ICON® Product Guide

The Quality Connection

LEONI



Product range

- Telecommunication cables
- Data- and Bus cables (copper and fiber optic)
- Mining cables
- Cables for special applications
- Instrumentation- and control cables
- Thermocouple extension and compensating cables
- Power cables (low and medium voltage)

This is not just a catalogue…

… it is what you have been looking for – a product guide to choosing the design you need for your project, plant or application…

… created to provide you with the cable solution you need.

The European Standard EN 50288-7 is the first ever standard for instrumentation and control cables to address the entire range of demands and reqirements of general and specific industrial cable applications.

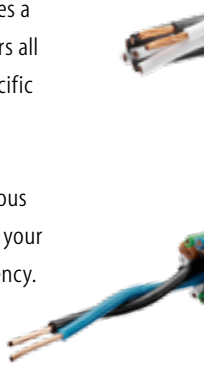
In contrast to the existing official regulations and specifications, the new standard covers the huge variety of cable designs used in today's global business. The meaningful and comprehensive (but nevertheless standardized) range of different versions in terms of design and materials used allows you to select cable designs which comply with the standard but still meet the requirements of the application.

The new standard will be complemented by European standards for materials and testing. These standards do not exist as yet, so we shall refer to IEC standards or national standards here.

On the solid basis of many years of experience in international business (either project-oriented or geared to the site requirements of the customers) in conjunction with the new standard, we have defined a very wide product range designed to meet all your field-driven product requirements.

We have selected and elaborated a product programme designed to cover all usual applications. The diversity of the environmental, electrical, mechanical, installation and safety requirements produces a need for an extensive range of products. This first section covers all necessary information on product families. Information on specific types will be provided on request or via other media.

The extremely systematic organisation of this guide to the various product families will allow you to select your product to match your application and meet your requirements with maximum efficiency.



Content

Issue August 2009

LEONI

ICON®

Five new brands posses the optimized cable solution for your plant:

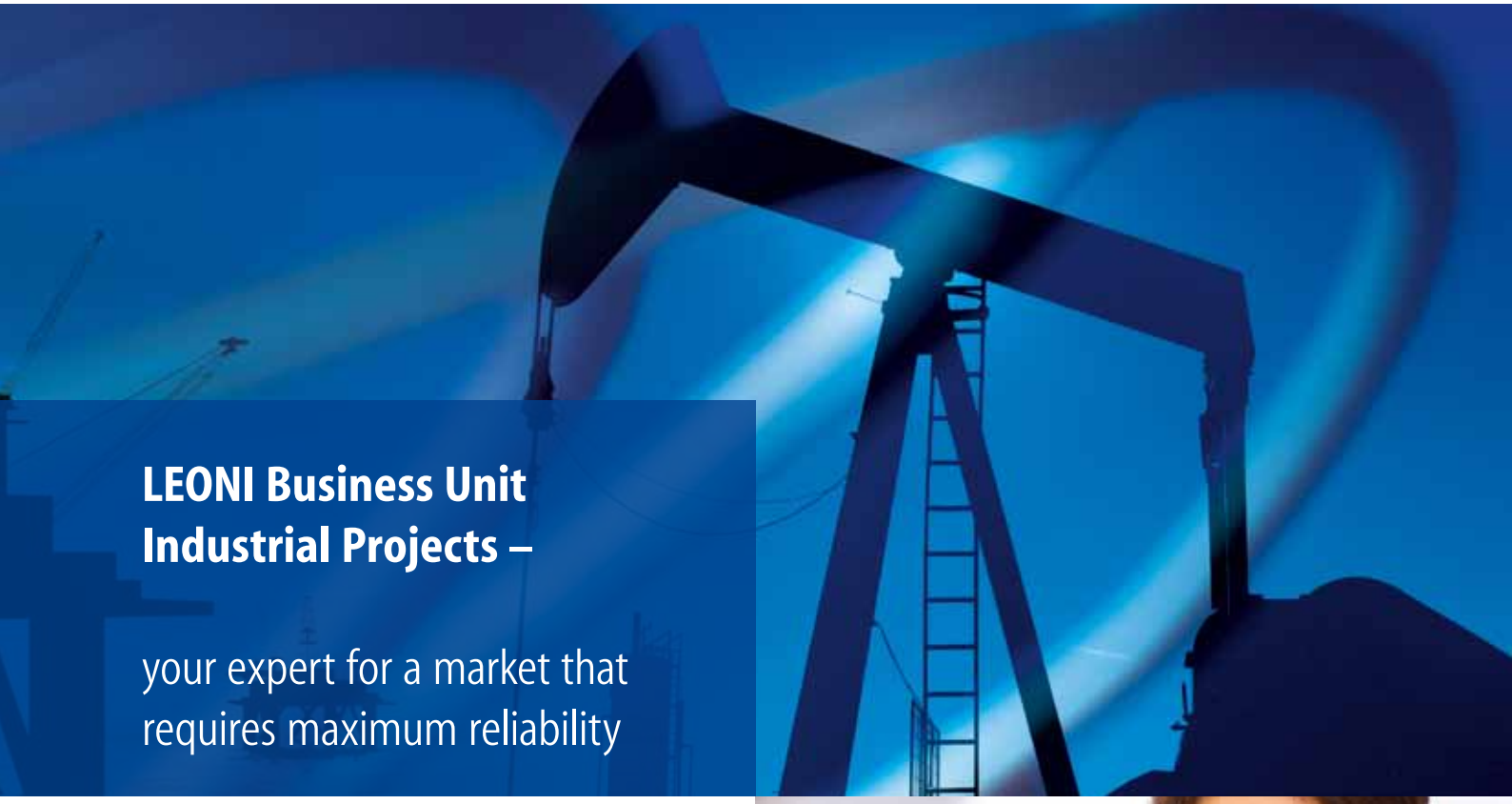
ICON®*base* … ensures reliable performance in all usual conditions.

ICON®*chem* … ensures the safety and functionality of your plant in aggressive environments.

ICON®*arctic* … offers excellent properties for applications in extremely cold environments.

ICON®*safe* … offers protection for saving lives and safeguarding investments.

ICON®*bus* … meets or exceeds the increased requirements of state-of-the-art automation technology.



LEONI Business Unit Industrial Projects –

your expert for a market that requires maximum reliability

Please visit our website www.leoni-industrial-projects.com

LEONI is one of the leading suppliers of standardised and customer-specific special cables and pre-assembled cable systems worldwide.

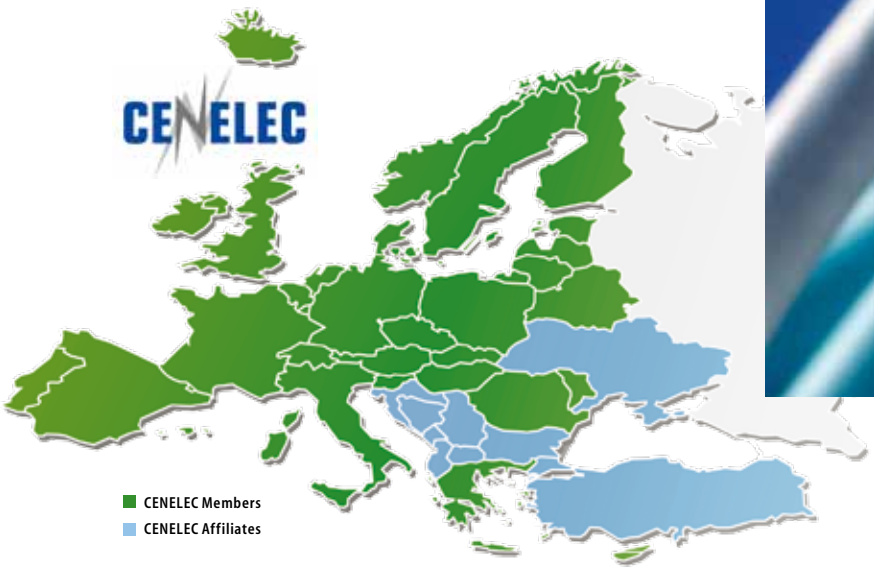
The Business Unit Industrial Projects allows us to give our customers access to the entire competence of a worldwide corporation, focused to meet the needs of industrial applications. We supply our products and solutions wherever everything depends on maximum reliability, quality and durability, such as in oil and gas extraction and processing as well as in the petrochemical and energy production industries. LEONI products are to be found in many other applications such as the pulp and paper, cement and pharmaceutical industries and in waste management, in which processes have to run in a controlled way via sensors and actuators.

For us reliability doesn't just mean keeping the right product available for you as a standard product or developing a project solution for you – it also means supplying it at precisely the agreed time.

Safety, availability and reliability are vital in industrial plant engineering and energy provision. This is because these are fields in which unexpected breakdowns are very expensive and have critical effects on the environment.

Companies are asking for solutions which are perfectly tailored to meet the application in question as well as the plant itself. 70 % of the cables leaving our company are developed, manufactured and assembled according to customer specifications. We produce quantities depending on the requirements of the projects and supply according to cable drumming schedules. We are also equipped to provide project quantities in a considerable two-digit million euro range. We take company-specific standards as well as all important industrial and environmental standards on the national and international level into account.

The EN 50288-7 standard



The EN 50288-7 standard

The European standard EN 50288-7 published in September 2005 is the first ever standard governing instrumentation cables for onshore applications to have been prepared by an established international standardisation body.

The following features distinguish this standard from the wide variety of existing product specifications:

- it complements the relevant standards for materials and testing
- it includes a wide range of design options
- it effectively matches design regulations with test requirements.

This standard thus enables the user to convert all demands with regard to systems, security, the environment, climate and installation into appropriate products in an efficient way.

The standard has been implemented in the form of national standards by all Cenelec members (28 countries at present). Its future significance is underlined by the fact that all former national standards which conflict with the EN standard had been withdrawn after a certain transitional period in April 2008 latest.

This standard also meets the requirements of the "European Low Voltage Directive".

The advantages

The application of this standard offers a number of advantages:

- it was prepared by a recognized standardisation body
- it represents the "state of the art" throughout
- it is available to everyone everywhere
- it specifies products easily, quickly, clearly and without ambiguity
- it includes a wide range of design options

It thus allows consultants, engineers, manufacturers and others to save time and money when

- preparing specifications
- dealing with inquiries, offers and orders
- organizing product-programmes

Summary:

The application of the standard EN 50288-7 should become as logical and widespread as the application of the IEC 60502 standard for power cables.

The product programme

The EN 50288-7 standard does not comprise specific products; instead it "merely" describes the individual cable elements and their design (including options and the relevant rules), defines materials, dimensions and test requirements and cites the relevant standards.

On the basis of more than thirty years of experience in the international instrumentation cable business, the Business Unit Industrial Projects has seized the opportunity and defined the EN 50288-7-based ICON® product programme, which consists of two sections:

"Customised types" and "Standard types"

Customised types

The "Customised types" section gives an overview of the entire range of design options covered by the standard and adds explanations and selection criteria. It thus provides optimum support for selecting and specifying products required. Product documentations and quotations are available on request.

Standard types

The „Standard types" section is an extract from the "Customized types" section. It presents a comprehensive range of products of the main types used in the market. A few thousand products are described in detail complete with geometrical data and design data, information on mechanical, thermal and flame behaviour properties and electrical data. For this information please see the attached CD-ROM.

Summary of the structure

The Standard EN 50288-7

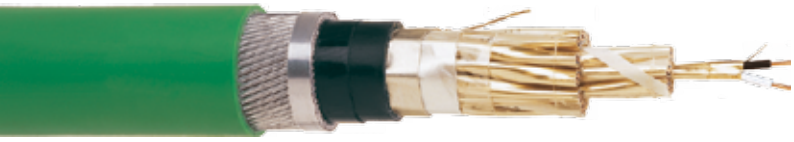
The ICON® Products

Standard types	Customised types
■ Thousands of conventionally used products ■ Complete technical documentation ■ Available immediately ■ Quotes provided rapidly ■ Cost-effective ■ Short delivery time	■ Technical basis for entire market demand ■ Allows specifications and products to be tailor-made ■ Clear and unambiguous design rules ■ Fast and flexible handling of products ■ Documentation on request ■ Modular design concept

Well-known quality from reliable project partners based on the international safety regulations

The ICON® product programme also covers instrumentation cables complying with UL standards UL13, 2250 and 1277 as well as bus cables according to PNO and FFO.

ICON® The Customised Types



The "Customised types" section gives a summary of the entire range of design options and design rules concerning the EN 50288-7 standard. A summary of it is shown in chart form on the last page of this chapter.

The contents of the standard are complemented by explanations and selection criteria to help you to find the best possible design solution.

General remarks

Applications

The standard covers instrumentation cables as well as thermocouple extension and compensating cables suitable for connecting instruments and control systems for the purposes of analogue and digital transmission.

The cables are not designed for use with power supplies and should not be connected directly to the mains or to other low-impedance power sources.

Valid local and national regulations must be taken into account during installation.

The standard must be used in connection with the referenced standards for materials and testing.

Designs

The cable can contain cores, pairs, triples or quads as cabling elements; they can have individual or overall screening and optionally include armouring and/or additional layers for moisture resistance or environmental protection. The maximum rated voltages of the cables are either 300 V or 500 V.

Design options and selection criteria for cable elements

Conductor for instrumentation cable

- Plain and metal coated copper conductors according to EN 60228 (IEC 60228)
- Class 1 (solid), class 2 (stranded) and class 5 (flexible)
- Sizes: 0.5 mm² up to 2.5 mm²

Criteria for the choice of conductor design and size are

- the DC-resistance
- the connection technology used (including crimping, clamping, soldering, wire wrap and termi-point)
- the flexibility requirements
- the diameter
- the environmental conditions

7-strands conductors are used in most cases.

Conductor for thermocouple extension and compensating cable

- conductor material according to the requirements of the HD 446.1 (IEC 60584-3); see table 2 on page 56
- design: solid, stranded or flexible
- sizes: 0.5 mm² up to 1.5 mm²

Criteria for the choice of type, design or size of conductor are:

- the type of thermoelement used
- the E.M.F-tolerances
- the flexibility

Solid conductors are used in most cases.

Insulation

Insulation materials

The insulating materials used include:

polyvinylchloride	PVC	EN 50290-2-21
polyethylene	PE	EN 50290-2-23
polypropylene	PP	EN 50290-2-25
Zero halogen, flame-retardant compound	HFRC	EN 50299-2-26
cross-linked polyethylene	XLPE	EN 50290-2-29

The most widely used insulating material today is polyethylene, followed by polyvinylchloride and cross-linked polyethylene. Other materials such as materials resistant to high temperatures, polypropylene and foamed materials are used for special purposes only.

Selection criteria for insulation materials are

- electrical transmission properties
- limited operating temperatures

The following criteria can also be significant in certain special cases:

- flame behaviour
- suitability for special connection techniques
- resistance to oil and gas
- resistance to radiation
- compatibility with filling compounds

Radial thickness of the insulation

Two values must be considered with reference to the radial thickness of the insulation:

- the minimum radial thickness
- the nominal radial thickness

The minimum radial thickness of the insulation is defined in the standard. The measured radial thickness of the insulation must not fall below the defined values at any point.

The nominal radial thickness of the insulation is a design value defined by the manufacturer to guarantee the specified electrical transmission properties. The nominal thickness is thus a reference value only and will not be dealt with here. Depending on the conductor size, the nominal thickness exceeds the minimum thickness by approx. 0.05 and 0.1 mm.

Table 1: Properties of the most important insulating materials

Properties		Polyvinylchloride PVC	Polyethylene PE	Cross linked polyethylene
Permittivity	ε_r	4 – 7	2.3	2.3
Spec.volume resistance at 20 °C	Ω x cm	10^{14}	10^{16}	10^{16}
max. operating temperature	°C	70 [1]	70 [2]	90 °C
Behaviour at low temperature		stiff, tends to become brittle	good	good
Flammability		self-extinguishing	inflammable	inflammable [3]

[1] Heat resistant modified PVC for temperatures limited to 90 °C and 105 °C
[2] 80 °C for high-density polyethylene HDPE
[3] also with self-extinguishing characteristic

Cabling elements

Cabling elements according to the standard are cores, pairs, triples and quads.

- A core is an insulated conductor
- A pair consists of two twisted cores which form a line circuit
- A triple consists of three twisted cores which form line circuits with one another
- A quad consists of four twisted cores in which the diametrically opposed cores form a line circuit

The length of lay of a part, triple or quad, must not exceed

- 100 mm for conductor sizes ≤ 1.5 mm² or
- 150 mm for conductor size 2.5 mm²

To keep internal interference of cabling elements – pairs, triples or quads – as low as possible, adjacent elements have different lengths of lay.

Cable assembly

The cable elements must be assembled in concentric layers to form the cable core either

- directly or
- in the form of units

Units consist of a certain number of cores, pairs, triples or quads.

The direction of lay of successive layers of multi layer cables changes from layer to layer. This measure also contributes to the mutual decoupling of unscreened pairs, triples or quads from each other.

Screening

Design

Screening can be either screening of individual cable elements and/or an overall screening. Screening measures according to the standard are listed below:

- plain or coated copper braid with a minimum filling factor of 0.6
- a combination of plastic-laminated metal foil and a plain or coated copper braid with a minimum filling factor of 0.3
- plastic-laminated metal foil with
  a minimum overlap of 20 %,
  a drain wire in direct contact with the metallic side of the foil and
  a laminated sheath (for overall screening only).

Screening measures must be provided in order to reduce or prevent possible interference such as

- cross-talk from adjacent line circuit in the cable itself or
- externally induced interference from sources outside the cable.

Internal interference

The only significant factor for Screening against internal interference is the capacitance (unbalanced) between the cabling elements. Magnetic interference can be disregarded here.

Precautions used for reducing and to avoiding internal interference are

- different length of lay of the various cabling elements (see page 9) or
- individual screening of the various cabling elements

Individual screening usually consists of plastic-laminated aluminum foil applied so as to overlap helically and a copper drain wire in continuous contact with the metallic side of the foil.

An at least 20 % overlap of the foil guarantees 100 % coverage of the cabling element even in small bends.

External interference

Screening against external interference has to take the influence of both electric and magnetic interference into account and make a distinction between LF and HF fields.

The design of the required screen depends on the type and strength of interference.

Screening in the LF-range

For screening in the LF-range – i.e. in the range of frequencies of up to 10 kHz – the influence of both electric and magnetic interference can be examined separately. Interference from electric fields can be virtually disregarded if conductive screens are used; the lower the dc resistance, the better the screening effect; however, care must be taken to ensure a high degree of coverage as the electric field may otherwise affect the cable core.

Screening against LF magnetic interference requires the use of magnetic materials such as steel wires or (even better) tapes. Materials of high permeability should be used for high levels of screening.

The measure of the effect of the screening in the LF range is the reduction factor. This is the ratio of the interference voltage with a screen to the interference voltage without a screen and is calculated according to the following formula:

$$r_c = \frac{R_0}{\sqrt{(R_0 + R_E)^2 + \omega (L_M + L_E)^2}}$$

with r_c = reduction factor

The lower the r_c the better the screening effect.

R_0	dc resistance of screen in	Ω/km
R_E	dc resistance of earth loop in (normally evaluated as 0.05 Ω/km)	Ω/km
L_M	internal screen inductance in (this value can be disregarded for non-magnetic screens)	H/km
L_E	external inductance of the earth loop in (the usual value is 0.002 H/km)	H/km
ω	angular frequency (2 π f) in Hz	

Screening in the HF-range

Screening in the HF range is based on energy losses due to electromagnetic interference caused by absorption and reflection in or on the Screening material.

