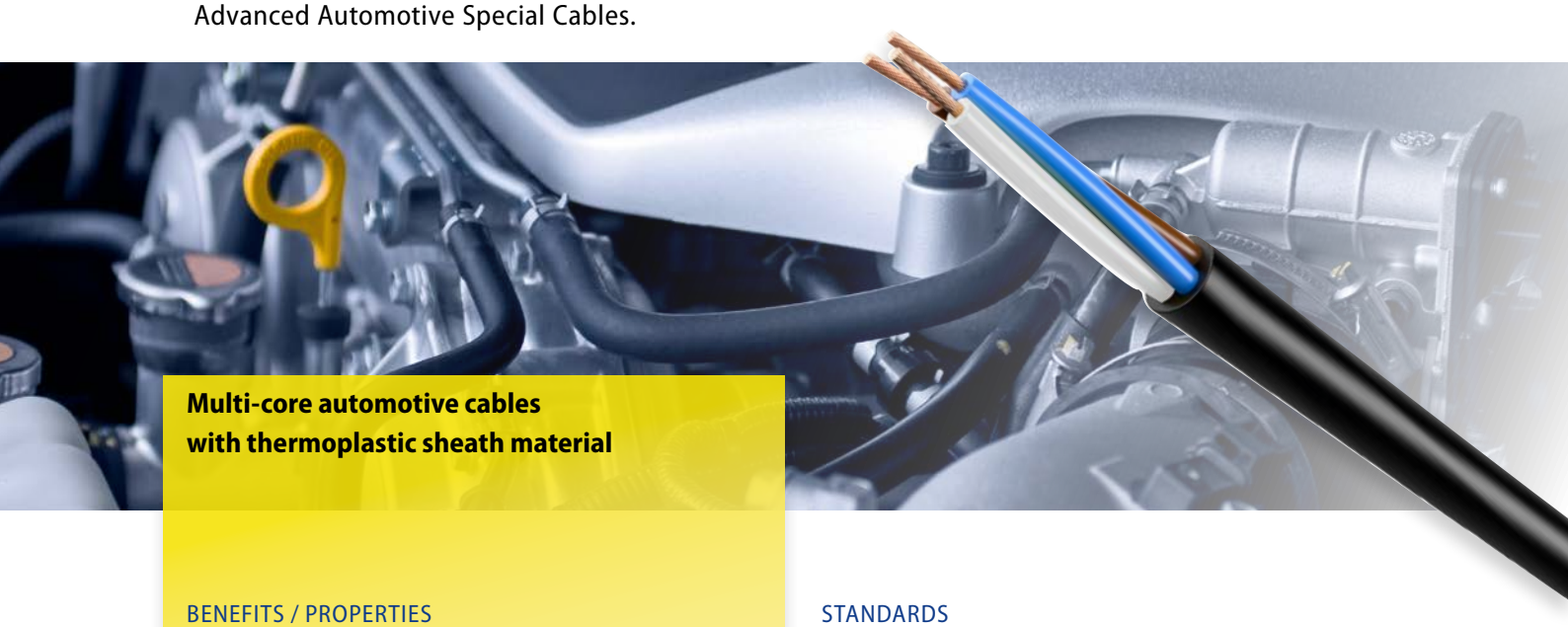
Excerpt of our product range

Description	Code	Number of cores	Nominal cross-section mm²	Insulation	Sheath	Shielding	Temperature range
Round cable	LEONI Adascar® Control 87xx	2 – 6	0.35 – 0.50	TPE-E	TPE-U	–	- 40 °C to + 150 °C
				XLPE			
				EVA			
Round cable shielded	LEONI Adascar® Control 97xx	2 – 6	0.35 – 0.50	TPE-E		B or C	
				XLPE			
				EVA			
Round cable	LEONI Adascar® Power 47xx	2 – 4	0.75 – 1.50	TPE-E		–	
				XLPE			
				EVA			
			2.00	TPE-E			
			2.50	TPE-E			
Round cable shielded	LEONI Adascar® Power 57xx	2 – 4	0.75 – 1.50	TPE-E		B or C	
				XLPE			
				EVA			
			2.00	TPE-E			
			2.50	TPE-E			

Additional cross-sections, strands and cable constructions on request. The number of cores can be increased.

LEONI **Adascar® Cables with special materials**

Advanced Automotive Special Cables.