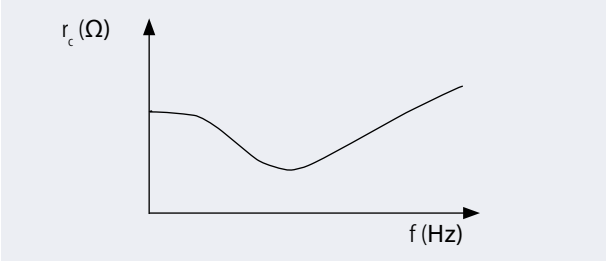
The measure for the effect of screening in the HF range is the coupling resistance, which is defined as follows

$$r_c = \frac{\text{induced interference voltage in the disturbed system}}{\text{current in the disturbing system}}$$

r_c = coupling resistance

The lower the r_c the better the screening effect.

The coupling resistance depends on the frequency. The typical curve of the coupling resistance is shown below.



Requirements for effective screening in the HF-range are basically a low DC resistance and maximum coverage of the screen. Here is a selection of screen designs (the screening effect increases from top to bottom):

- plastic laminated aluminum foil
- laminated aluminum tape overlapping longitudinally
- optimized copper braid of high density
- copper tape, lapped or overlapping longitudinally
- copper tubing

Plastic sheaths

The different types

The standard defines 4 different types of extruded plastic sheaths

- **the outer sheath**
  providing the protection of the cable from outside
- **the inner sheath**
  applied under a metallic protection and – optional – under a lead sheath
- **the multi layer sheath**
  a special type of inner sheath; an alternative possibility for a lead sheath as environmental and chemical protection
- **the bedding**
  a separation sheath applied between a lead sheath and a metallic protection (may also consists of plastic tapes)

The following materials can be used for the inner and outer sheath and for the bedding:

PVC	according to EN 50290-2-22
polyethylene	according to EN 50290-2-24
Zero halogen, flame-retardant compound	according to EN 50290-2-27

Inner sheath and bedding

The main function of the bedding and/or an inner sheath is to protect the cable core from mechanical stress and moisture. Here are some additional criteria which must be considered when the type of material is determined:

- maximum and minimum temperatures during operation
- flame behaviour
- halogen content

Multi layer sheath

A multi layer sheath consists of a longitudinal plastic-coated aluminum tape, a layer of high-density polyethylene bonded to the aluminum tape and an additional layer of polyamide.

The high-density polyethylene must be in accordance with EN 50290-2-24, the material specification for polyamide is in the discussion stage at present.

Overall sheath

The conditions prevailling during transportation and storage, installation and operation determine the type of material to be used. The following criteria must be taken into account in the selection of a suitable sheath material:

- way of laying i.e.
- mechanical stress
- environmental conditions
- climatic conditions
- demands made on fire behaviour and flame retardancy
- demand made on coloring and marking

Sheathing materials

Polyvinylchloride (PVC)
As a result of its great value for money, PVC has been the most widely used sheathing material for instrumentation cables up to now. Its great ability to be modified allows a selective adaptation of desired properties which makes it suitable for a wide range of applications.

PVC is suited for indoor and outdoor laying in dry and wet locations, in conduits and for direct burial.

Its maximum permissible temperature ranges from 70 °C for standard types to 90 °C or 105 °C for special heat-resistant types. The recommended minimum temperatures for these types are - 5 °C for installation and - 0 °C for operation.

Special cold resistant types permit significantly lower temperature during operation and installation. The maximum permissible temperature is 70 °C or 90 °C.

PVC is a flame-retardant, self-extinguishing material. Its flame retardancy can be increased to higher levels. The emission of halogen acid gas and the smoke density in the event of fire can be reduced in the same way. Most PVC-compounds are resistant to oil and solvents to a certain degree. Specially designed types are recommended for more stringent requirements.

PVC can be supplied in a wide range of colors. When exposed to sunlight, the colors fade, but this has no effect on the function. All sheathing compounds are resistant to sunlight.

Zero halogen flame-retardant compound (LSZH)
Starting from a low level, the use of Zero halogen flame-retardant compounds has increased steadily over the last ten years as a result of the growing need for Zero halogen flame-retardant cables as a special measure to protect persons and/or important material assets.

In the event of fire, Zero halogen flame-retardant compounds are distinguished by characteristics such as the following:
- reduced flame propagation
- reduced acidity and toxicity of gases
- reduced smoke density
- no halogen acid gases

Zero halogen flame-retardant compounds are suitable for indoor and outdoor application. Special compounds with reduced water absorption are recommended for direct burial. The maximum temperature limits of the types defined are 70 °C and 90 °C. The recommended minimum temperatures are –5 °C for installation and –30 °C for operation.

Standard Zero halogen flame-retardant compounds are only partly resistant to oils and solvents. Standard compounds meet the requirements of the oil resistance test according to ICEA S82-552. Special types must be used for more stringent requirements.

Most Zero halogen flame-retardant compounds can be supplied in a wide variety of colors. When exposed to sunlight, the colors fade, but this has no effect on the function.

Polyethylene (PE)
Polyethylene sheaths can be made of LDPE, MDPE and HDPE materials (low-density, medium-density and high-density polyethylene). The lack of flame-retardancy restricts the use of polyethylene sheathes to direct buried cables.

As a result of its excellent mechanical properties such as its high tensile strength, its high resistance to abrasion, its hardness and its extremely low water absorption, polyethylene is the ideal material for this application.

The maximum permissible temperature is 70 °C for LDPE and MDPE and 80 °C for HDPE. As a result of its outstanding resistance to low tempeartures, cable insulated and sheathed with polyethylene can be installed down to temperatures of –20 °C.

The material becomes harder in proportion to the temperature, however. The bending resistance of the cable increases, with the corresponding negative effects on handling during installation. Polyethylene stands out through its high resistance to oil and chemicals. This and the mechanical properties increase from LDPE to HDPE.

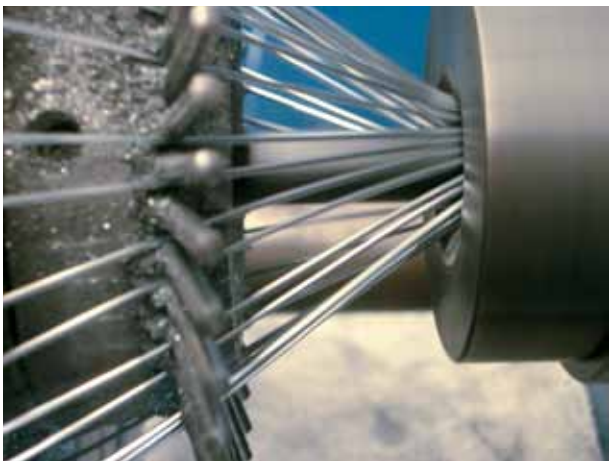
As mentioned above, polyethylene is not flame-retardant. When ignited, it tends to drip and burn on after removal of the flame. For this reason, polyethylene sheathing should not be used for indoor applications. Polyethylene must stabilized against UV using soot. This is why the outer sheath is black in color.

Chemical and/or environmental protection

If there is a risk of oils and chemicals affecting cables after installation, protective measures must be taken.

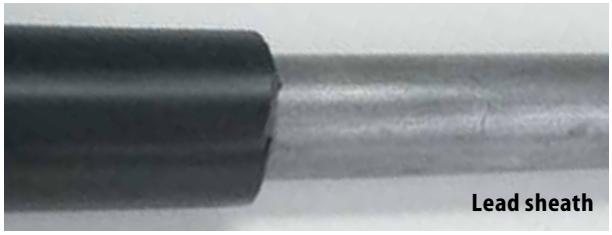
The grading of the possible effects on the cables is determined by the nature, condition and quantity of the effecting medium, the duration of immersion and the temperature. In certain cases, plastic sheaths afford adequate protection, but more stringent measures must usually be taken in order to avoid negative effects on the long-term functioning of the cables involved.

For directly buried cables in particular, the EN standard recommends the following structural elements:



Lead sheath
Lead sheathes are the best protective measure against oils and chemicals. They are especially recommended where soils are heavily polluted. Lead alloy sheathed types should be used where there are high mechanical loads due to vibration.

Multi layer sheath
Multilayer sheaths consist of a longitudinal plastic-coated aluminum foil, a layer of high-density polyethylene and an additional covering of polyamide. The aluminum foil is bonded inside the overlap and with the inner surface of the HDPE sheath.


Lead sheath


Multi layer sheath

Multilayer sheaths are an adequate alternative to lead sheaths for a large number of applications. Compared to cables with lead sheaths, those with multilayer sheaths are smaller and lighter, thus allowing longer handling lengths.

Armour

If an armour is specified, it should be selected from the types listed below:

- **Galvanised round steel wire armour**
  The wire diameter depends on the cable diameter under armour, min. diameter 0.9 mm
- **Galvanised flat steel wire armour**
  The minimum is wire diameter; this armour shall be used for cables, where the diameter under armour is > 15 mm
- **Single or double layer of steel or brass tapes**
  The minimum thickness of a tape shall be 0.2 mm for steel and 0.075 for brass.
- **Metal braid**
  The minimum filling factor must be 0.57 (corresponding optical coverage 81.5 %), the minimum wire diameter 0.3 mm.


Galvanised round steel wire armour

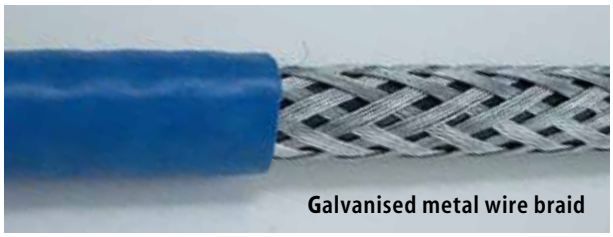
The choice of the most suitable type of armour depends on the demands of installation and operation. In addition, local and legal regulations must be complied with.

The most important selection criteria are:

- maximum expected tensile load and minimum required load-bearing capacity during installation and/or operation
- maximum expected pressure and tensile load after laying
- protection against attack by rodents
- minimum required bending radius
- protection against external interferences

The types of armour listed above are characterized by the following features:

- **Galvanised metal wire braid**
  Lightweight armour of galvanised steel or plain or tinned round copper wire; suited for small tensile and pressure loads; permits the smallest bending radii of all armour types; mainly used for small cable diameters.
- **Galvanised steel tapes**
  Applied as single- or dual-layer armour with 100 % covering of the cable assembly; excellent protection against pressure and impact loads; not suitable for tensile loads; very good protection against rodents; of all types of armour listed, they provide the best inductive protection.
- **Brass tapes**
  These are applied in the same way as steel tapes; especially recommended to prevent attack by rodents and termites.


Galvanised metal wire braid

- **Galvanised flat steel wires**
  Good protection against pressure and impact loads; suitable for high tensile loads; the least flexibile of all types of armour listed.
- **Galvanised round steel wire**
  Coverage: more than 90 %; very good mechanical protection against pressure and impact loads, suitable for high tensile loads, good protection against rodents; the type of armour used most frequently for direct buried cables.

Design options/Construction details according to EN 50288-7

Multi-Element Metallic Cables for Analogue and Digital Communication and Control Systems

Conductor*
- Copper, plain or tinned
- Conductor sizes: 0.5 mm² up to 2.5 mm²
- Conductor shape: solid, stranded or flexible

*(for thermocouple & extension cables see to IEC 60584-3)

Insulation
- PVC, PE (solid and foam), XLPE, PP (solid and foam), zero halogen, flame-retardant compounds
- Additional materials under preparation

Cabling elements
- Cores, pairs, triples, quads

Individual screen
- Plastic laminated metal foil with drain wire
- Plain or coated metal braid
- Combination of a braid and a foil

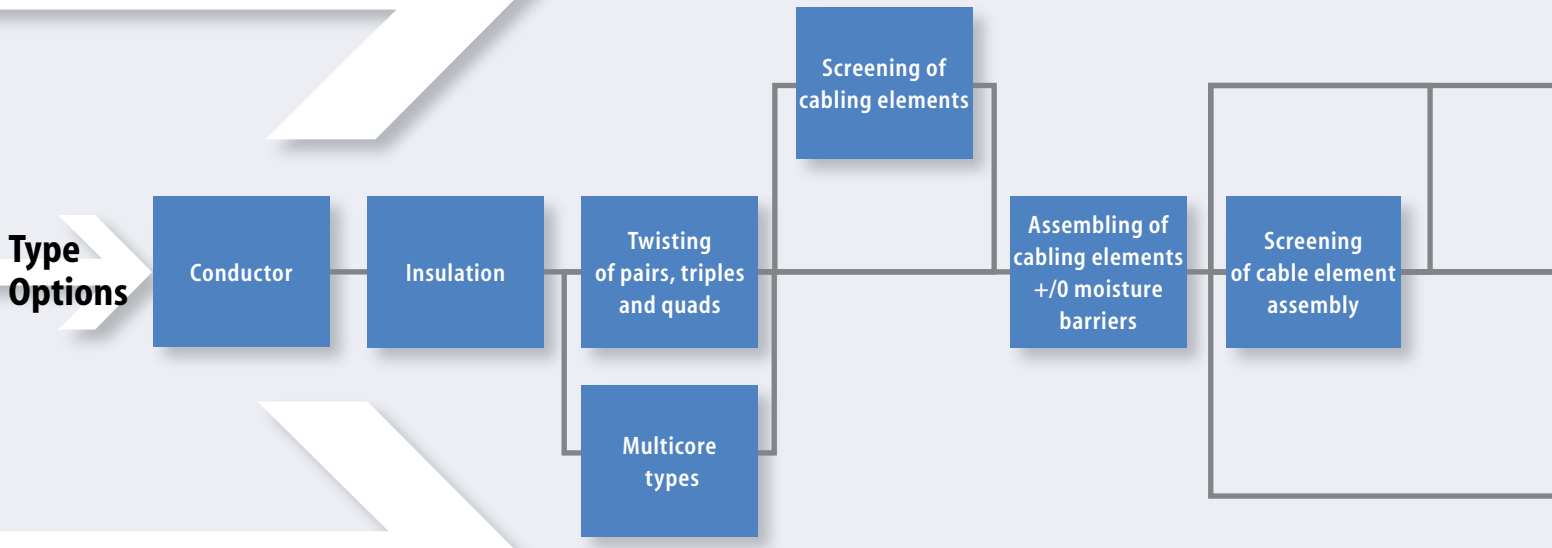
Assembling
- Directly or in units in concentric layers
- With or without moisture barrier

Moisture barriers
- Dry ➔ swellable tapes, and/or cords, swellable powder
- Wet ➔ petrojelly filling compound

Overall screen
- Plastic laminated metal foil with drain wire
- Plain or coated metal braid
- Combination of a braid and a foil

Laminated sheath

Design Options



Construction Details

Reference Standards

Conductor
- According to EN 60228, class 1, 2 or 5
- Max. conductor resistance for multi-element cables (beside cores): Standard value +2 %

Insulation
- Acc. to EN 50290-2-21, 23, 25, 26 a. 29
- Concentricity of insulation: min. 0.75 mm
- Min. insulation thickness depending on voltage rating and conductor size

Cabling elements
- Max. length of lay:
  up to 1.5 mm² ≤ 100 mm
  2.5 mm² ≤ 150 mm
- Identification: numbered cores or tapes or acc. to IEC 60189-2 or IEC 60708-1

Individual screen
- Overlapping of the foil: min. 20 %
- Filling factor of the braid 0.6 and 0.3 resp. when combined with a foil

Assembling
- Wrappings of non hygroscopic tapes interstitial fillers, where neccessary
- Moisture barriers
- Petrojelly according to EN 50290-2-29

Overall screen
- Overlapping of the foil min. 20 %
- Filling factor of the braid >0.6 and >0.3 resp. when combined with a foil
- One or both side laminated aluminum tape longitudinally overlapped, bonded to the inner surface of an extruded sheath, thickness of alum. tape: min. 0.15 mm without coating

Inner sheath
- PVC, PE, zero halogen, flame-retardant compounds
- Additional materials under preparation

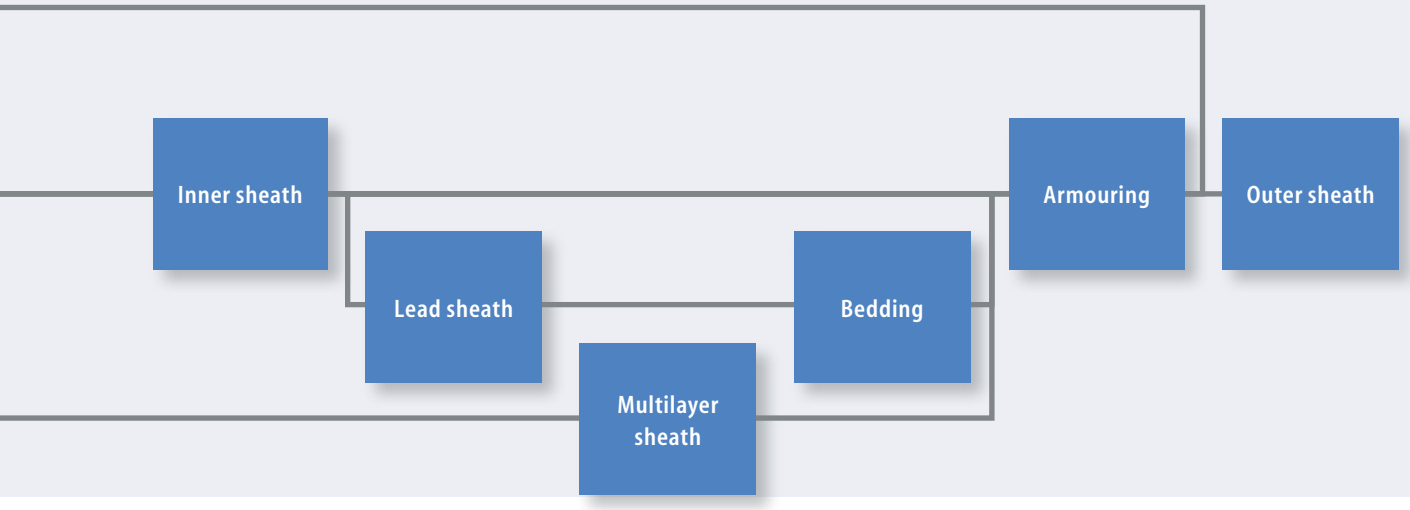
Chemical and/or environmental protection
a) Lead sheath or
b) Multi layer sheath
- Laminated HDPE sheath and an additional polyamid covering

Bedding
- Extruded layer of PVC, PE or halogenfree, flameretardant compounds or
- Helically applied tape(s)

Armour
- Single layer of round steel wires (SWA)
- Single or double layer of steel or brass tapes (B)
- Metal braid (Q)

Outer sheath
- PVC, PE, or halogenfree, flame-retardant compounds
- Additional materials under preparation

Voltage rating 300 V / 500 V



Inner sheath
- According to EN 50290-2-22 and 27
- Optional under lead sheath
- Thickness: 0.04 x D*+0.7 mm (min. 0.8 mm)

*(D = Diameter under inner sheath)

a) Lead sheath
- According to EN 50307
- Thickness: 0.03 x D*+0.7 mm (min. 0.8 mm)

*(D = Diameter under lead sheath)

b) Multi layer sheath
- Thickness of polyamid covering: min. 0.3

Bedding
- According to EN 50290-2-22, 24 and 27
- Thickness: depending on diameter under bedding; min.1.0 mm

Armour
- SWA: acc. to EN 10257-1; min. Ø 0.9 mm
- B: min. thickness: 0.2 mm a. 0.075 mm resp.
- Q: Filling factor: min. 0.57, wire Ø min. 0.3. mm

Outer sheath
- According to EN 50290-2-22, 24 and 27
- Thickness for unarmoured types: 0.04 x D* + 0.7 mm (min. 0.8 mm)
- Thickness for armoured types: 0.028 x D* + 1.1 mm (min. 1.3 mm)

(D = diameter under outer sheath)

ICON® The Standard Types

The part "standard types" presents the most customary types out of the "customised types" It is an excerpt of it. The programme covers some thousands different cables, thorough described on the following pages and in detail on the CD ROM attached.

The product information in this chapter are presented in a systematically structured condensed form. So, you find an optimum overview and an optimal product selection guide.

Please find current available data sheets for standard products on this CD-ROM.
System requirements: Min. 512 MB RAM, Windows 2000, XP, Java 1.5.x enabled, Java Script enabled, Acrobat Reader 6.0
Optimized for: 800 x 600 pixels, 256 colors, Internet Explorer 6.0 or higher installed.
Insert disc to launch the ICON catalogue CD. The CD starts automatically.
Otherwise right click on the CD icon in the explorer to open the contextmenu, choose menu item "auto-play".
The catalogue can be started with or without installation at the local system.

Structure of the product programme “standard types”

The product programme is arranged within three main groups:

Main group	Cabling elements
Instrumentation cables	pair and triple
(instrumentation) control cables	core
thermocouple extension & compensating cables	pair

Pairs and triples may be with or without individual screen.

Each main group is derived into three subgroups:

- common types (PVC-sheathed)
- Zero halogen, flame-retardant types (LSZH-sheathed)
- fire-resisting, flame-retardant types (LSZH-sheathed)

Each sub-group describes different product-families (2 up to 4). Product-family stands for a product line with a certain insulation material, containing unarmoured and armoured products; and for the subgroups “common types” armoured versions with chemical environmental protection (lead or multi-layer sheath) additionally. The miscellaneous insulation materials offers options for optimising electrical, thermic or other relevant product properties.

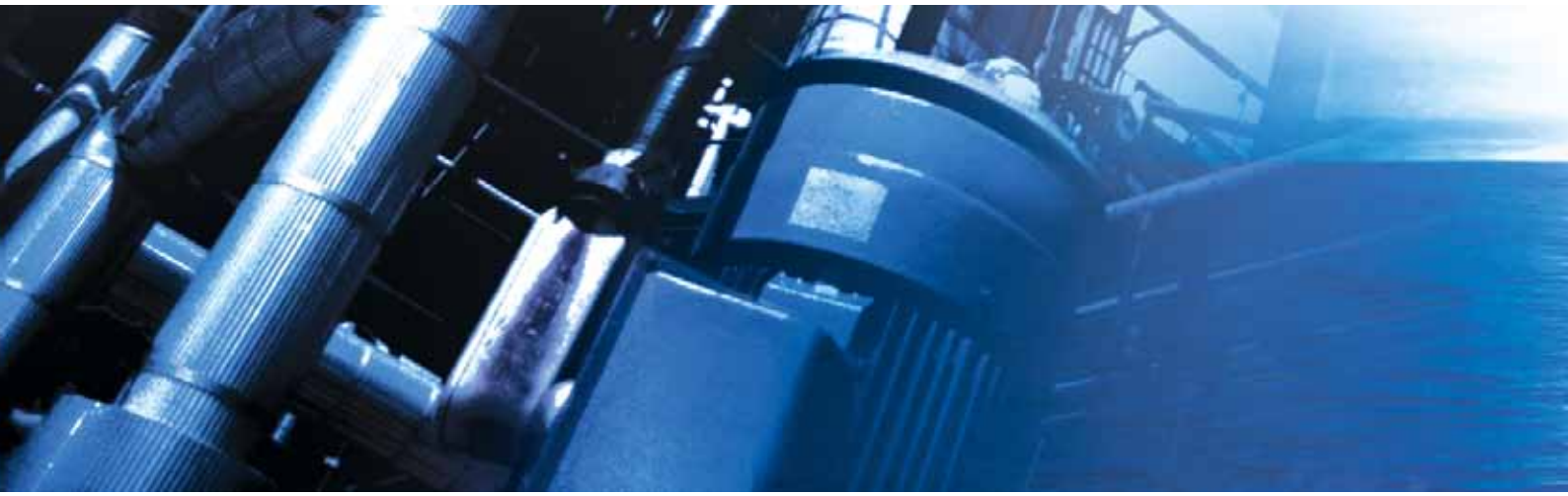
Presentation of product data and data sheets

The product data are headed:

- **Technical data**
  Contains information on application range, laying, temperature limitations, bending radius, flame behaviour, and others.
- **Construction**
  Describes the design of the cables
- **Electrical data**
  Contains the electrical properties of the described products

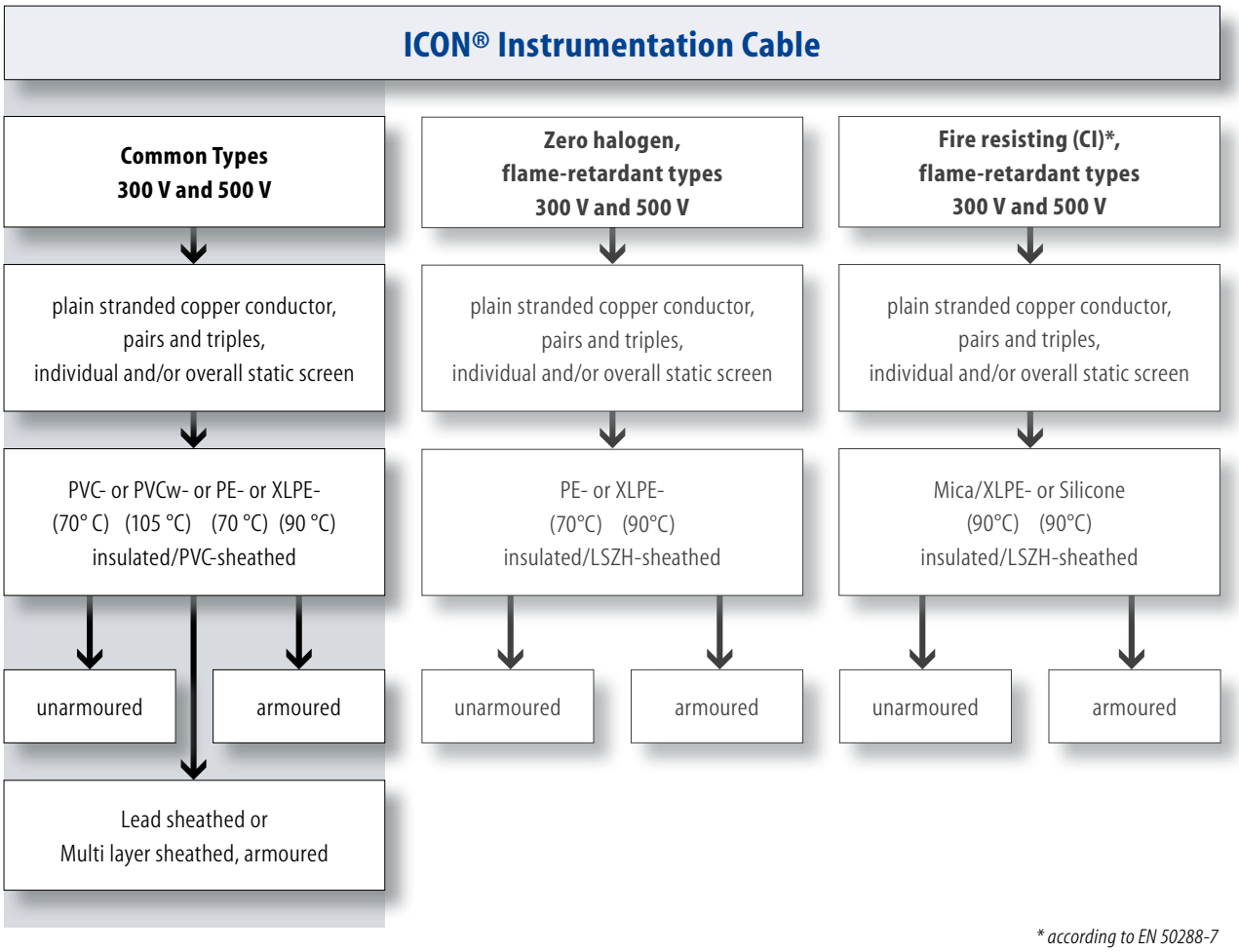
Product data sheets:

The product descriptions are completed by product data sheets recorded on the attached CD-ROM. An example of a product data sheet is shown on page 64. The data sheets also itemise the usual geometrical data of every individual product.



ICON® Instrumentation Cable according to EN 50288-7

Common Types – 300 V and 500 V



** according to EN 50288-7*

ICON® Instrumentation Cable according to EN 50288-7
Common types

Single & Multi pair and Multi triple, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured
- with chemical protection, armoured

300 V and 500 V

Technical Data					
Type of insulation/sheath		**PVC/PVC**	**PVCw/PVCw**	**PE/PVC**	**XLPE/PVC**
Type of cabling elements		Pair, Triple, PiMF, TiMF			
No. of cabling elements		1, 2, 4, 5, 6, 8, 10, 12, 16, 20, 24			
Conductor sizes		0.5 mm², 0.75 mm², 1.0 mm², 1.3 mm², 1.5 mm²			
1. Unarmoured types		RE-Y(St)Y-fl	RE-Yw(St)Yw-fl	RE-2Y(St)Y-fl [1]	RE-2X (St)Y-fl
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations			
Bending radius		7.5 x cable Ø			
2. Armoured types		RE-Y(St)YSWAY-fl	RE-Yw(St)YwSWAYw-fl	RE-2Y(St)YSWAY-fl	RE-2X(St)YSWAY-fl
Laying		Recommended for outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial			
Bending radius		10 x cable Ø			
3. Armoured types with chemical protection					
a) Lead sheathed		RE-Y(St)YMYSWAY-fl	—	—	RE-2X(St)YMYSWAY-fl
b) Multi layer sheathed		—	—	—	RE-2X(L)2Y4YSWAY [2) 3)]
Laying		Recommended for direct burial, especially in presence of oil and aggressive chemical substances			
Bending radius		15 x cable Ø			
Reaction to fire					
Flame propagation a) Test on single cable b) Test on bunched cables		IEC 60332-1-2 IEC 60332-3 part 24 (Cat. C), (excluded types with multi layer-sheath)			
Temperature range	during operation during installation	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 105 °C –5 °C up to 50 °C	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 90 °C –5 °C up to 50 °C
Sunlight resistance		UL 1581 Section 1200			
Oil resistance		ICEA S-82-552			
Application		For transmission of analogue and digital signals in instrument and control systems; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 79-14), not allowed for direct connection to low impedance sources, e.g. public mains electricity supply			

[1)] *Also with increased thickness of outer sheath (Yv).*
[2)] *Also with HDPE outer sheath; in this case tests "Reaction to Fire" are not passed.*
[3)] *Max. operating temperature 80 °C.*

ICON® Instrumentation Cable according to EN 50288-7
Common types

Single & Multi pair and Multi triple, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured
- with chemical protection, armoured

300 V and 500 V

Construction						
Product types		**Unarmoured types**		**Armoured types**	**Lead sheathed, armoured types**	**Multi layer sheathed, armoured types**
Conductor		Plain annealed copper; 7 stranded according to EN 60228, Class 2				
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5
Conductor design	mm	7 x 0.3	7 x 0.37	7 x 0.43	7 x 0.49	7 x 0.53
Insulation materials		Cross linked polyethylene XLPE or Polyethylene PE or Polyvinylchloride PVC or Polyvinylchloride heat resistant PVCw			PVC or XLPE	XLPE
Cabling element [1]						
without individual screen		Pair, Triple				
with individual screen		PiMF, TiMF				
Individual screen		Aluminum/plastic-tape over solid tinned copper drain wire, 0.6 mm plastic-tape under and above screen				
Wrapping		at least one plastic tape above cable core			at least one plastic tape above cable core	
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm				see multi layer sheath
Inner sheath		—		PVC and PVCw resp. , black	PVC	—
Metal sheath		—		—	Lead sheath	—
Bedding		—		—	PVC	—
Multi layer-sheath		—		—	—	Longitudinal one side plastic coated aluminum foil over tinned copper drain wire, 7 x 0.3 mm, high density polyethylene sheath with an additional polyamide covering. The aluminum foil is bonding within the overlapping and with the inner surface of the polyethylene sheath
Armouring		—		Galvanized steel wire; wire Ø depending on cable-Ø under armouring, at least 0.9 mm		
Outer sheath		PVC and PVCw resp.			PVC	PVC or PE (high density)
Color		black or blue for intrinsically safe systems			black	
Marking		LEONI KERPEN ICON INSTRUMENTATION CABLE EN 50288-7 RATED VOLTAGE RP[3] CE PRODUCTION LOT CODE LENGTH MARKING				

[1] *Also with increased thickness of outer sheath (Yv) for PE-insulated, unarmoured types.*
[2] *Color code of cabling elements see page 57 .*
[3] *RP = Reduced flame propagation, excluded types with multi layer sheath.*

ICON® Instrumentation Cable according to EN 50288-7
Common types

Single & Multi pair and Multi triple, individual and/or overall screen, PVC-sheath

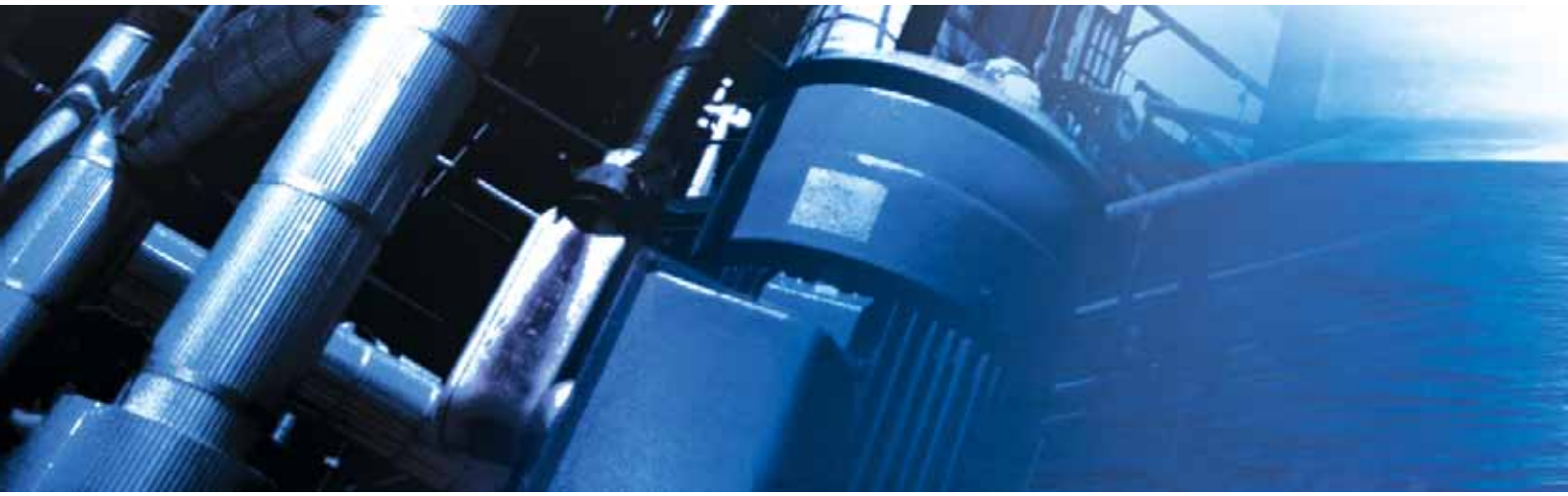
- unarmoured
- armoured
- with chemical protection, armoured

300 V and 500 V

Electrical Data at 20 °C			300 V						
Conductor sizes			nom.	mm²	0.5	0.75	1.0	1.3	1.5
Conductor resistance			max.	Ω/km	36.7	25.0	18.5	14.2	12.3
Insulation resistance	PVC / PVCw-insulation		min.	MΩxkm	100				
	PE / XLPE-insulation		min.	MΩxkm	5000				
L/R Ratio			max.	µH/Ω	25			40	
Inductance			max.	mH/km	1				
Mutual capacitance									
PVC / PVCw-insulation	Pair, Triple [1) 2)] PiMF, TiMF		max.	nF/km	150 190			160 200	
PE / XLPE-insulation	Pair, Triple [1) 2)] PiMF, TiMF		max.	nF/km	75 115			85 115	
Capacitance unbalanced [3)]	Pair		max.	pF/500m	500				
Test voltage	Core/core Core/screen	(U_{rms}) (U_{rms})		V	1500 1500				
Operating voltage		(U_{rms})	max.	V	300				

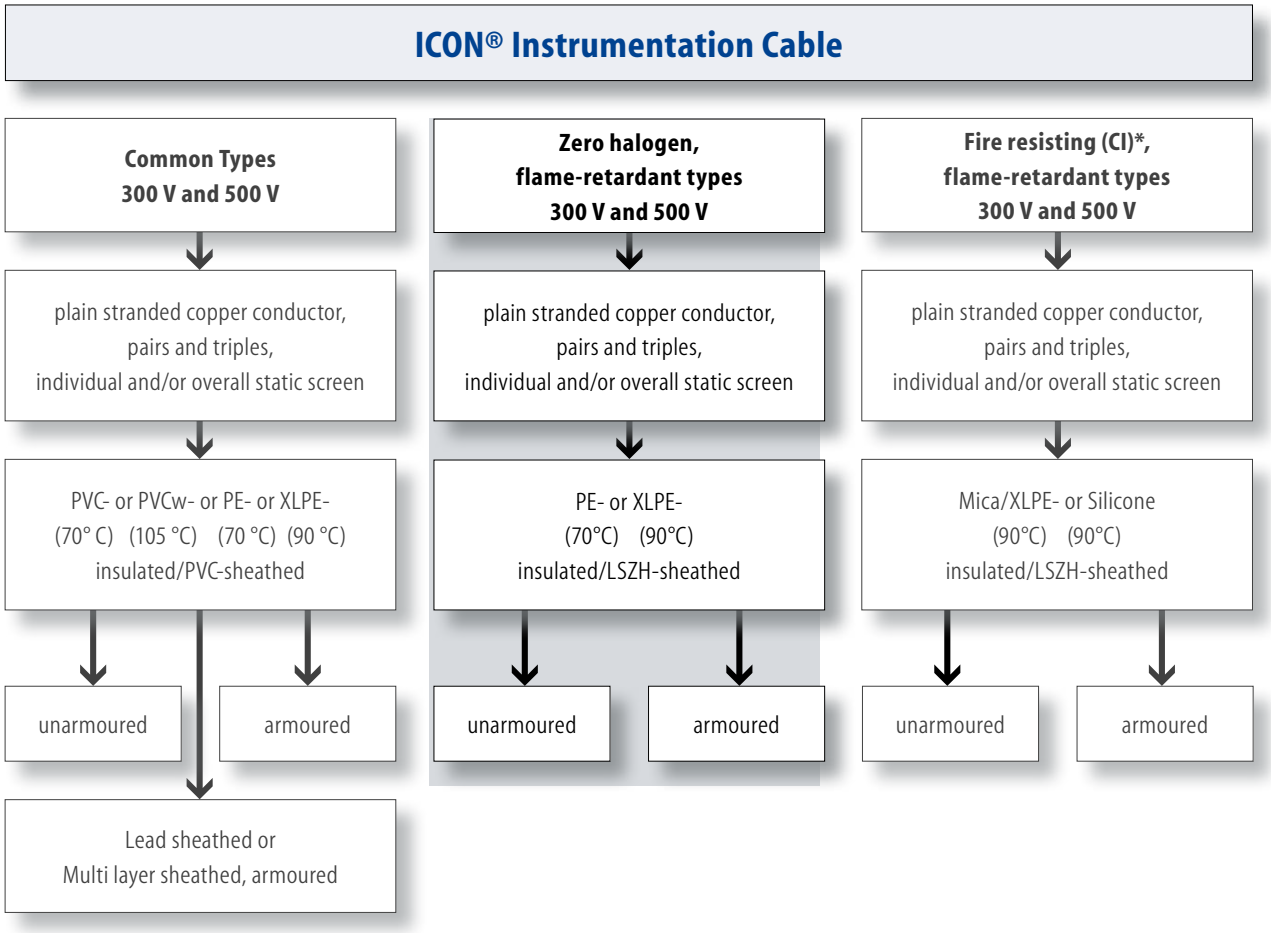
Electrical Data at 20 °C			500 V						
Conductor sizes			nom.	mm²	0.5	0.75	1.0	1.3	1.5
Conductor resistance			max.	Ω/km	36.7	25.0	18.5	14.2	12.3
Insulation resistance	PVC / PVCw-insulation		min.	MΩxkm	100				
	PE / XLPE-insulation		min.	MΩxkm	5000				
L/R Ratio			max.	µH/Ω	25			40	
Inductance			max.	mH/km	1				
Mutual capacitance									
PVC / PVCw-insulation	Pair, Triple [1) 2)] PiMF, TiMF		max.	nF/km	120 160			130 170	
PE / XLPE-insulation	Pair, Triple [1) 2)] PiMF, TiMF		max.	nF/km	65 100			75 100	
Capacitance unbalanced [3)]	Pair		max.	pF/500m	500				
Test voltage	Core/core Core/screen	(U_{rms}) (U_{rms})		V	2000 2000				
Operating voltage		(U_{rms})	max.	V	500				