Multi-core automotive cables with thermoplastic sheath material

BENEFITS / PROPERTIES

- good heat resistance within thermal overload
- good insert moulding
- high flexibility
- lasting media resistance when immersed in oils
- crosslinked resp. non crosslinked sheath material
- solvent resistance (increased swelling resistance)
- thermal resistance up to 1,000 hours/180 °C
- flame retardance/non flame retardance

APPLICATIONS

- brake system wiring
- sensors for engine compartment
- wiring for gear unit

STANDARDS

In accordance with ISO 6722-1, LV 212, ISO 14572

INSULATION

- Polyethylene (irradiation, silane, peroxide crosslinked) (XLPE)
- Ethylene/tetrafluoroethylene (ETFE)

SHEATH

- Thermoplastic elastomer on polyamide basis (TPE-A)
- Thermoplastic elastomer on polyether ester basis (TPE-E)

OPERATING VOLTAGE

≤ 60 V

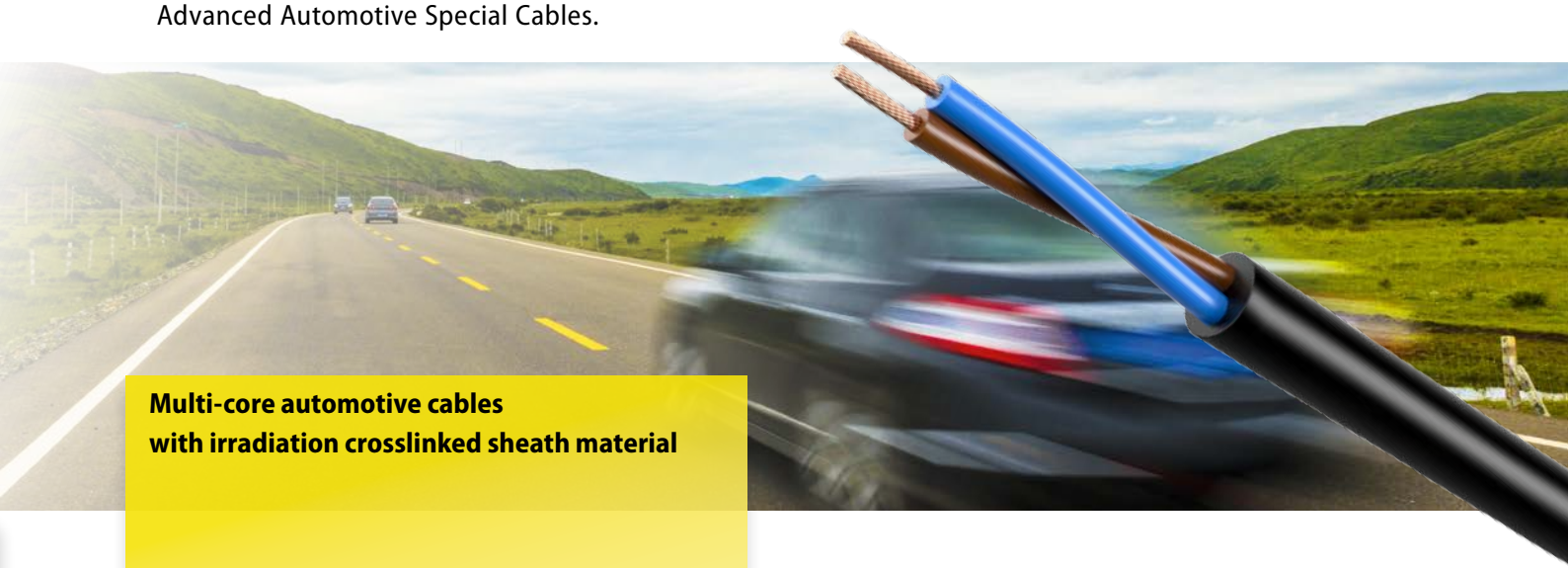
Excerpt of our product range

Description	Code	Number of cores	Nominal cross-section mm²	Insulation	Sheath	Shielding	Temperature range
Round cable heat resistant	LEONI Adascar® Control 87xx	2 – 4	0.35 – 0.50	XLPE	TPE-A	–	- 40 °C to + 150 °C
				ETFE			
Round cable oil resistant			0.35 – 0.50	ETFE	TPE-E		
Round cable heat resistant shielded	LEONI Adascar® Control 97xx		0.35 – 0.50	XLPE	TPE-A	B or C	
				ETFE			
Round cable heat resistant	LEONI Adascar® Power 47xx		0.75 – 1.50	XLPE	TPE-A	–	
				ETFE			
			2.00	ETFE			
Round cable oil resistant			0.75 – 1.50	ETFE	TPE-E		
Round cable heat resistant shielded	LEONI Adascar® Power 57xx		2.00	ETFE	TPE-A	B or C	
			0.75 – 1.50	XLPE			
				ETFE			
			2.50				