[1)] *Values for cables with 1 element correspond to those for PiMF and TiMF resp..*
[2)] *Values for cables with 2 up to 4 elements +20 %.*
[3)] *To apply only for PE, XLPE-insulated types.*



ICON Instrumentation Cable according to EN 50288-7

Zero halogen, flame-retardant types 300 V and 500 V



** according to EN 50288-7*

ICON® Instrumentation Cable according to EN 50288-7

Zero halogen, flame-retardant types

Single & Multi pair and Multi triple, individual and/or overall screen, LSZH-sheath

- unarmoured
- armoured

300 V and 500 V

Technical Data			
Type of insulation/sheath		**PE/LSZH**	**XLPE/LSZH**
Type of cabling elements		Pair, Triple, PiMF, TiMF	
No. of cabling elements		1, 2, 4, 5, 6, 8, 10, 12, 16, 20, 24	
Conductor sizes		0.5 mm², 0.75 mm², 1.0 mm², 1.3 mm², 1.5 mm²	
1. Unarmoured types		RE-2Y(St)H	RE-2X(St)H
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations	
Bending radius		7.5 x cable Ø	
2. Armoured types		RE-2Y(St)HSWAH	RE-2X(St)HSWAH
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial	
Bending radius		10 x cable Ø	
Reaction to fire			
Flame propagation a) Test on single cable b) Test on bunched cables		IEC 60332-1 IEC 60332-3 part 24 (Cat. C)	
Test on gases evolved during combustion a) amount of halogen acid gas b) degree of acidity of gases		IEC 60754-1 (0 %) IEC 60754-2 (pH > 4.3, c < 10 µS/mm)	
Measurement of smoke density		IEC 61034-2 (L.T. [1] >60 %)	
Temperature range	during operation during installation	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 105 °C –5 °C up to 50 °C
Sunlight resistance		UL 1581 Section 1200	
Oil resistance		ICEA S-82-552	
Application		For transmission of analogue and digital signals in instrument and control systems; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 79-14), not allowed for direct connection to low impedance sources, e.g. public mains electricity supply. Recommended for use as fire protection measure for people and important material assets.	

[1] *L.T. = Light Transmission.*

ICON® Instrumentation Cable according to EN 50288-7

Zero halogen, flame-retardant types

Single & Multi pair and Multi triple, individual and/or overall screen, LSZH-sheath

- unarmoured
- armoured

300 V and 500 V

Construction						
Product type		**Unarmoured types**			**Armoured types**	
Conductor		Plain annealed copper; 7 stranded according to EN 60228, Class 2				
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5
Conductor design	mm	7 x 0.3	7 x 0.37	7 x 0.43	7 x 0.49	7 x 0.53
Insulation materials		Cross linked polyethylene XLPE or Polyethylene PE				
Cabling element [1]						
without individual screen		Pair, Triple				
with individual screen		PiMF, TiMF				
Individual screen		Aluminum/plastic-tape over tinned copper drain wire, 0.6 mm, plastic tape under and above screen				
Wrapping		at least one plastic tape above cable core				
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm				
Inner sheath		—			LSZH, black	
Armouring		—			Galvanized steel wire armouring; wire Ø depending on cable-Ø under armouring, at least 0.9 mm	
Outer sheath		PVC and PVCw resp.				
Color		black or blue for intrinsically safe systems				
Marking		LEONI KERPEN ICON INSTRUMENTATION CABLE EN 50288-7 RATED VOLTAGE LSZH CE PRODUCTION LOT CODE LENGTH MARKING				

[1] *Color code of cabling elements see page 57.*

ICON® Instrumentation Cable according to EN 50288-7

Zero halogen, flame-retardant types

Single & Multi pair and Multi triple, individual and/or overall screen, LSZH-sheath

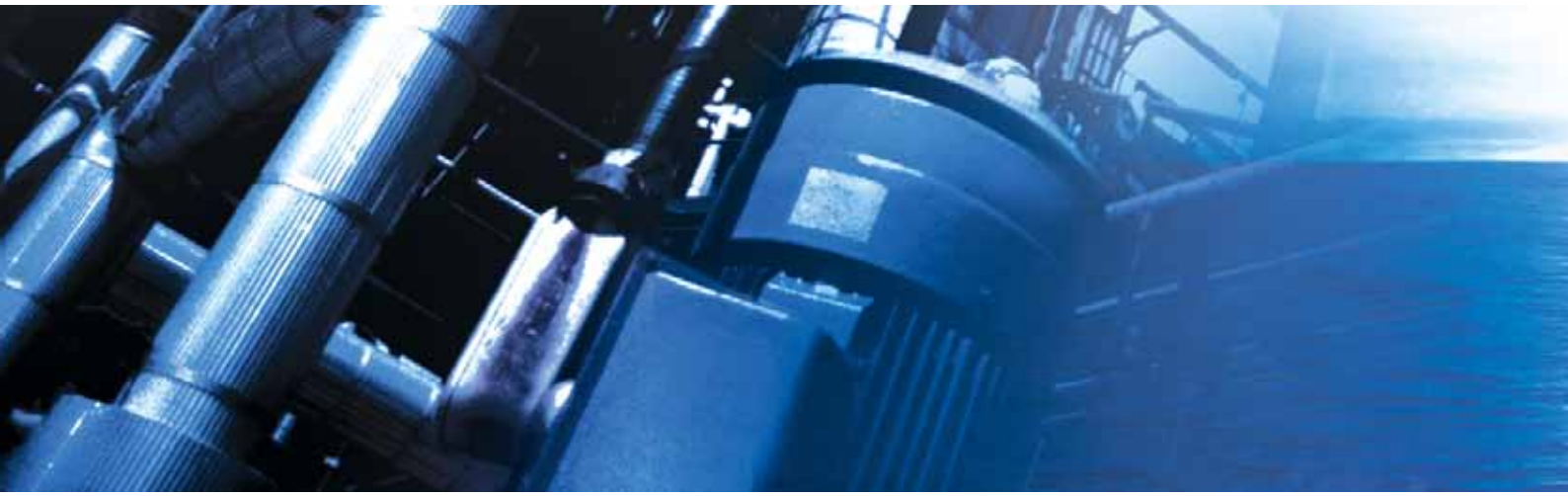
- unarmoured
- armoured

300 V and 500 V

Electrical Data at 20 °C				**300 V**				
Conductor sizes		nom.	mm²	0.5	0.75	1.0	1.3	1.5
Conductor resistance		max.	Ω/km	36.7	25.0	18.5	14.2	12.3
Insulation resistance	PE / XLPE-insulation	min.	MΩxkm	5000				
L/R Ratio		max.	µH/Ω	25			40	
Inductance		max.	mH/km	1				
Mutual capacitance								
PE / XLPE-insulation	Pair, Triple [1) 2)]	max.	nF/km	75			85	
	PiMF, TiMF	max.	nF/km	115			115	
Capacitance unbalanced [3)]	Pair	max.	pF/500m	500				
Test voltage	Core/core (U_{rms}) Core/screen (U_{rms})		V	1500 1500				
Operating voltage	(U_{rms})	max.	V	300				

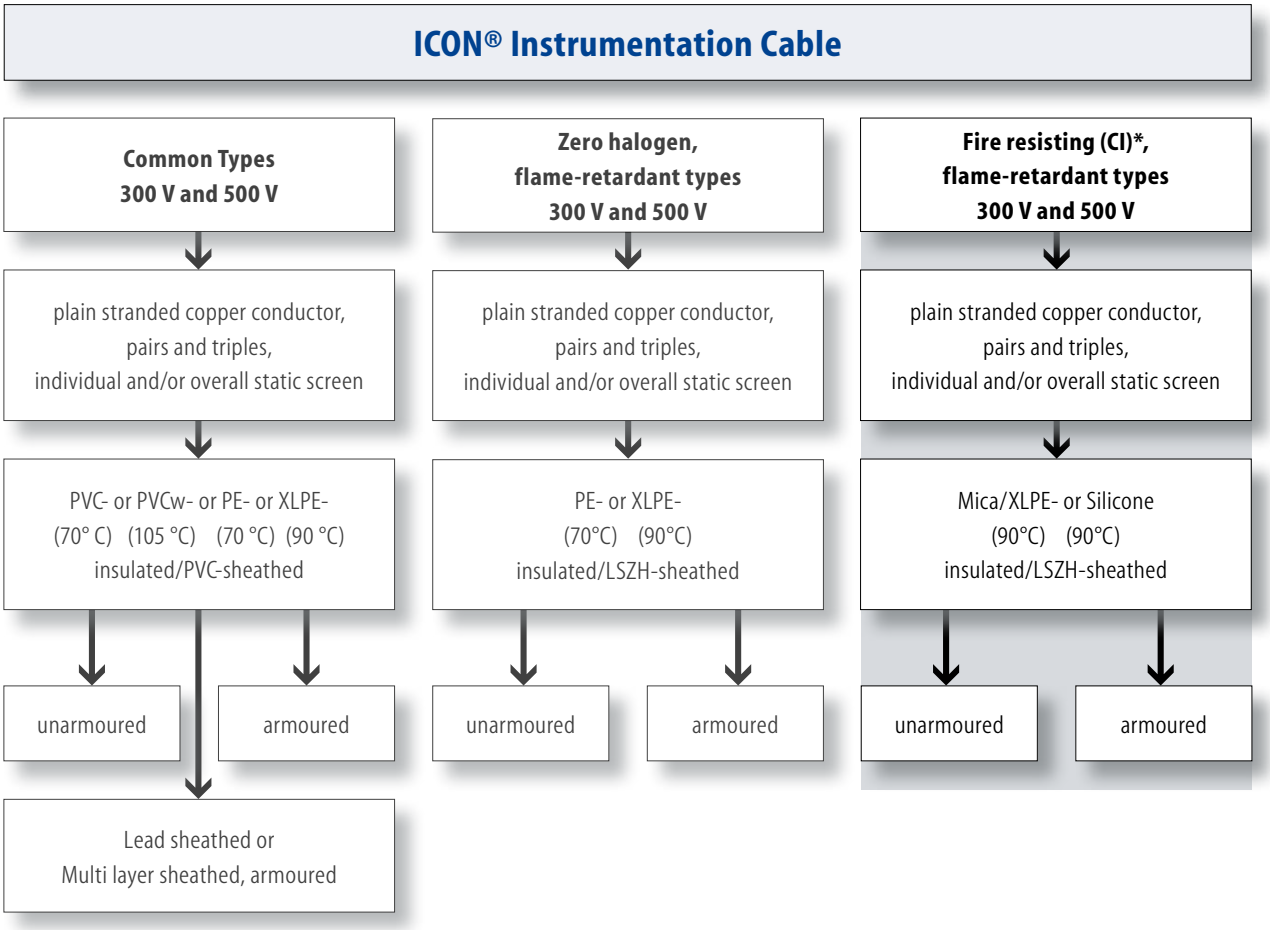
Electrical Data at 20 °C				**500 V**				
Conductor sizes		nom.	mm²	0.5	0.75	1.0	1.3	1.5
Conductor resistance		max.	Ω/km	36.7	25.0	18.5	14.2	12.3
Insulation resistance	PE / XLPE-insulation	min.	MΩxkm	5000				
L/R Ratio		max.	µH/Ω	25			40	
Inductance		max.	mH/km	1				
Mutual capacitance								
PE / XLPE-insulation	Pair, Triple [1) 2)]	max.	nF/km	65			75	
	PiMF, TiMF	max.	nF/km	100			100	
Capacitance unbalanced [3)]	Pair	max.	pF/500m	500				
Test voltage	Core/core (U_{rms}) Core/screen (U_{rms})		V	2000 2000				
Operating voltage	(U_{rms})	max.	V	500				

[1)] *Values for cables with 1 element correspond to those for PiMF and TiMF resp..*
[2)] *Values for cables with 2 up to 4 elements +20 %.*



ICON® Instrumentation Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types 500 V



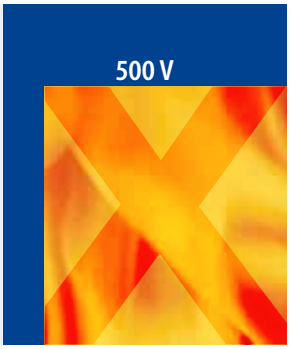
** according to EN 50288-7*

ICON® Instrumentation Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types

Single & Multi pair and Multi triple, individual and/or overall screen, LSZH-sheath

- unarmoured
- armoured



Technical Data		
Type of insulation/sheath	**Mica tape + XLPE/LSZH**	**Silicone/LSZH**
Type of cabling elements	Pair, Triple, PiMF, TiMF	
No. of cabling elements	1, 2, 4, 5, 6, 8, 10, 12, 16, 20, 24	
Conductor sizes	0.5 mm², 0.75 mm², 1.0 mm², 1.3 mm², 1.5 mm²	
1. Unarmoured types	RE-2X(St)H..CI	RE-2G(St)H..CI
Laying	Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations	
Bending radius	7.5 x cable Ø	
2. Armoured types	RE-2X(St)HSWAH [1]..CI	RE-2G(St)HSWAH [1]..CI
Laying	Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial	
Bending radius	10 x cable Ø	
Resistance to fire Circuit Integrity	a) IEC 60331-21, b) BS 6387 Cat C, W, Z	
Reaction to fire		
Flame propagation a) Test on single cable b) Test on bunched cables	IEC 60332-1 IEC 60332-3 part 24 (Cat. C)	
Test on gases evolved during combustion a) amount of halogen acid gas b) degree of acidity of gases	IEC 60754-1 (0 %) IEC 60754-2 (pH > 4.3, c < 10 µS/mm)	
Measurement of smoke density	IEC 61034-2 (L.T.[2] >60 %)	
Temperature range during operation during installation	–30 °C up to 90 °C –5 °C up to 50 °C	–30 °C up to 90 °C –5 °C up to 50 °C
Sunlight resistance	UL 1581 Section 1200	
Oil resistance	ICEA S-82-552	
Application	For transmission of analogue and digital signals in instrument and control systems, where maintenance of circuit integrity in case of fire is required; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 60079-14); not allowed for direct connection to low impedance sources, e.g. public mains electricity supply.	

[1] *Alternative with outer sheath PVC; in this case tests "Test on gases evolved during combustion". and "Measurement of smoke density" are not applicable.*

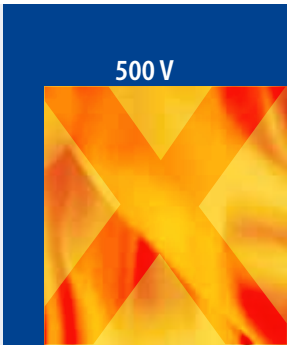
[2] *L.T. = Light Transmission.*

ICON® Instrumentation Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types

Single & Multi pair and Multi triple, individual and/or overall screen, LSZH-sheath

- unarmoured
- armoured



Construction						
Product type		**Unarmoured types**			**Armoured types**	
Conductor		Plain annealed copper; 7 stranded according to EN 60228, Class 2				
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5
Conductor design	mm	7 x 0.3	7 x 0.37	7 x 0.43	7 x 0.49	7 x 0.53
Insulation materials		Mica tape + cross linked polyethylene XLPE or silicone				
Cabling element [1]						
without individual screen		Pair, Triple				
with individual screen		PiMF, TiMF				
Individual screen		Aluminum/plastic-tape over tinned copper drain wire, 0.6 mm, plastic tape under and above screen				
Wrapping		at least one plastic tape above cable core				
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm				
Inner sheath		—			LSZH, black	
Armouring		—			Galvanized steel wire armouring; wire Ø depending on cable-Ø under armouring, at least 0.9 mm	
Outer sheath		LSZH[1]				
Color		black or blue for intrinsically safe systems				
Marking		LEONI KERPEN ICON INSTRUMENTATION CABLE GEN. TO EN 50288-7 RATED VOLTAGE LSZH[2] CE PRODUCTION LOT CODE LENGTH MARKING				

[1] *For armoured types also with outer sheath of PVC.*

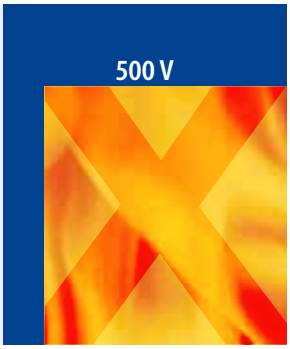
[2] *The sign "LSZH" is not applicable, if an outer sheath of PVC is applied.*

ICON® Instrumentation Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types

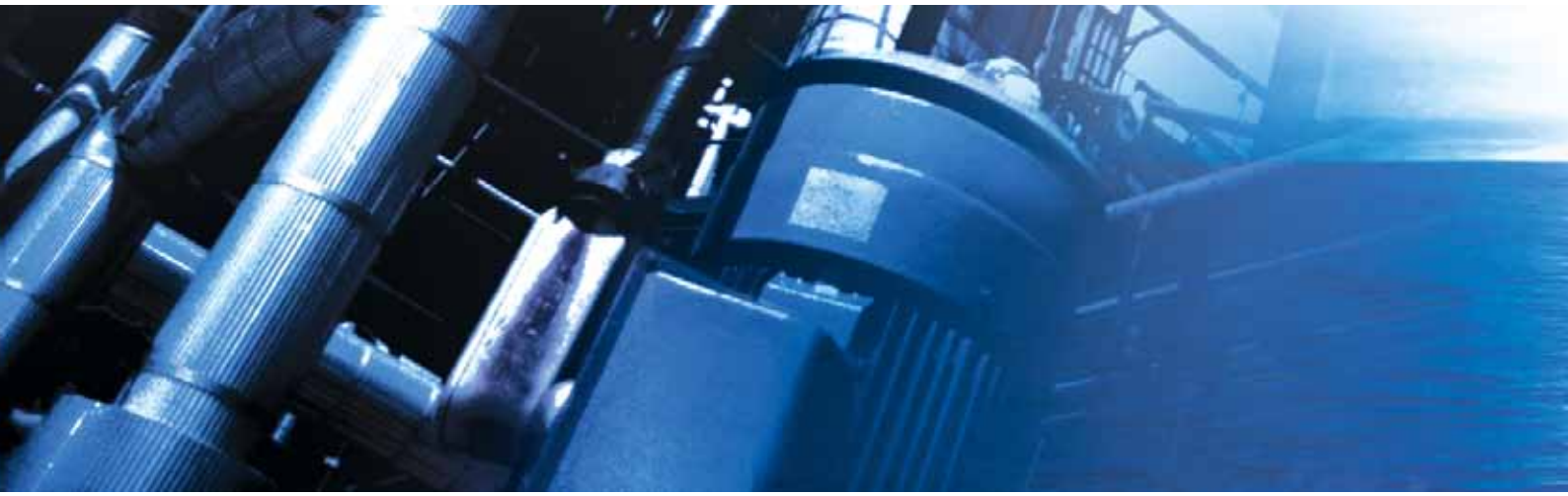
Single & Multi pair and Multi triple, individual and/or overall screen, LSZH-sheath

- unarmoured
- armoured



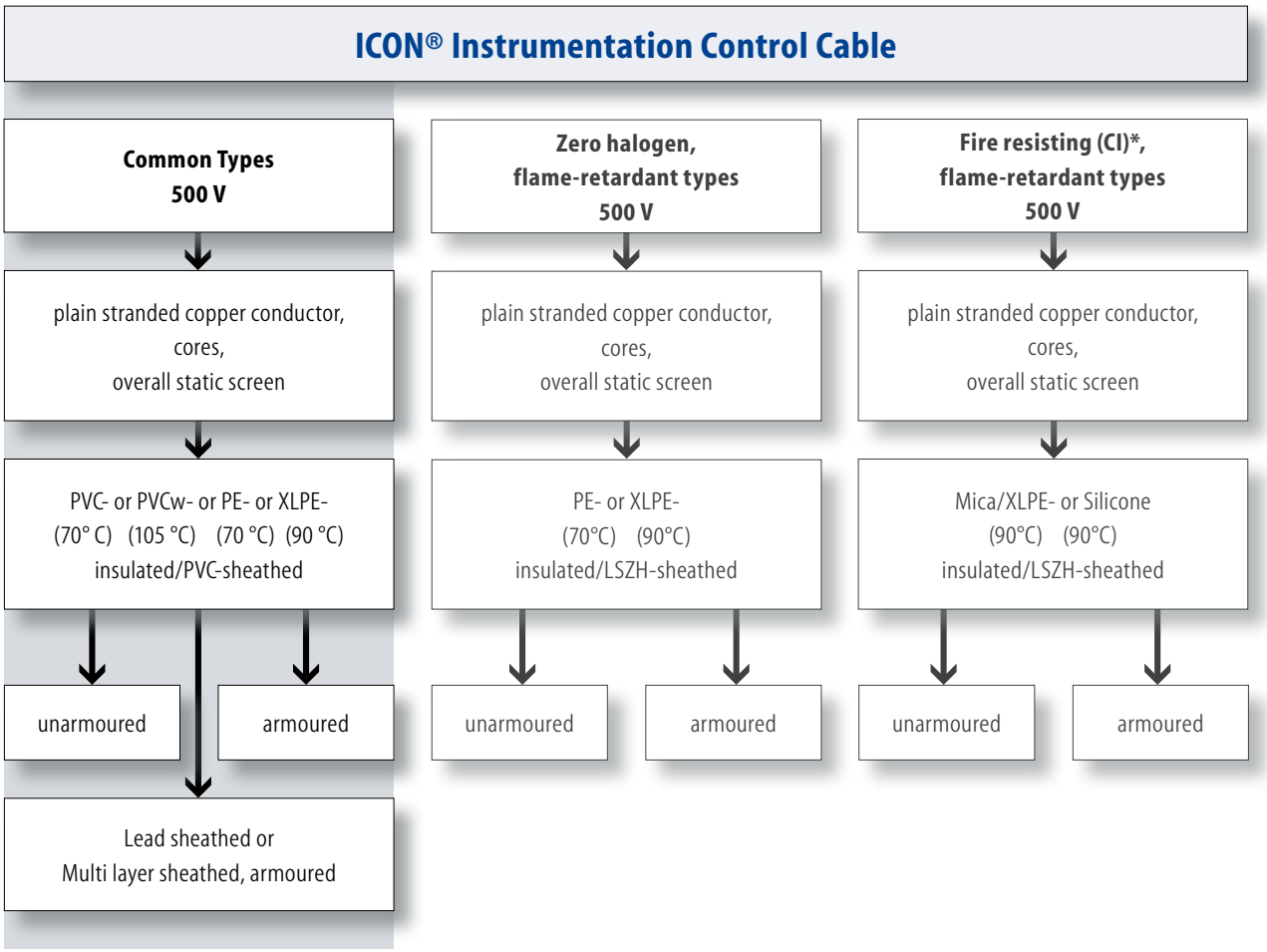
Electrical Data at 20 °C								
Conductor sizes		nom.	mm²	0.5	0.75	1.0	1.3	1.5
Conductor resistance		max.	Ω/km	36.7	25.0	18.5	14.2	12.3
Insulation resistance								
	PE / XLPE-insulation	min.	MΩxkm	5000				
	Silicone	min.	MΩxkm	300				
L/R Ratio		max.	µH/Ω	25			40	
Inductance		max.	mH/km	1				
Mutual capacitance								
Mica tape + XLPE-insulation								
	Pair, Triple [1) 2)]	max.	nF/km	65			75	
	PiMF, TiMF			100			100	
Silicone								
	Pair, Triple [1) 2)]	max.	nF/km	110			110	
	PiMF, TiMF	max.	nF/km	150			150	
Test voltage								
	Core/core (U_{rms}) Core/screen (U_{rms})		V	2000 2000				
Operating voltage	(U_{rms})	max.	V	500				

[1)] *Values for cables with 1 element correspond to those for PiMF and TiMF resp..*
[2)] *Values for cables with 2 up to 4 elements +20 %.*



ICON® Instrumentation Control Cable according to EN 50288-7

Common Types
500 V



** according to EN 50288-7*

ICON® Instrumentation Control Cable according to EN 50288-7
Common types

Multi core, overall screen, PVC-sheath
- unarmoured
- armoured
- with chemical protection, armoured

500 V

Technical Data					
Type of insulation/sheath		**PVC/PVC**	**PVCw/PVCw**	**PE/PVC**	**XLPE/PVC**
Type of cabling elements		Core			
No. of cabling elements		2, 4, 5, 6, 8, 10, 12, 16, 20, 24, 36, 40			
Conductor sizes		0.5 mm², 0.75 mm², 1.0 mm², 1.3 mm², 1.5 mm², 2.5 mm²			
1. Unarmoured types		RE-Y(St)Y-fl	RE-Yw(St)Yw-fl	RE-2Y(St)Y-fl [1]	RE-2X (St)Y-fl
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations			
Bending radius		7.5 x cable Ø			
2. Armoured types		RE-Y(St)YSWAY-fl	RE-Yw(St)YwSWAYw-fl	RE-2Y(St)YSWAY-fl	RE-2X(St)YSWAY-fl
Laying		Recommended for outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial			
Bending radius		10 x cable Ø			
3. Armoured types with chemical protection					
a) Lead sheathed		RE-Y(St)YMYSWAY-fl	—	—	RE-2X(St)YMYSWAY-fl
b) Multi layer sheathed		—	—	—	RE-2X(L)2Y4YSWAY [2) 3)]
Laying		Recommended for direct burial, especially in presence of oil and aggressive chemical substances			
Bending radius		15 x cable Ø			
Reaction to fire					
Flame propagation a) Test on single cable b) Test on bunched cables		IEC 60332-1-2 IEC 60332-3 part 24 (Cat. C), (excluded types with multi layer-sheath)			
Temperature range	during operation during installation	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 105 °C –5 °C up to 50 °C	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 90 °C –5 °C up to 50 °C
Sunlight resistance		UL 1581 Section 1200			
Oil resistance		ICEA S-82-552			
Application		For control purposes, e.g. controlling of valves or engines; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 60079-14); not allowed for direct connection to low impedance sources, e.g. public mains electricity supply			

[1)] *Also with increased thickness of outer sheath (Yv).*
[2)] *Also with HDPE outer sheath; in this case tests "Reaction to Fire" are not passed.*
[3)] *Max. operating temperature 80 °C.*

ICON® Instrumentation Control Cable according to EN 50288-7
Common types

Multi core, overall screen, PVC-sheath
- unarmoured
- armoured
- with chemical protection, armoured

500 V

Construction							
Product types		**Unarmoured types**		**Armoured types**	**Lead sheathed, armoured types**		**Multi layer sheathed, armoured types**
Conductor		Plain annealed copper 7 stranded according to EN 60228, Class 2					
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5	2.5
Conductor design	mm	7 x 0.3	7 x 0.37	7 x 0.43	7 x 0.49	7 x 0.53	7 x 0.67
Insulation materials		Cross linked polyethylene XLPE or Polyethylene PE or Polyvinylchloride PVC or Polyvinylchloride heat resistant PVCw			PVC or XLPE		XLPE
Cabling element [1]		Core					
Wrapping		at least one plastic tape above cable core			Plastic tape above cable core		
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm					see multi layer sheath
Inner sheath		—		PVC and PVCw resp. , black	PVC		—
Metal sheath		—		—	Lead sheath		—
Bedding		—		—	PVC		—
Multi layer-sheath		—		—	—		Longitudinal one side plastic coated aluminum foil over tinned copper drain wire, 7 x 0.3 mm, high density polyethylene sheath with an additional polyamide covering. The aluminum foil is bonding within the overlapping and with the inner surface of the polyethylene sheath
Armouring		—		Galvanized steel wire; wire Ø depending on cable-Ø under armouring, at least 0.9 mm			
Outer sheath		PVC and PVCw resp.			PVC		PVC or PE (high density)
Color		black or blue for intrinsically safe systems					
Marking		LEONI KERPEN ICON INSTRUMENTATION CABLE EN 50288-7 RATED VOLTAGE RP[2] CE PRODUCTION LOT CODE LENGTH MARKING					

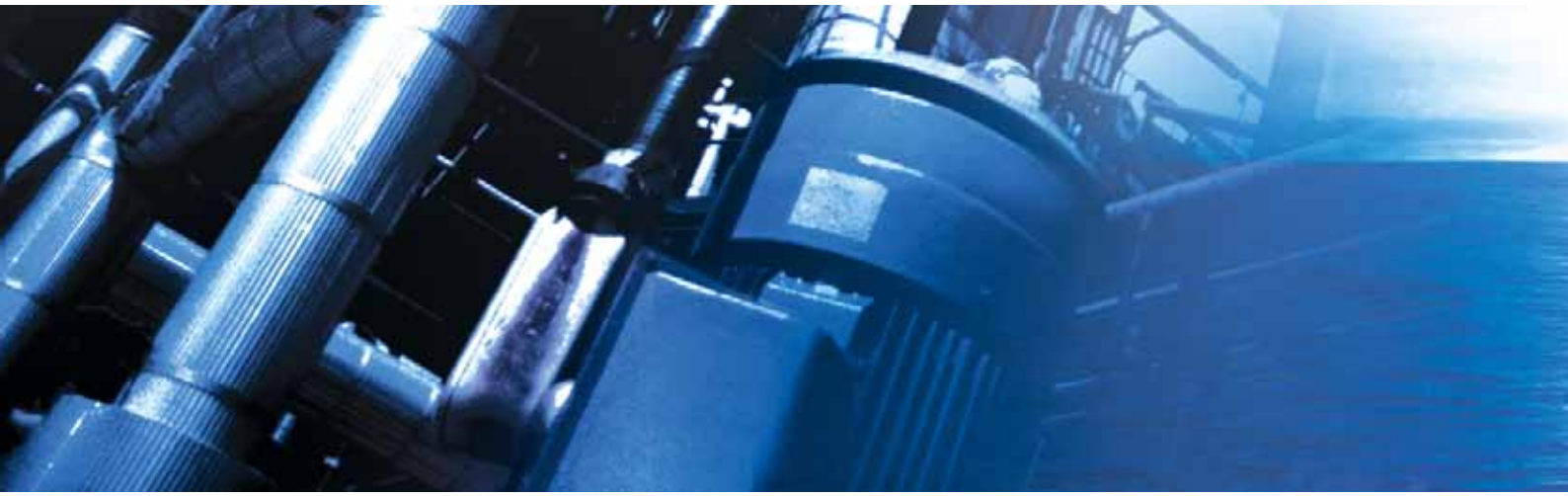
[1] *Color code of cabling elements see page 57.*
[2] *RP = Reduced flame propagation, excluded types with multi layer sheath.*

ICON® Instrumentation Control Cable according to EN 50288-7
Common types

Multi core, overall screen, PVC-sheath
- unarmoured
- armoured
- with chemical protection, armoured

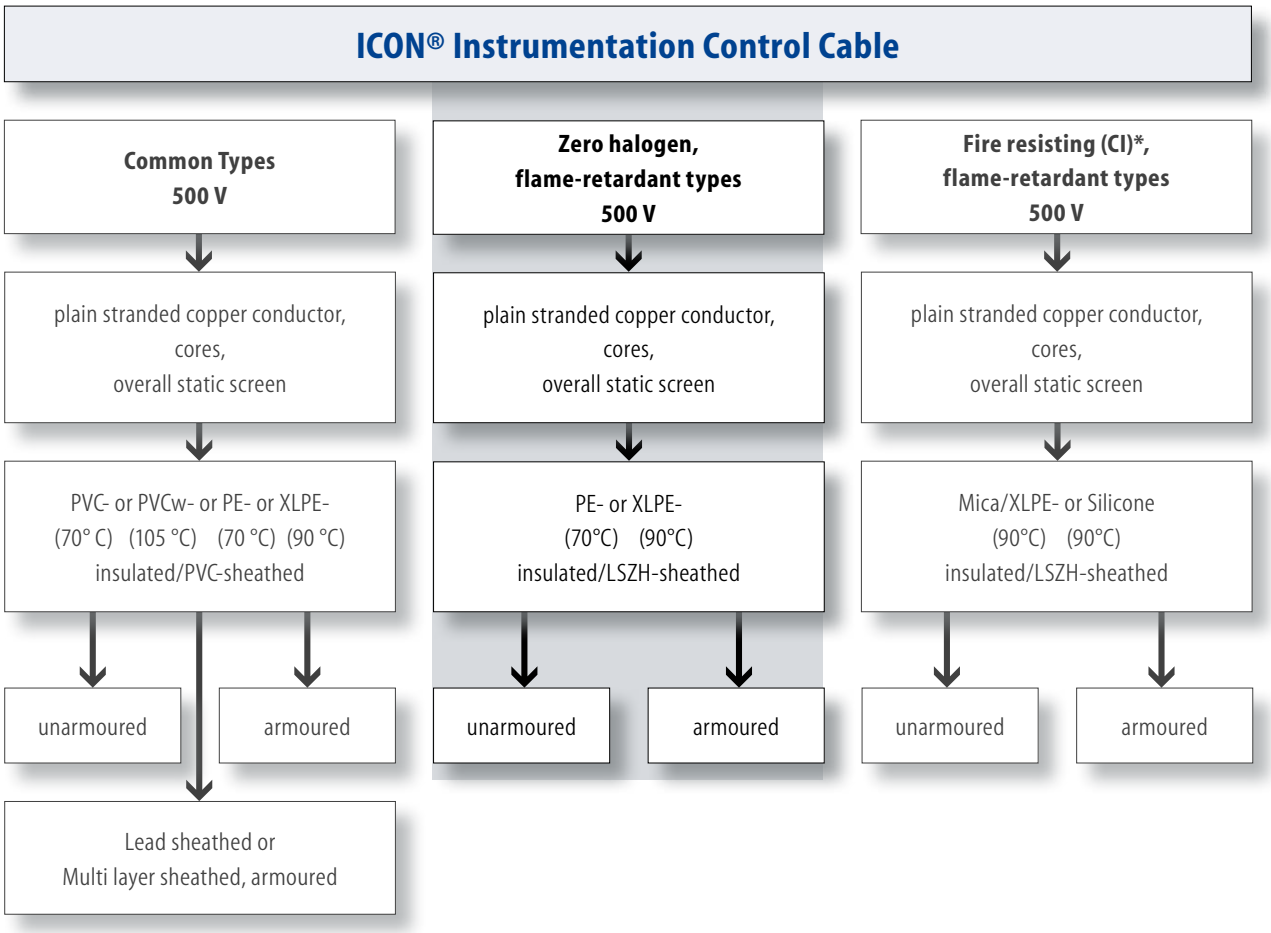
500 V

Electrical Data at 20 °C								
Conductor sizes	nom.	mm²	0.5	0.75	1.0	1.3	1.5	2.5
Conductor resistance	max.	Ω/km	36.0	24.5	18.1	13.9	12.1	7.41
Insulation resistance								
PVC / PVCw insulation	min.	nF/km	100					
PE / XLPE-insulation	min.	nF/km	5000					
L/R Ratio	max.	µH/Ω	25			40		60
Inductance	max.	mH/km	1					
Mutual capacitance								
PVC / PVCw insulation	max.	nF/km	170					
PE / XLPE-insulation	max.	nF/km	115					
Test voltage								
Core/core (U_{rms})		V	2000					
Core/screen (U_{rms})		V	2000					
Operating voltage (U_{rms})	max.	V	500					



ICON® Instrumentation Control Cable according to EN 50288-7

Zero halogen, flame-retardant types 500 V



** according to EN 50288-7*

ICON® Instrumentation Control Cable according to EN 50288-7

Zero halogen, flame-retardant types

Multi core overall screen, LSZH-sheath

- unarmoured
- armoured

500 V

Technical Data			
Type of insulation/sheath		**PE/LSZH**	**XLPE/LSZH**
Type of cabling elements		Core	
No. of cabling elements		2, 4, 5, 6, 8, 10, 12, 16, 20, 24, 36,40	
Conductor sizes		0.5 mm², 0.75 mm², 1.0 mm², 1.3 mm², 1.5 mm², 2.5 mm²	
1. Unarmoured types		RE-2Y(St)H	RE-2X(St)H
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations	
Bending radius		7.5 x cable Ø	
2. Armoured types		RE-2Y(St)HSWAH	RE-2X(St)HSWAH
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial	
Bending radius		10 x cable Ø	
Reaction to fire			
Flame propagation a) Test on single cable b) Test on bunched cables		IEC 60332-1 IEC 60332-3 part 24 (Cat. C)	
Test on gases evolved during combustion a) amount of halogen acid gas b) degree of acidity of gases		IEC 60754-1 (0 %) IEC 60754-2 (pH > 4.3, c < 10 µS/mm)	
Measurement of smoke density		IEC 61034-2 (L.T. [1] >60 %)	
Temperature range	during operation during installation	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 90 °C –5 °C up to 50 °C
Oil resistance		ICEA S-82-552	
Application		For control purposes, e.g. controlling of valves or engines; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 60079-14); not allowed for direct connection to low impedance sources, e.g. public mains electricity supply. Recommended for use as fire protection measure for people and for important material assets.	