Additional cross-sections, strands and cable constructions on request. The number of cores can be increased.

LEONI **Adascar® Irradiation crosslinked cables**

Advanced Automotive Special Cables.



Multi-core automotive cables with irradiation crosslinked sheath material

BENEFITS / PROPERTIES

- good heat resistance within thermal overload
- good chemical resistance
- solvent resistance (increased swelling resistance)
- bending strength
- abrasion resistance
- flame retardance

APPLICATIONS

- brake system wiring
- sensors for engine compartment
- wiring for gear unit

STANDARDS

In accordance with ISO 6722-1, LV 212, ISO 14572

INSULATION

- Polyethylene (irradiation, silane, peroxide crosslinked) (XLPE)
- Ethylene/tetrafluoroethylene (ETFE)

SHEATH

- Polyethylene (irradiation crosslinked)) (XLPE)

OPERATING VOLTAGE

≤ 60 V

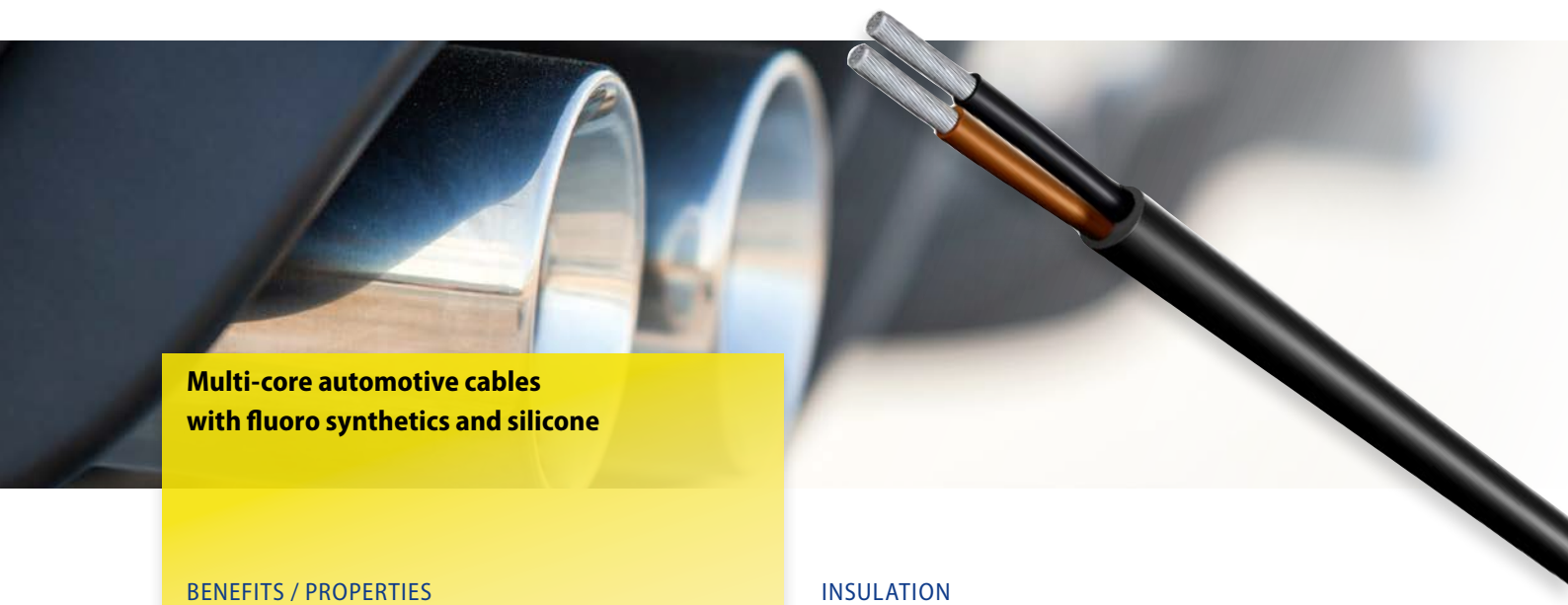
Excerpt of our product range

Description	Code	Number of cores	Nominal cross-section mm²	Insulation	Sheath	Shielding	Temperature range
Round cable irradiation crosslinked	LEONI Adascar® Control 87xx	2 – 4	0.35 – 0.50	XLPE ETFE	XLPE	–	- 40 °C to + 150 °C
Round cable irradiation crosslinked shielded	LEONI Adascar® Control 97xx	2 – 4	0.35 – 0.50	XLPE ETFE	XLPE	B or C	- 40 °C to + 150 °C