[1] *L.T. = Light Transmission.*

ICON® Instrumentation Control Cable according to EN 50288-7

Zero halogen, flame-retardant types

Multi core overall screen, LSZH-sheath

- unarmoured
- armoured

500 V

Construction							
Product type		**unarmoured types**			**armoured types**		
Conductor		Plain annealed copper; 7 stranded according to EN 60228, Class 2					
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5	2.5
Conductor design	mm	7 x 0.3	7 x 0.37	7 x 0.43	7 x 0.49	7 x 0.53	7 x 0.67
Insulation materials		Cross linked polyethylene XLPE or Polyethylene PE					
Cabling element		Core					
Wrapping		at least one plastic tape above cable core					
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm					
Inner sheath		—			LSZH, black		
Armouring		—			Galvanized steel wire armouring; wire Ø depending on cable-Ø under armouring, at least 0.9 mm		
Outer sheath		LSZH					
Color		black or blue for intrinsically safe systems					
Marking		LEONI KERPEN ICON INSTRUMENTATION CABLE EN 50288-7 RATED VOLTAGE LSZH CE PRODUCTION LOT CODE LENGTH MARKING					

[1] *Color code of cabling elements see page 57.*

ICON® Instrumentation Control Cable according to EN 50288-7

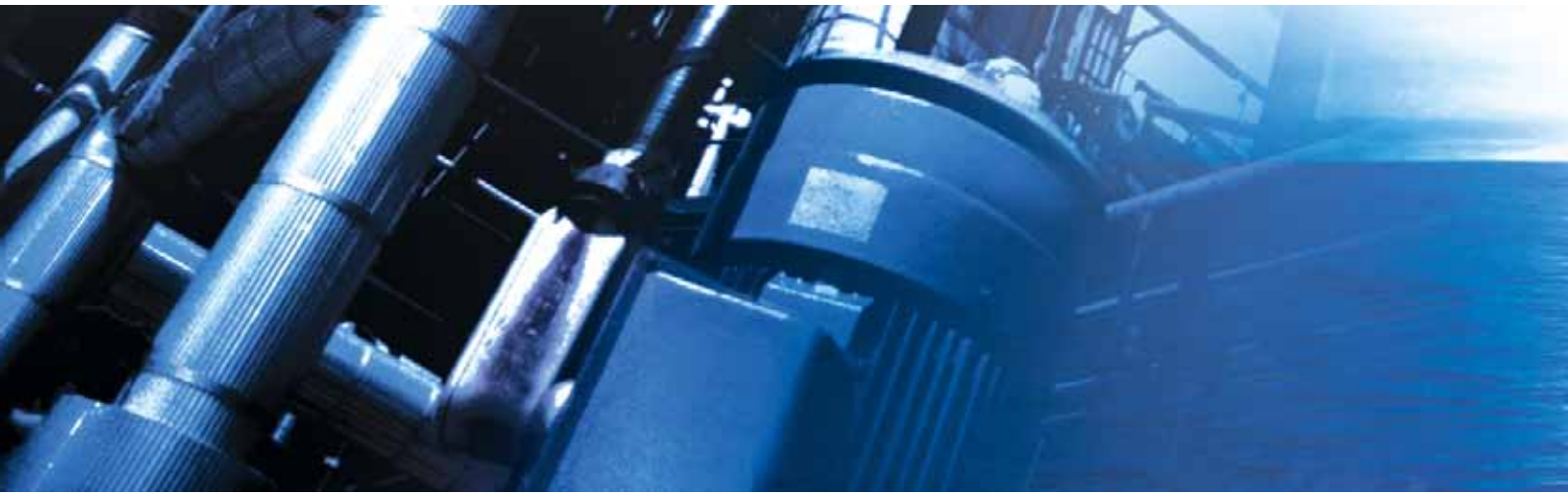
Zero halogen, flame-retardant types

Multi core overall screen, LSZH-sheath

- unarmoured
- armoured

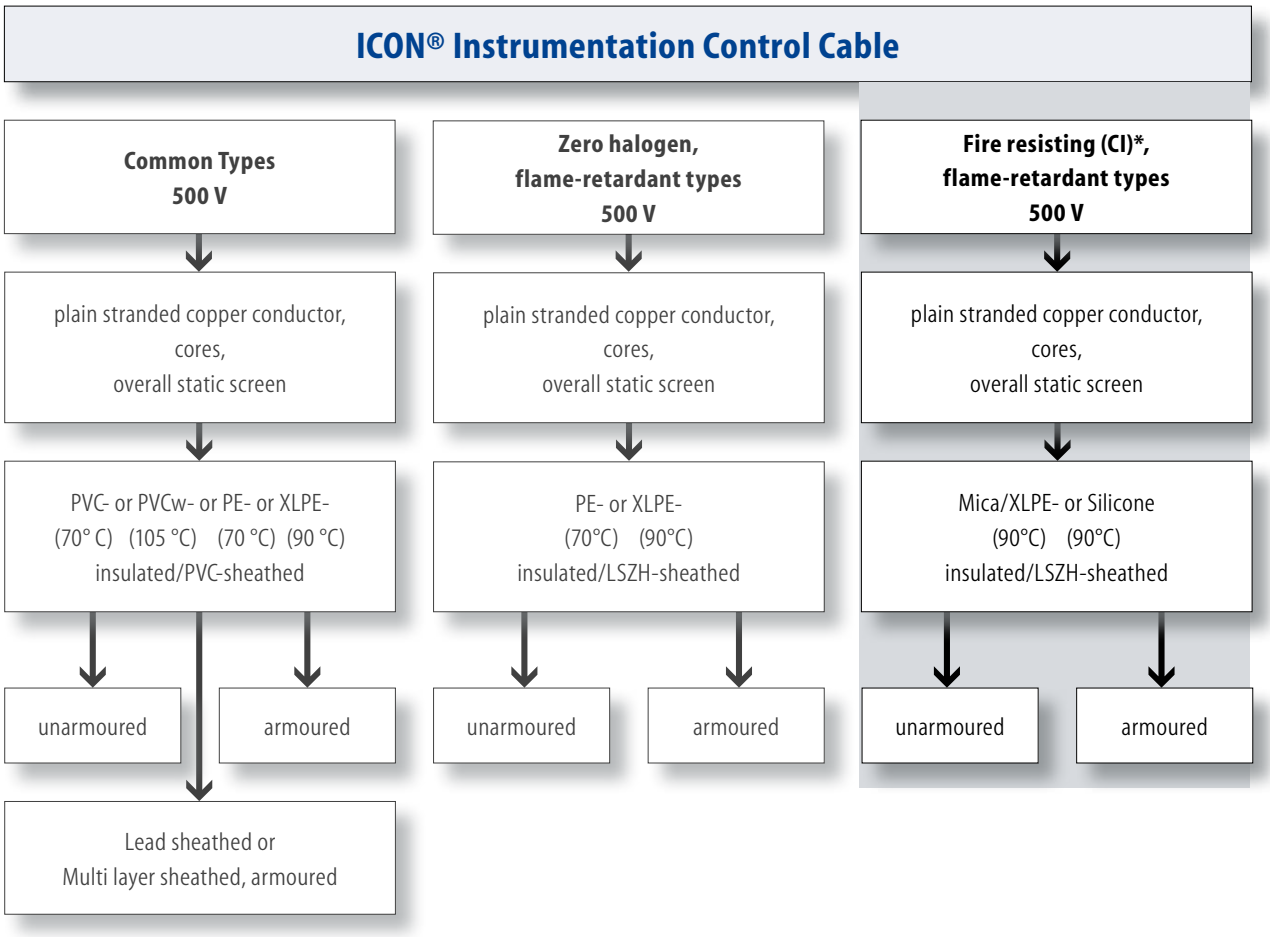
500 V

Electrical Data at 20 °C								
Conductor sizes	nom.	mm²	0.5	0.75	1.0	1.3	1.5	2.5
Conductor resistance	max.	Ω/km	36.0	24.5	18.1	13.9	12.1	7.41
Insulation resistance								
PE / XLPE-insulation	min.	MΩxkm	5000					
L/R Ratio	max.	µH/Ω	25			40		60
Inductance	max.	mH/km	1					
Mutual capacitance	max.	nF/km	115					
Test voltage								
Core/core (U_{rms}) Core/screen (U_{rms})		V	2000 2000					
Operating voltage (U_{rms})	max.	V	500					



ICON® Instrumentation Contol Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types – 500 V



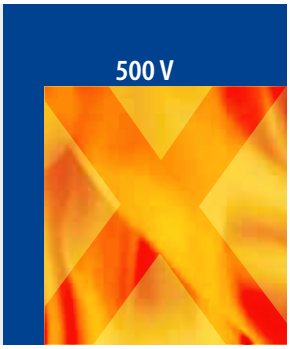
** according to EN 50288-7*

ICON® Instrumentation Control Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types

Multi core overall screen, LSZH-sheath

- unarmoured
- armoured



Technical Data		
Type of insulation/sheath	**Mica tape + XLPE/LSZH**	**Silicone/LSZH**
Type of cabling elements	Core	
No. of cabling elements	2, 4, 5, 6, 8, 10, 12, 16, 20, 24, 36, 40	
Conductor sizes	0.5 mm², 0.75 mm², 1.0 mm², 1.3 mm², 1.5 mm² , 2.5 mm²	
1. Unarmoured types	RE-2X(St)H..CI	RE-2G(St)H..CI
Laying	Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations	
Bending radius	7.5 x cable Ø	
2. Armoured types	RE-2X(St)HSWAH [1]..CI	RE-2G(St)HSWAH [1]..CI
Laying	Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial	
Bending radius	10 x cable Ø	
Resistance to fire		
Circuit Integrity	a) IEC 60331-21 b) BS 6387 Cat. C, W, Z	
Reaction to fire		
Flame propagation a) Test on single cable b) Test on bunched cables	IEC 60332-1 IEC 60332-3 part 24 (Cat. C)	
Test on gases evolved during combustion a) amount of halogen acid gas b) degree of acidity of gases	IEC 60754-1 (0 %) IEC 60754-2 (pH > 4.3, c < 10 µS/mm)	
Measurement of smoke density	IEC 61034-2 (L.T. [2] >60 %)	
Temperature range during operation during installation	 –30 °C up to 70 °C –5 °C up to 50 °C	 –30 °C up to 90 °C –5 °C up to 50 °C
Sunlight resistance	UL 1581 Section 1200	
Oil resistance	ICEA S-82-552	
Application	For control purposes, e.g. controlling of valves or engines where maintenance of circuit integrity in case of fire is required; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 60079-14); not allowed for direct connection to low impedance sources, e.g. public mains electricity supply.	

[1] *Alternative with outer sheath PVC; in this case tests "Test on gases evolved during combustion". and "Measurement of smoke density" are not applicable.*

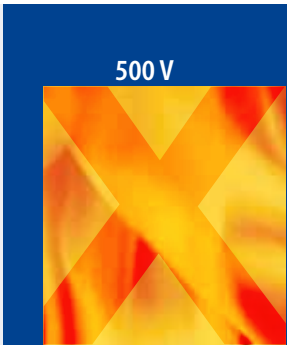
[2] *L.T. = Light Transmission.*

ICON® Instrumentation Control Cable according to EN 50288-7

Fire resisting (CI), flame-retardant types

Multi core overall screen, LSZH-sheath

- unarmoured
- armoured



Construction							
Product type		**Unarmoured types**			**Armoured types**		
Conductor		Plain annealed copper; 7 stranded according to EN 60228, Class 2					
Cross-section **Conductor design**	mm² mm	0.5 7 x 0.3	0.75 7 x 0.37	1.0 7 x 0.43	1.3 7 x 0.49	1.5 7 x 0.53	2.5 7 x 0.67
Insulation materials		Mica tape + cross linked polyethylene XLPE or silicone					
Cabling element [1]		Core					
Wrapping		at least one plastic tape above cable core					
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm					
Inner sheath		—			LSZH, black		
Armouring		—			Galvanized steel wire armouring; wire Ø depending on cable-Ø under armouring, at least 0.9 mm		
Outer sheath		LSZH					
Color		black or blue for intrinsically safe systems					
Marking		LEONI KERPEN ICON INSTRUMENTATION CABLE EN 50288-7 RATED VOLTAGE LSZH[1] CI CE PRODUCTION LOT CODE LENGTH MARKING					

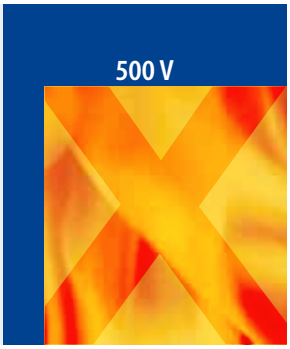
[1] *The sign "LSZH" is not applicable, if an outer sheath of PVC is applied*

ICON® Instrumentation Control Cable according to EN 50288-7

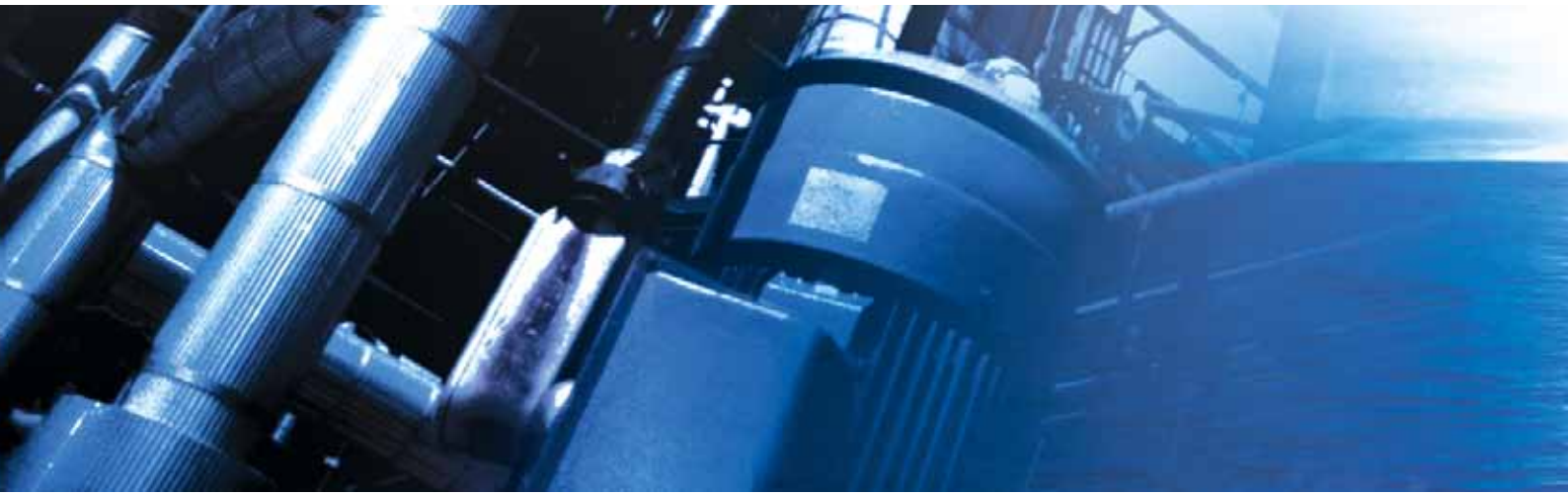
Fire resisting (CI), flame-retardant types

Multi core overall screen, LSZH-sheath

- unarmoured
- armoured

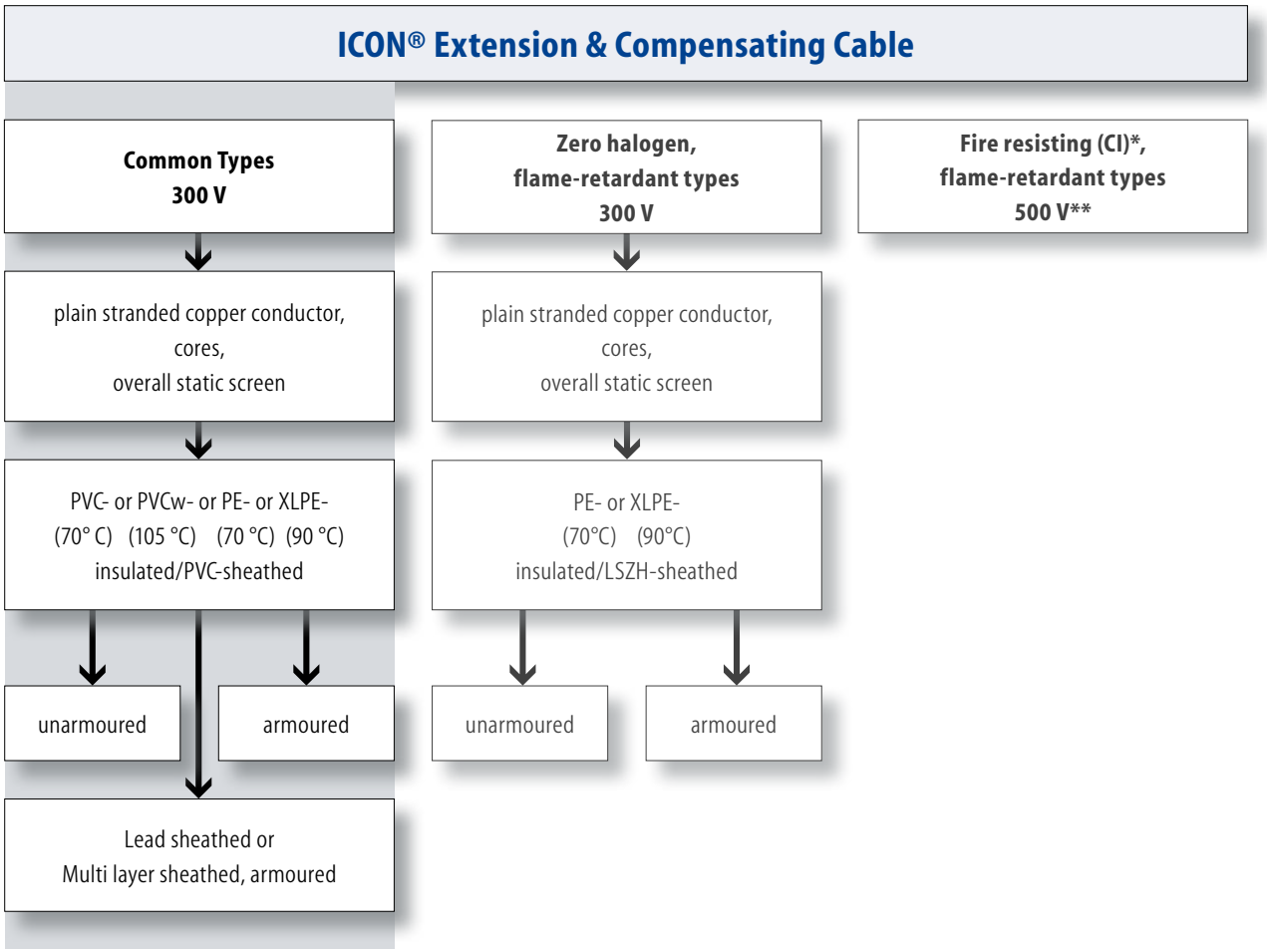


Electrical Data at 20 °C								
Conductor sizes	nom.	mm²	0.5	0.75	1.0	1.3	1.5	2.5
Conductor resistance	max.	Ω/km	36.0	24.5	18.1	13.9	12.1	7.41
Insulation resistance								
PE / XLPE-insulation	min.	MΩxkm	5000					
Silicone	min.	MΩxkm	150					
L/R Ratio	max.	µH/Ω	25			40		60
Inductance	max.	mH/km	1					
Mutual capacitance								
Mica tape + XLPE-insulation			100					
Silicone	min.	nF/km	150					
Test voltage								
Core/core (U_{rms}) Core/screen (U_{rms})		V	2000 2000					
Operating voltage (U_{rms})	max.	V	500					