Round cable irradiation crosslinked	LEONI Adascar® Control 97xx	2	2.00 2.50	ETFE	XLPE	–	- 40 °C to + 150 °C
Round cable irradiation crosslinked	LEONI Adascar® Power 47xx	2 – 4	0.75 – 1.50	XLPE ETFE	XLPE	–	- 40 °C to + 150 °C
Round cable irradiation crosslinked shielded	LEONI Adascar® Power 57xx	2 – 4	0.75 – 1.50	XLPE ETFE	XLPE	B or C	- 40 °C to + 150 °C

Additional cross-sections, strands and cable constructions on request. The number of cores can be increased.

LEONI **Adascar® Cables with high performance polymer**

Advanced Automotive Special Cables.



Multi-core automotive cables with fluoro synthetics and silicone

BENEFITS / PROPERTIES

- good mechanical and heat resistance properties
- particularly suitable for internal wiring
- very good media resistance
- abrasion resistance
- flame retardance

APPLICATIONS

- exhaust system
- engine compartment

STANDARDS

In accordance with ISO 6722-1, LV 212, ISO 14572

INSULATION

- Polytetrafluoroethylene (PTFE)
- Perfluoroalkoxy copolymer (PFA)
- Ethylene / Tetrafluoroethylene (ETFE)
- Tetrafluoroethylene / Hexafluoropropylene (FEP)

SHEATH

- Polytetrafluoroethylene (PTFE)
- Perfluoroalkoxy copolymer (PFA)
- Ethylene / Tetrafluoroethylene (ETFE)
- Tetrafluoroethylene / Hexafluoropropylen (FEP)
- Silicone rubber (SIR)

OPERATING VOLTAGE

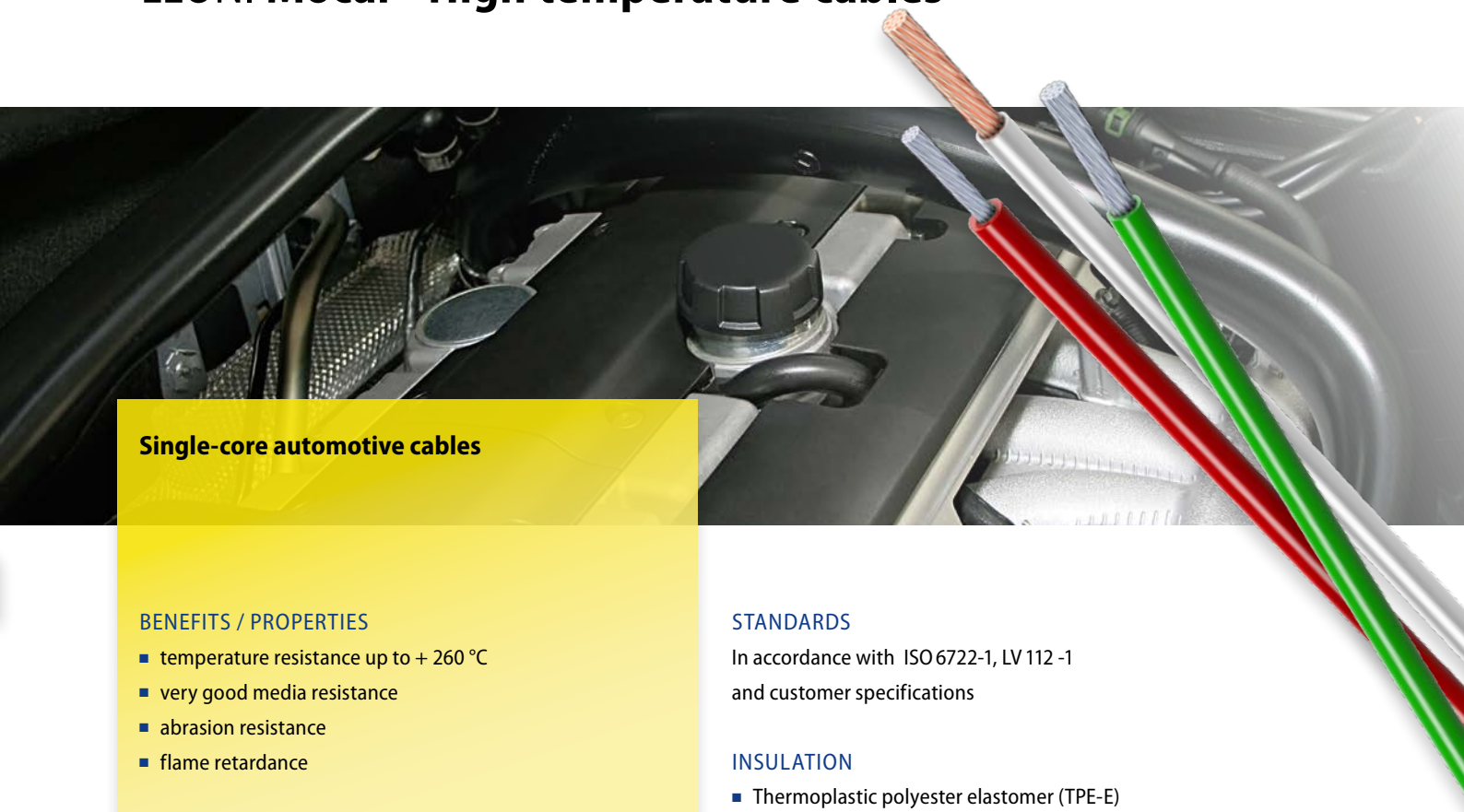
≤ 60 V

Excerpt of our product range

Description	Code	Number of cores	Nominal cross-section mm²	Insulation	Sheath	Temperature range
Round cable	LEONI Adascar® Control 87xx	2 – 4	0.35 – 0.50	ETFE	ETFE	– 40 °C to + 180 °C
				FEP	SIR	– 40 °C to + 200 °C
					FEP	– 40 °C to + 210 °C
				PFA	PFA	– 40 °C to + 260 °C
				PTFE	PTFE	
	LEONI Adascar® Power 47xx		0.75 – 1.50	ETFE	ETFE	– 40 °C to + 180 °C
				FEP	SIR	– 40 °C to + 200 °C
					FEP	– 40 °C to + 210 °C
				PFA	PFA	– 40 °C to + 260 °C
				PTFE	PTFE	

Additional cross-sections, strands and cable constructions on request. The number of cores can be increased.

LEONI **Mocar® High temperature cables**



Single-core automotive cables

BENEFITS / PROPERTIES

- temperature resistance up to + 260 °C
- very good media resistance
- abrasion resistance
- flame retardance

APPLICATIONS

- exhaust system
- engine compartment
- temperature sensors
- brake wear indicator
- battery cables

STANDARDS

In accordance with ISO 6722-1, LV 112 -1
and customer specifications

INSULATION

- Thermoplastic polyester elastomer (TPE-E)
- Ethylene / Tetrafluoroethylene (ETFE)
- Silicone rubber (SIR)
- Tetrafluoroethylene / Hexafluoropropylene (FEP)
- Perfluoroalkoxy copolymer (PFA)
- Polytetrafluoroethylene (PTFE)