ICON® Extension & Compensating Cable according to EN 50288-7

Common types
300 V



** according to EN 50288-7*
*** on request*

ICON® Extension & Compensating Cable according to EN 50288-7
Common types

Single & Multi pair, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured
- with chemical protection, armoured

300 V

Technical Data					
Type of insulation/sheath		**PVC/PVC**	**PVCw/PVCw**	**PE/PVC**	**XLPE/PVC**
Type of cabling elements		Pair, PiMF			
No. of cabling elements		1, 2, 4, 5, 6, 8, 10, 12, 16, 20, 24			
Conductor material		Extension or compensating material according to IEC 60584-3 (see page 55)			
Conductor sizes		0.8 mm, 1.02 mm, 1.13 mm, 1.29 mm, 1.38 mm			
1. Unarmoured types		RE-Y(St)Y-fl	RE-Yw(St)Yw-fl	RE-2Y(St)Y-fl	RE-2X (St)Y-fl
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations			
Bending radius		7.5 x cable Ø			
2. Armoured types		RE-Y(St)YSWAY-fl	RE-Yw(St)YwSWAYw-fl	RE-2Y(St)YSWAY-fl	RE-2X(St)YSWAY-fl
Laying		Recommended for outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial			
Bending radius		10 x cable Ø			
3. Armoured types with chemical protection					
a) Lead sheathed		RE-Y(St)YMYSWAY-fl	—	—	RE-2X(St)YMYSWAY-fl
b) Multi layer sheathed		—	—	—	RE-2X(L)2Y4YSWAY [1) 2)]
Laying		Recommended for direct burial, especially in presence of oil and aggressive chemical substances			
Bending radius		15 x cable Ø			
Reaction to fire					
Flame propagation a) Test on single cable b) Test on bunched cables		IEC 60332-1-2 IEC 60332-3 part 24 (Cat. C), (excluded types with multi layer-sheath)			
Temperature range	during operation during installation	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 105 °C –5 °C up to 50 °C	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 90 °C –5 °C up to 50 °C
Sunlight resistance		UL 1581 Section 1200			
Oil resistance		ICEA S-82-552			
Application		For transmission of thermoelectric voltage from measuring junction to reference junction; allowed for use in zone 1 and zone 2, group II (IEC 60079-14)			

[1)] *Also with HDPE outer sheath; in this case tests "Reaction to Fire" are not passed.*
[2)] *Max. operating temperature 80 °C.*

ICON® Extension & Compensating Cable according to EN 50288-7
Common types

Single & Multi pair, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured
- with chemical protection, armoured

300 V

Construction						
Product types		**Unarmoured types**		**Armoured types**	**Lead sheathed, armoured types**	**Multi layer sheathed, armoured types**
Conductor		Extension or compensating material according to IEC 60584-3 (see page 55)				
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5
Conductor design	mm	1 x 0.8	1 x 1.02	1 x 1.13	1 x 1.29	1 x 1.38
Insulation materials		Cross linked polyethylene XLPE or Polyethylene PE or Polyvinylchloride PVC or Polyvinylchloride heat resistant PVCw			PVC or XLPE	XLPE
Cabling element [1] without individual screen with individual screen		Pair PiMF				
Individual screen		Aluminum/plastic-tape over solid tinned copper drain wire, 0.6 mm plastic-tape under and above screen				
Wrapping		at least one plastic tape above cable core				
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm				see multi layer sheath
Inner sheath		—	PVC and PVCw resp. , black		PVC	—
Metal sheath		—	—		Lead sheath	—
Bedding		—	—		PVC	—
Multi layer-sheath		—	—		—	Longitudinal one side plastic coated aluminum foil over tinned copper drain wire, 7 x 0.3 mm, high density polyethylene sheath with an additional polyamide covering. The aluminum foil is bonding within the overlapping and with the inner surface of the polyethylene sheath
Armouring		—	Galvanized steel wire; wire Ø depending on cable-Ø under armouring, at least 0.9 mm			
Outer sheath		PVC and PVCw resp.			PVC	PVC or PE (high density)
Color		according to color code [1] or blue for intrinsically safe systems			according to color code [1]	
Marking		LEONI KERPEN ICON EXTENSION OR COMPENSATING CABLE EN 50288-7 RATED VOLTAGE RP[2] CE PRODUCTION LOT CODE LENGTH MARKING				

[1] *Color code of cabling elements see page 55.*
[2] *RP = Reduced flame propagation, excluded types with multi layer sheath.*

ICON® Extension & Compensating Cable according to EN 50288-7

Common types

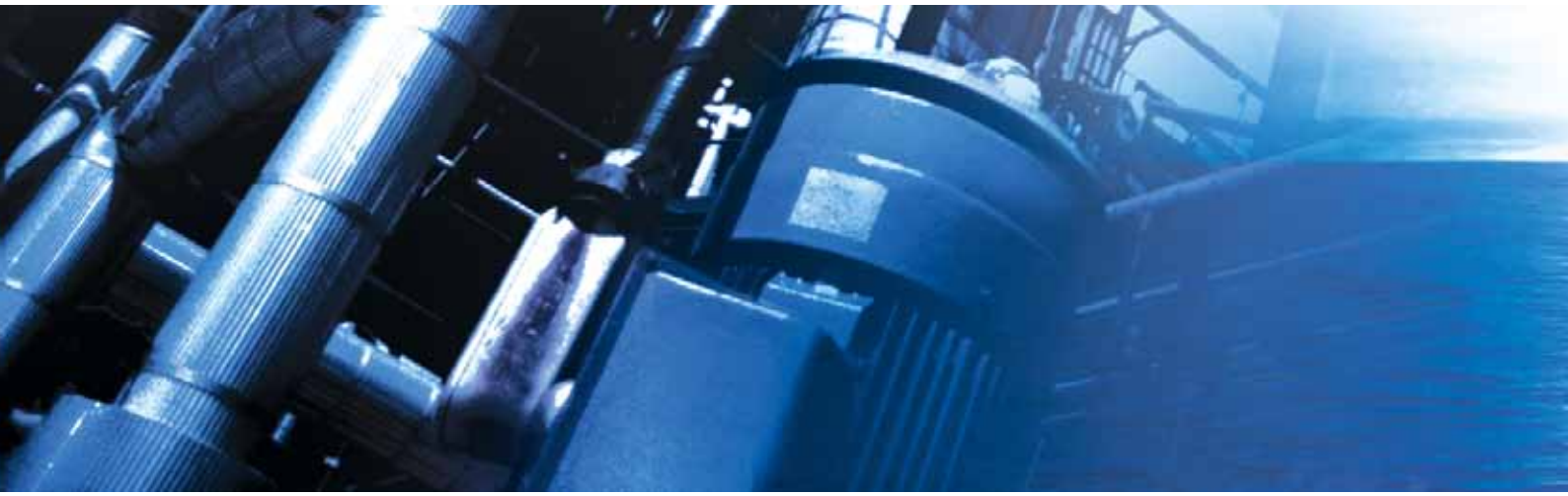
Single & Multi pair, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured
- with chemical protection, armoured

300 V

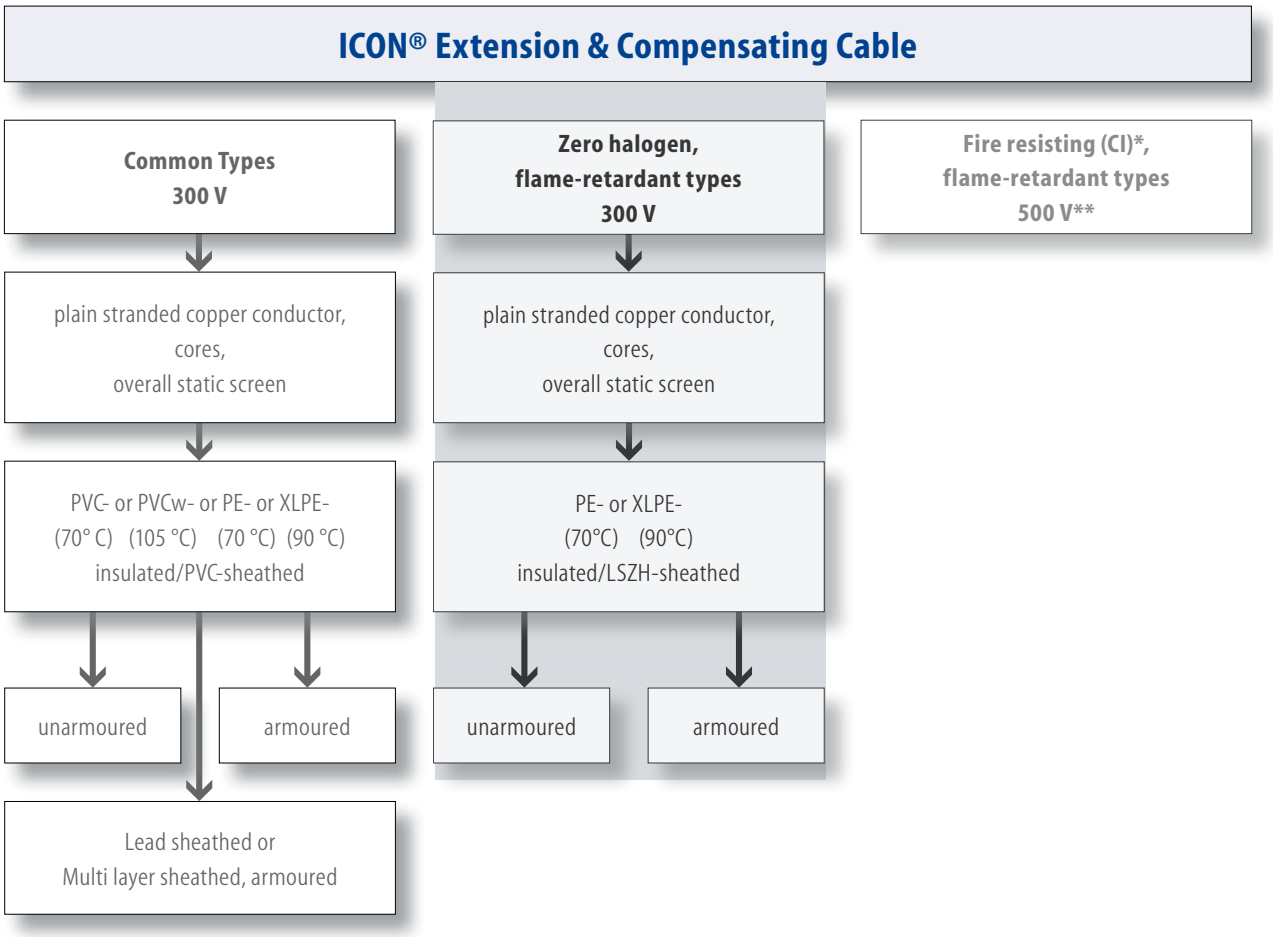
Electrical Data at 20 °C								
Conductor sizes	nom.	mm²	0.5	0.75	1.0	1.3	1.5
Conductor resistance	max.	Ω/km	see table 2 (page 56)				
Insulation resistance							
PVC / PVCw-insulation	min.	MΩxkm	100				
PE / XLPE-insulation	min.	MΩxkm	5000				
Inductance	max.	mH/km	see table 2 (page 56)				
Mutual capacitance							
PVC / PVCw-insulation							
Pair [1) 2)]	max.	nF/km	150			160	
PiMF	max.	nF/km	190			200	
PE / XLPE-insulation							
Pair [1) 2)]	max.	nF/km	75			85	
PiMF	max.	nF/km	115			115	
Test voltage							
Core/core (U_{rms}) Core/screen (U_{rms})		V	1500 1500				
Operating voltage (U_{rms})	max.	V	300				

[1)] *Values for cables with 1 element correspond to those for PiMF.*
[2)] *Values for cables with 2 up to 4 elements +20 %.*



ICON® Extension & Compensating Cable according to EN 50288-7

Zero halogen, flame-retardant types 300 V



** according to EN 50288-7*
*** on request*

ICON® Extension & Compensating Cable according to EN 50288-7

Zero halogen, flame-retardant types

Single & Multi pair, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured

300 V

Technical Data			
Type of insulation/sheath		**PE/LSZH**	**XLPE/LSZH**
Type of cabling elements		Pair, PiMF	
No. of cabling elements		1, 2, 4, 5, 6, 8, 10, 12, 16, 20, 24	
Conductor material		Extension or compensating material according to IEC 60584-3 (see table 2 on page 56)	
Conductor sizes		0.5 mm, 0.75 mm, 1.0 mm, 1.3 mm, 1.5 mm	
1. Unarmoured types		RE-2Y(St)H	RE-2X(St)H
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations	
Bending radius		7.5 x cable Ø	
2. Armoured types		RE-2Y(St)HSWAH	RE-2X(St)HSWAH
Laying		Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations, for direct burial	
Bending radius		10 x cable Ø	
Reaction to fire			
Flame propagation a) Test on single cable b) Test on bunched cables		IEC 60332-1 IEC 60332-3 part 24 (Cat. C)	
Test on gases evolved during combustion a) amount of halogen acid gas b) degree of acidity of gases		IEC 60754-1 (0 %) IEC 60754-2 (pH > 4.3, c < 10 µS/mm)	
Measurement of smoke density		IEC 61034-2 (L.T. [1] >60 %)	
Temperature range	during operation during installation	–30 °C up to 70 °C –5 °C up to 50 °C	–30 °C up to 90 °C –5 °C up to 50 °C
Oil resistance		ICEA S-82-552	
Application		For transmission of thermoelectric voltage from measuring junction to reference junction; allowed for use in zone 1 and zone 2, group II, classified areas (IEC 79-14).	

[1] *L.T. = Light Transmission.*

ICON® Extension & Compensating Cable according to EN 50288-7

Zero halogen, flame-retardant types

Single & Multi pair, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured

300 V

Construction						
Product type		**unarmoured types**			**armoured types**	
Conductor		Extension or compensating material according to IEC 60584-3				
Cross-section	mm²	0.5	0.75	1.0	1.3	1.5
Conductor design	mm	1 x 0.8	1 x 1.02	1 x 1.13	1 x 1.29	1 x 1.38
Insulation materials		Cross linked polyethylene XLPE or Polyethylene PE				
Cabling element [1]						
without individual screen with individual screen		Pair PiMF				
Individual screen		Aluminum/plastic-tape over tinned copper drain wire, 0.6 mm, plastic tape under and above screen				
Wrapping		at least one plastic tape above cable core				
Overall screen		Aluminum/plastic-tape over tinned copper drain wire 0.5 mm² / 7 x 0.3 mm				
Inner sheath		—			LSZH, black	
Armouring		—			Galvanized steel wire armouring; wire Ø depending on cable-Ø under armouring, at least 0.9 mm	
Outer sheath		LSZH				
Color		according to color code [1] or blue for intrinsically safe systems				
Marking		LEONI KERPEN ICON EXTENSION OR COMPENSATING CABLE EN 50288-7 RATED VOLTAGE LSZH CE PRODUCTION LOT CODE LENGTH MARKING				

[1] *Color code of cabling elements see page 55.*

ICON® Extension & Compensating Cable according to EN 50288-7

Zero halogen, flame-retardant types

Single & Multi pair, individual and/or overall screen, PVC-sheath

- unarmoured
- armoured

300 V

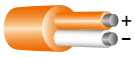
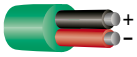
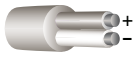
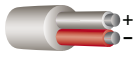
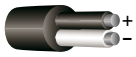
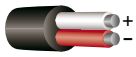
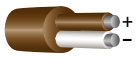
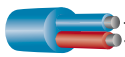
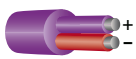
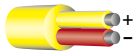
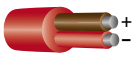
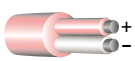
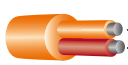
Electrical Data at 20 °C								
Conductor sizes	nom.	mm²	0.5	0.75	1.0	1.3	1.5	
Conductor resistance	max.	Ω/km	see table 2 on page 56					
Insulation resistance								
PE / XLPE-insulation	min.	MΩxkm	5000					
L/R Ratio	max.	µH/Ω	25			40		
Inductance	max.	mH/km	see table 2 on page 56					
Mutual capacitance								
PE / XLPE-insulation								
Pair [1) 2)]	max.	nF/km	75			85		
PiMF	max.	nF/km	115			115		
Test voltage								
Core/core (U_{rms}) Core/screen (U_{rms})		V	1500 1500					
Operating voltage (U_{rms})	max.	V	300					

[1)] *Values for cables with 1 element correspond to those for PiMF.*
[2)] *Values for cables with 2 up to 4 elements +20 %.*

General

Standards for thermocouple extension & compensating cables

Table 1: Temperature ranges and tolerances of conductors. Color codes of insulations and outer sheaths.

Type	Thermocouple material	IEC 60584 [1) 2)]		ASTM E 230 [1)]	
R	+ Platinum–13 % Rhodium – Platinum	RCA/SCA 0 °C up to +100 °C	Copper/Copper-Nickel (Class 1:----------) (Class 2: ±30 µV/ ±2.5 °C)	RX -200 °C	Copper/Copper-Nickel (±5 °C)
		RCB/SCB 0 °C up to +200 °C	Copper/Copper-Nickel (Class 1:----------) (Class 2: ±60 µV/ ±5 °C)	SX 0 °C up to +200 °C	Copper/Copper-Nickel (±5 °C)
S	+ Platinum–10 % Rhodium – Platinum		Cu CuNi		Cu CuNi
B	+ Platinum–30 % Rhodium – Platinum–6 % Rhodium	BC 0 °C up to +100 °C	Copper/Copper (± 40 µV/ ± 3.5 °C)	BX 0 °C up to +100 °C	Copper-alloy/Copper (+0.0 µV/+0 °C) (–33 µV/–3.7 °C)
			Cu Cu		Cu-alloy (Cu) Cu (Cu)
J	+ Iron – Copper–Nickel	JX –25 °C up to +200 °C	Iron/Copper-Nickel (Class 1: ±85 µV/ ±1.5 °C) (Class 2: ±140 µV/ ±2.5°C)	JX 0 °C up to +200 °C	Iron/Copper-Nickel (special: ±1.1 °C) (standard: ±2.2 °C)
			Fe CuNi		Fe CuN
T	+ Copper – Copper–Nickel	TX –25 °C up to + 100 °C	Copper/Copper-Nickel (Class 1: ±30 µV/ ±0.5 °C) (Class 2: ±60 µV/ ±1.0 °C)	TX 0 °C up to +100 °C	Copper/Copper-Nickel (special: ±0.5 °C) (standard: ±1.0 °C)
			Cu CuNi		Cu CuNi
E	+ Nickel–Chromium – Copper–Nickel	EX –25 °C up to + 200 °C	Nickel-Chromium/Copper-Nickel (Class 1: ±120 µV/ ±1.5 °C) (Class 2: ±200 µV/ ±2.5°C)	EX 0 °C up to +200 °C	Nickel-Chromium/Copper-Nickel (special: ±1.1 °C) (standard: ±1.7 °C)
			NiCr CuNi		NiCr CuNi
K	+ Nickel–Chromium – Nickel–Aluminum	KX –25 °C up to +200 °C	Nickel-Chromium/Nickel-Aluminium (Class 1: ± 60 µV/ ±1.5 °C) (Class 2: ±100 µV/ ±2.5 °C)	KX 0 °C up to +200 °C	Nickel-Chromium/ Nickel-Aluminium (special: ±1.1 °C) (standard: ±2.2 °C)
		KCB 0 °C up to +100 °C	Copper/Copper-Nickel (Class 1:----------) (Class 2: ±100µV/ ±2.5 °C)		NiCr NiAl
		KCA 0 °C up to +150 °C	Iron/Copper-Nickel (Class 1:----------) (Class 2: ±100µV/ ±2.5 °C)	VX ISA RP 1.1 0 °C up to +100 °C	Copper/Copper-Nickel (±2.2 °C)
			KX NiCr NiAl KCB Cu CuNi KCA Fe CuNi		Cu CuNi
N	+ Nickel–Chromium–Silicon – Nickel–Silicon	NX –25 °C up to +200 °C	Nickel-Chromium-Silicon/ Nickel-Silicon (Class 1: ± 60 µV/ ±1.5 °C) (Class 2: ± 100 µV/ ±2.5 °C)	NX 0 °C up to +200 °C	Nickel-Chromium-Silicon/ Nickel-Silicon (special: ±1.1 °C) (standard: ±2.2 °C)
		NC 0 °C up to +150 °C	Copper/Copper-Nickel (Class 1:----------) (Class 2: ±100 µV/ ±2.5 °C)		
			NX NiCrSi NiSi NC Cu CuNi		NiCrSi NiSi

1) *In all standards the basic EMF values of the same thermocouple type are identical*
2) *Following standards are corresponding with the IEC-Standard 60584 DIN 43722 and JIS C 1610 section 1*

Temperature ranges and tolerances to IEC 60584. Part 3, November 2007. Color coding for conductors and outer sheaths to IEC 60584. Part 3, November 2007.
Besides the identification letter of the thermocouple type, extension cables are identified by "X" compensating cables by "C"
The color coding of BC, NX and NC is according to DIN 43722.