Excerpt of our product range

Description	Code	Number of wires	Nominal cross-section mm²	Insulation	Temperature range
Automotive cable heat resistant	LEONI Mocar® 150 C	7 – 19	Type A ➔ 0.22 – 2.5	TPE-E	– 40 °C to + 150 °C
		12 – 84	Type B ➔ 0.35 – 6		
Automotive cable high temperature resistant	LEONI Mocar® 180 E	7 – 19	Type A ➔ 0.35 – 2.5	ETFE	– 65 °C to + 180 °C
		12 – 84	Type B ➔ 0.35 – 6		
	LEONI Mocar® 200 G	12 – 457	0.35 – 95	SIR	– 80 °C to + 200 °C
	LEONI Mocar® 200 G AL (Aluminium)	50 – 305	10 – 120		
	LEONI Mocar® 210 F	7 – 19	Type A ➔ 0.35 – 2.5	FEP	– 65 °C to + 210 °C
		12 – 84	Type B ➔ 0.35 – 6		
	LEONI Mocar® 260 T	7 – 56	0.35 – 4	PFA	– 80 °C to + 260 °C
	LEONI Mocar® 260 R	7 – 19	Type A ➔ 0.22 – 2.5	PTFE	– 90 °C to + 260 °C
		12 – 84	Type B ➔ 0.35 – 6		

Production technologies

for high-temperature cables

Silicone extrusion

PRODUCTION TECHNOLOGIES

LEONI has state-of-the-art machinery for processing high-temperature materials and covers all the relevant technologies in-house:

CROSSLINKING OF MATERIALS

Crosslinked materials involve the use of simple base materials that are mixed with a corresponding crosslinking accelerator. The crosslink in the material can be activated by three methods: physical, chemical and by irradiation. Additional crosslinks of the molecule chains form in the insulation material, which create greater resistance to environmental influences.

RAM EXTRUSION

PTFE may be processed by means of ram extrusion. The base material for this special process is a PTFE powder that is mixed with a lubricant and is, using a preform press, pressed into a cylindrical preform with an inner bore.

This preform is inserted into the ram extrusion cylinder and pressed through an extruder nozzle with a piston.
The material coats the conductor that is fed through the extruder head. After the extrusion process, the lubricant is extracted again from the cable by applying heat and the cable is subsequently sintered at high temperature in a continuous furnace.

SILICONE PROCESSING

The principle for processing silicone is similar to that for PVC extrusion.
Yet the key difference lies in the temperature profile. Silicone is always processed cold, i.e. the mixing mill and the extruder are kept at a constant temperature of less than 20°C via a large number of different control areas. The heat generated during compounding and extrusion is directly dissipated. After extrusion, the silicone rubber has to be crosslinked. The molecules are linked into three-dimensional webs using a crosslinking agent. This takes place inside separately controllable crosslinking furnaces through which the product passes immediately after extrusion. Various temperature profiles can be set here.
Applying a high temperature enables or accelerates the crosslinking process, depending on the two following methods:

- Peroxide crosslinking requires a higher temperature and more time before the crosslinking process is completed.
- The process of platinum catalysed crosslinking takes place even below room temperature. To prevent premature crosslinking of the silicone rubber, sufficient cooling of the mixing mill and the extruder is therefore absolutely necessary.

Quality and environmental management

LEONI – The Quality Connection

The wire and cable production locations of LEONI are certified worldwide in line with ISO 9001:2008; all locations, in which automotive cables are produced, are certified in accordance with ISO/TS 16949:2009.
Our environmental management is certified in compliance with DIN EN ISO 14001:2004.


CERTIFICATE

LEONI

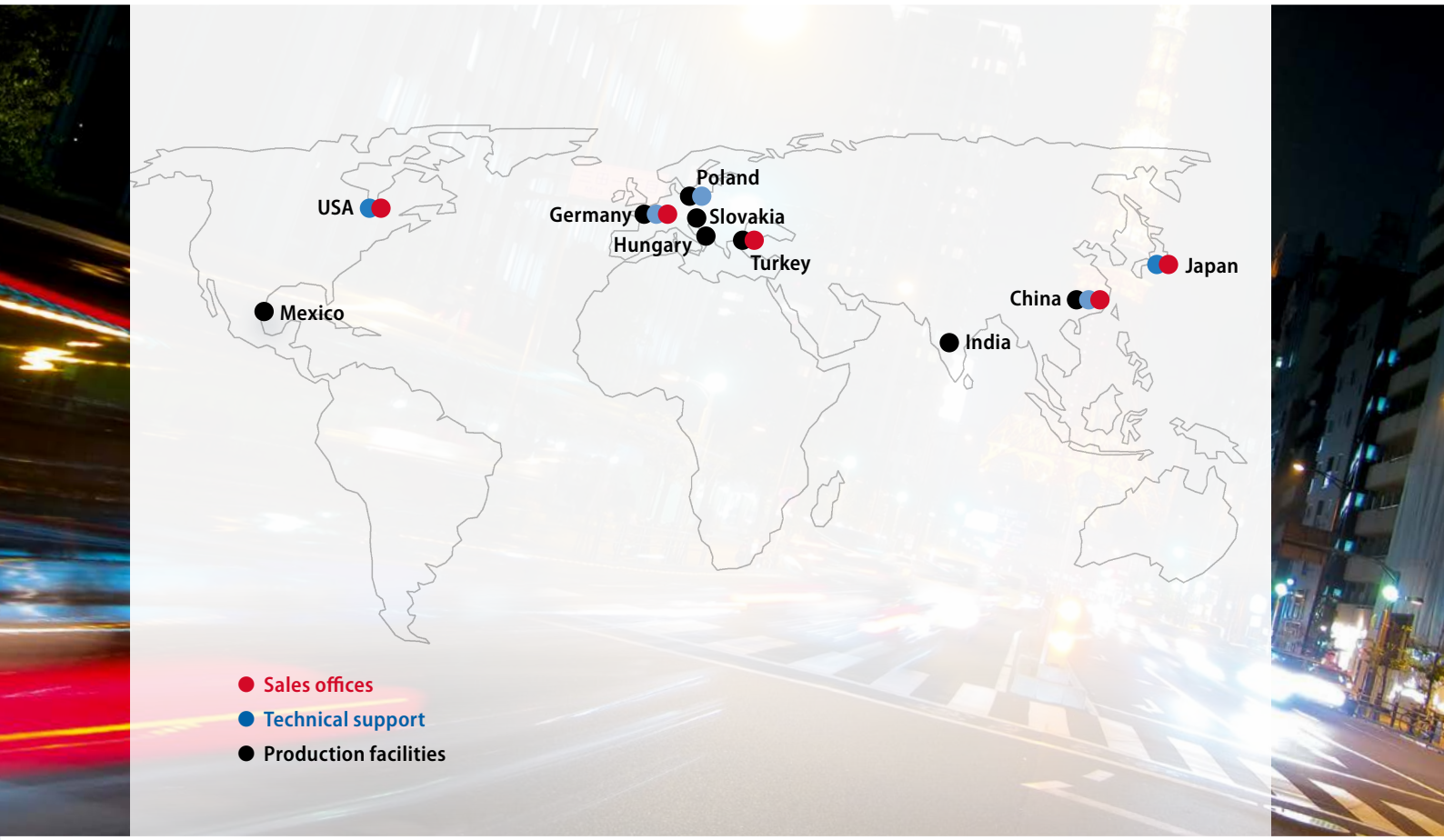
ISO 14001:2004


CERTIFICATE

ISO/TS 16949:2009

LEONI worldwide

Facilities of the Business Group Automotive Cables



Proximity to our customers is a core element of our corporate policy. LEONI is a dependable partner to its customers – all over the world. We also regard maintaining, as well as raising quality and service at the same high level everywhere in the world as a sign of proximity.

We support efficient operating as well as our customers' power of innovation and market position on the basis of our own international positioning, standardised methods and clearly defined processes.

No matter where we apply our know-how, commitment and ideas: we want satisfied customers worldwide.

An overview of all entities

Germany
LEONI Kabel GmbH, Roth
LEONI HighTemp Solutions GmbH, Halver

China
LEONI Wire (Changzhou) Co. Ltd., Changzhou

Japan
LEONI Wire & Cable Solutions Japan K.K., Aichiken

India
LEONI Cable Solutions (India) Pvt. Ltd., Pune

Mexico
LEONI Cable Mexico S.A. de C.V., Cuauhtémoc

Poland
LEONI Kabel Polska Sp.z.o.o., Kobierzyce

Slovakia
LEONI Slovakia, spol. s r.o., Trenčianska Teplá

Turkey
LEONI Kablo ve Teknolojileri San. ve Tic. Ltd. Sti., Gemlik

Hungary
LEONI Kábelgyár Hungaria Kft., Hatvan

USA
LEONI Cable Inc., Rochester

Find out more:

Business Group Automotive Cables

www.leoni-automotive-cables.com

LEONI Kabel GmbH
Stieberstraße 5
91154 Roth
Germany
Phone +49 (0)9171-804-2378
Fax +49 (0)9171-804-2421
E-mail cable-info@leoni.com

11.2014 / en