The identification system of ASTM does not differ between extension and compensating cables; all materials are marked "X".
For BX the temperature range and tolerance have to be agreed upon between end-user and manufacturer.
ISA RP 1.1 is withdrawn; VX material is still available.

Standards for thermocouple extension & compensating cables

Table 2: Electrical characteristics of conductors (approx. values)

Standard	Code		Volume resistivity	Ω x mm / m	Loop inductance mH/km
	(+) leg	(–) leg	(+) leg	(–) leg	
IEC	RPCA/SPCA	RNCA/SNCA	0.017	0.12	1
IEC	RPCB/SPCB	RNCA/SNCA	0.017	0.12	1
ANSI	SPX	SNX	0.017	0.12	1
IEC	BPC	BNC	0.017	0.017	1
ANSI	BPX	BNX	0.125	0.017	1
IEC	JPX	JNX	0.12	0.49	8
ANSI	JPX	JNX	0.12	0.49	8
IEC	TPC	TNC	0.017	0.49	1
ANSI	TPX	TNX	0.017	0.49	1
IEC	EPX	ENX	0.72	0.49	3
ANSI	EPX	ENX	0.72	0.49	3
IEC	KPX	KNX	0.72	0.27	3
IEC	KPCB	KNCB	0.017	0.49	1
IEC	KPCA	KNCA	0.12	0.51	8
ANSI	KPX	KNX	0.72	0.27	3
ISA	VPX	VNX	0.017	0.49	1
IEC	NPX	NNX	0.98	0.34	3
IEC	NPC	NNC	0.017	0.52	1
ANSI	NPX	NNX	0.98	0.34	3

Table 3: Loop resistance at 20 °C (nominal value in Ω/km)

Thermo-couple	Conductor material		Conductor size				
	IEC 60584	**ANSI MC 96.1**	0.5 mm²	0.8 mm²	1.0 mm²	1.3 mm²	1.5 mm²
	solid		0.8 mm Ø	1.02 mm Ø	1.13 mm Ø	1.29 mm Ø	1.38 mm Ø
R/S	RC/SC	SX	282	173	141	109	94
B	…	BX	293	179	148	112	98
B	BC	…	70	43	35	27	23
J	JX	JX	1257	769	628	483	418
T	TX	TX	1044	639	522	402	348
E	EX	Ex	2493	155	1246	958	831
K	KX	KX	2039	1248	1020	785	680
K	KCB	VX*	1044	639	522	402	348
K	KCA	…	1298	794	649	499	433
N	NX	…	2719	1663	1359	1046	906
N	NC	…	1106	677	553	425	369

** VX according to ISA RP 1.1*

Colour Codes (approx. values)

Color code of instrumentation and instrumentation control cables according to EN 50288-7

Color code of standardized product programme.

	Cabling element		
	Core*	**Pair****	**Triple ****
Rated voltage 300 V	—	black/white black/white/red continuously numbered on white core 1, 2, 3… for multi-element cables, starting with 1 in the center	
Rated voltage 500 V	black continuously numbered 1, 2, 3… for multi-core cables, starting with 1 in the center	black/blue black/blue/red continuously numbered on blue core 1, 2, 3… for multi-element cables, starting with 1 in the center	

* *If specified green-yellow core principally applied as last element in the outer layer.*

** *Identification scheme for elements with and without individual screen.*

Further color codes on request.

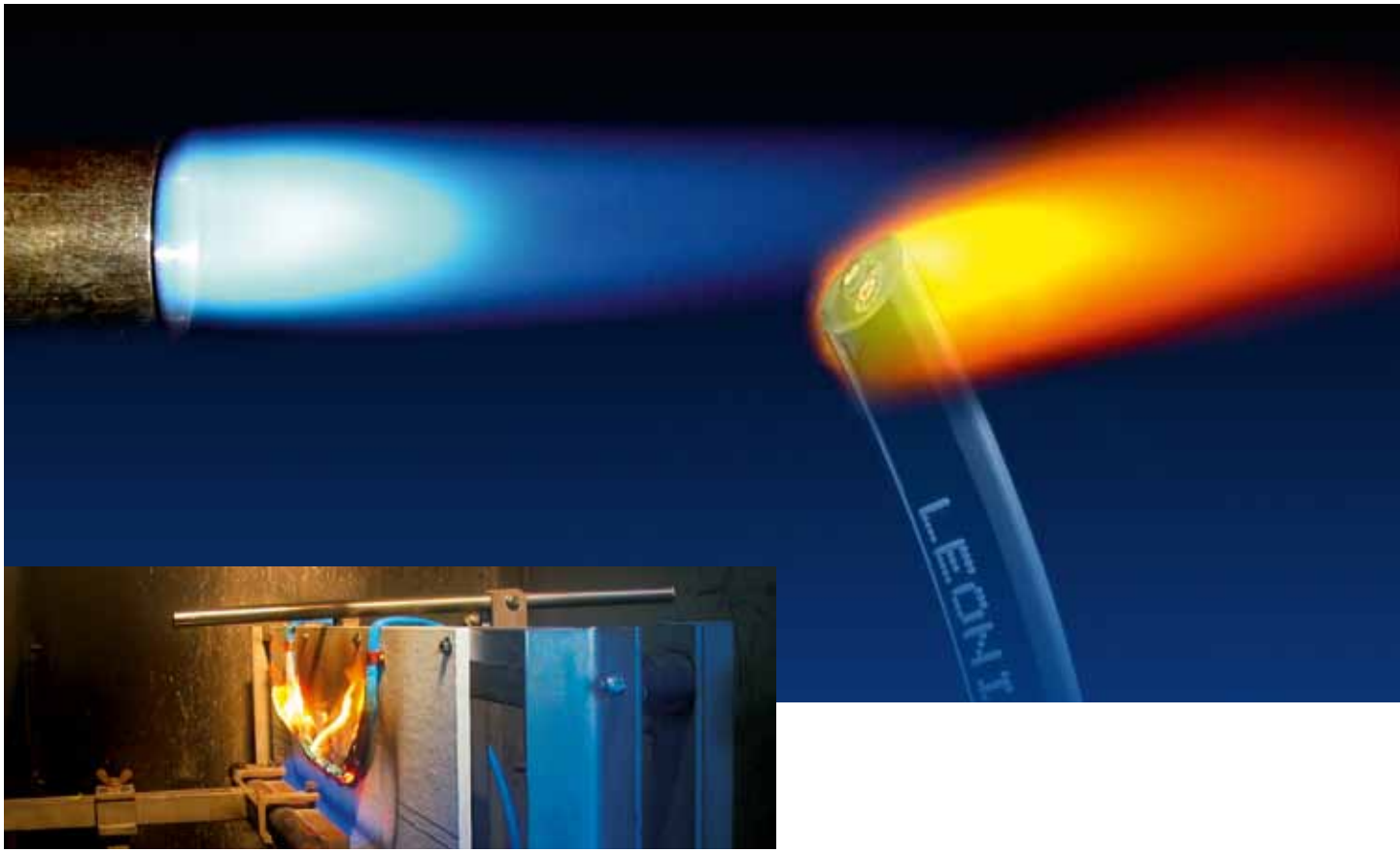
Cables under fire conditions (Common test methods)

**Reaction to Fire –
IEC and corresponding European Standards**

IEC Standard		CENELEC Standard	
No.	Title	No.	Title
IEC 60332	**Test on electric and optical cables under fire conditions**	**EN 60332**	**Test on electrical and optical cables under fire conditions. Test for vertical flame propagation for a single insulated wire or cable**
IEC 60332**-1-1**	Test on a single vertical insulated wire or cable – Apparatus	EN 60332**-1-1**	- Apparatus
IEC 60332**-1-2**	– Procedure	EN 60332**-1-2**	- Procedure for 1 kV pre-mixed flame
IEC 60332**-1-3**	– Procedure for determination of flaming droplets / particles	EN 60332**-1-3**	- Procedure for determination of flaming droplets / particles
IEC 60332	**Tests on electric cables under fire conditions**	**EN 60332**	**Test for vertical flame propagation for a single small insulated wire or cable**
IEC 60332**-2-1**	Test on a single vertical insulated wire or cable – Apparatus	EN 60332**-2-1**	- Apparatus
IEC 60332**-2-2**	Test on a single vertical insulated wire or cable – Procedure	EN 60332**-2-2**	- Procedure for diffusion flame
IEC 60332	**Tests on bunched wires or cables**	**EN 50266**	**Test for vertical flame spread of vertically mounted bunched wires o. cables**
IEC 60332**-3**			
IEC 60332**-10**	Apparatus	EN 50266**-1**	Apparatus
IEC 60332**-21**	Procedures Category A F/R	EN 50266**-2-1**	Procedures – Category A F/R
IEC 60332**-22**	Procedures Category A	EN 50266**-2-2**	Procedures – Category A
IEC 60332**-23**	Procedures Category B	EN 50266**-2-3**	Procedures – Category B
IEC 60332**-24**	Procedures Category C	EN 50266**-2-4**	Procedures – Category C
IEC 60332**-25**	Procedures – small cables –	EN 50266**-2-5**	Procedures – small cables –
IEC 60754	**Tests on gases evolved during combustion of materials from cables**	**EN 50267**	**Tests on gases evolved during combustion of materials from cables**
IEC 60754**-1**	Determination of amount of halogen acid gas	EN 50267**-1**	Apparatus
IEC 60754**-2**	Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity	EN 50267**-2-1**	Procedures – Determination of the amount of halogen acid gas
		EN 50267**-2-2**	Procedures – Determination of degree of acidity of gases for materials by measuring pH and conductivity
		EN 50267**-2.3**	Procedures – Determination of degree of acidity of gases for cables by determination of the weighted average of pH and conductivity
IEC 61034	**Measurement of smoke density of cables burning under defined conditions**	**EN 61034**	**Measurement of smoke density of cables burning under defined conditions**
IEC 61034**-1**	Test apparatus	EN 61034**-1**	Apparatus
IEC 61034**-2**	Test procedure and requirements	EN 61034**-2**	Test procedure and requirements

Fire resistance (IEC 60 331)

IEC Standard		CENELEC Standard	
No.	Title	No.	Title
IEC 60331	**Tests for electric cables under fire conditions – Circuit Integrity**		
IEC 60331**-11**	Apparatus – Fire alone at temperature of at least 750 °C		
IEC 60331**-21**	Procedures and requirements – Cables of rated voltage up to and including 0,6/1 kV	**under consideration**	**under consideration**
IEC 60331**-22**	Procedures and requirements – Cables of rated voltage greater than 1 kV (under consideration)		
IEC 60331**-23**	Proc. and requirements – Electric data cables		
IEC 60331**-25**	Proc. and requirements – Optical fiber cables		



Type designation (for instrumentation and thermocouple cables)

The type designations of LEONI's instrumentation- and thermocouple cables are read as follows:

- type abbreviation
- number of cabling elements
- type of cabling element
- conductor size in mm² (stranded conductors) or conductor diameter in mm (solid conductors)

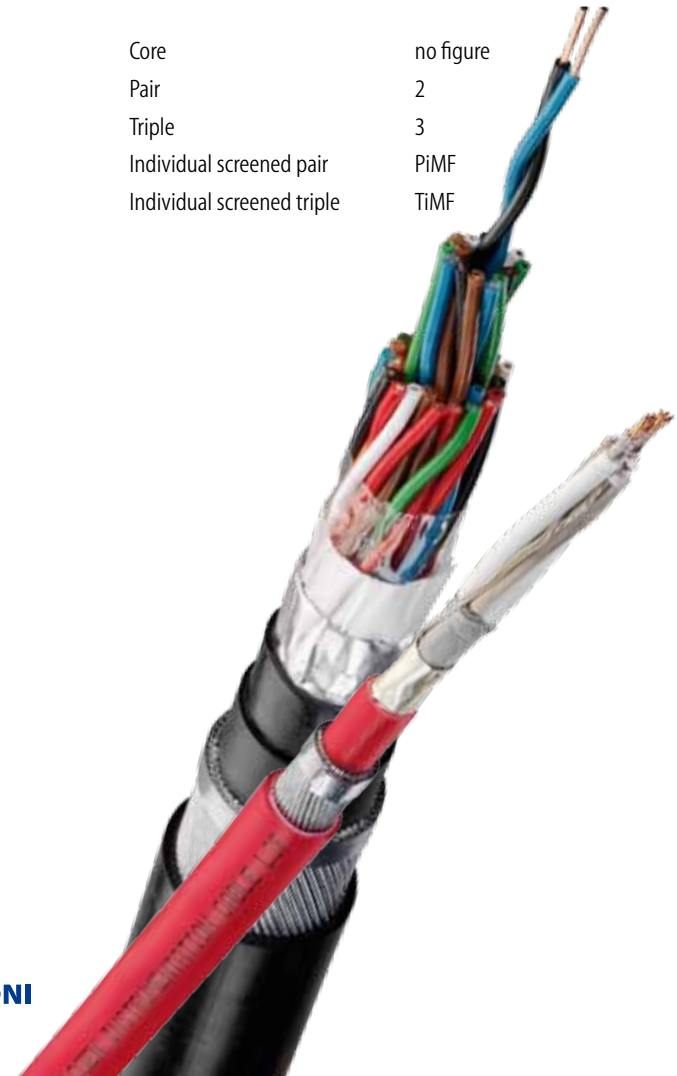
followed by (when applicable):

- type of conductor material (for thermocouple cable only, see table 1 on page 56
- abbreviation for cables with circuit integrity properties
- Individual screening of pairs and triples
- rated voltage
- standard

Type of Cabling Elements

The type of cabling elements are indicated by figures responsible by figures with an additional information for individual screened cabling elements

Core	no figure
Pair	2
Triple	3
Individual screened pair	PiMF
Individual screened triple	TiMF



Examples

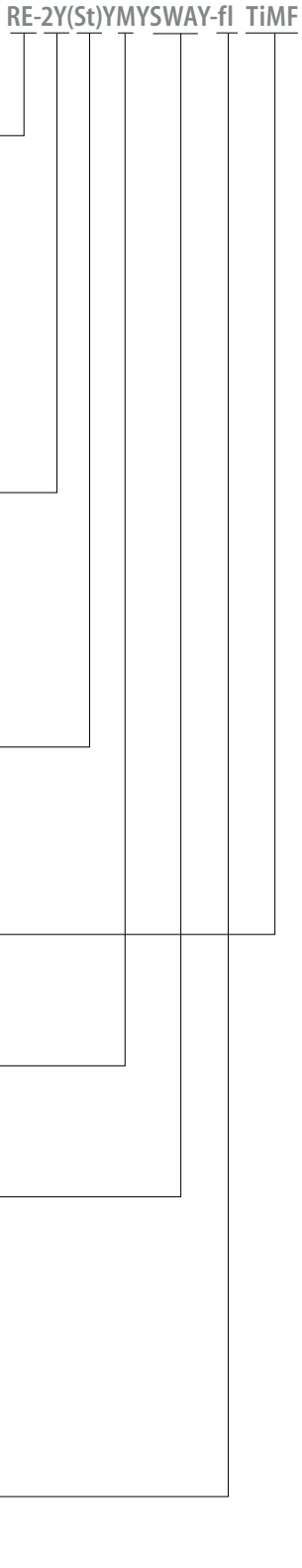
RE-2Y(St)YMYSWAY-fl 24 x 3 x 1.3 mm² TiMF 300 V EN 50288-7
Instrumentation cable (**RE**), 24 triples (**3**), conductor size **1.3 mm²**, insulation of PE (**2Y**), individual **TiMF** and overall screen **(St)**, inner sheath of PVC (**Y**), lead sheath (**M**), inner sheath made of PVC (**Y**), steel wire armour (**SWA**), outer sheath of PVC (**Y-fl**), rated voltage **300 V**, standard **EN 50288-7**

RT-Yw(St)YwSWAYw-fl 8 x 2 x 0.8 mm KX 300 V EN 50288-7
Thermocouple extension (**RT-**), 8 pairs (**2**), conductor diameter **0,8 mm**, conductor material (**KX**), insulation of heat resistant PVC (**Yw**), overall screen (**St**), inner sheath made of heat resistant PVC (**Yw**), steel wire armour (**SWA**), outer sheath made of heat resistant PVC (**Yw**), rated voltage **300 V**, standard **EN 50288-7**

RE-2X(St)H 8 x 2.5 mm² CI 500 V EN 50288-7
Instrumentation control cable (**RE-**), Zero halogen with Circuit Integrity (**CI**), **8** cores, conductor size **2.5 mm²**, insulation of XLPE (**2X**), overall screen (**St**), outer sheath made of Zero halogen, flame-retardant compound (**H**), rated voltage **500 V**, standard **EN 50288-7**

RE-2X(L)2Y4YSWA2Y 12 x 2 x 1.5 mm² PiMF 300 V EN 50288-7
Instrumentation cable (**RE**), **12** pairs **2**, conductor size **1.5 mm²**, insulation made of XLPE (**2X**), individual screen (**PiMF**), multi layer sheath (**L**)(**2Y**), steel wire armour (**SWA**), outer sheath made of PE (**2Y**), rated voltage **300 V**, standard **EN 50288-7**

Abbreviation code



Cable type	Code
Instrumentation and instrumentation control cable	RE-
Thermocouple extension or compensating cable	RT-
Metal cladding of conductor	
Copper conductor, tinned	-v
Insulation and/or sheath materials	
Insulation, inner or outer sheath of polyvinylchloride (PVC)	Y
Insulation, inner or outer sheath made of heat resistant polyvinylchloride (PVCw)	Yw
Outer sheath made of polyvinylchloride of increased thickness	Yv
Insulation, inner or outer sheath made of polyethylene (PE)	2Y
Insulation made of cross linked polyethylene (XLPE)	2X
Inner or outer sheath made of Zero halogen, flame-retardant compound (LSZH)	H
Insulation made of silicone (Sil)	2G
Covering made of polyamide (nylon)	4Y
Screening	
Static screen made of laminated plastic tape laminated with aluminum	(ST)
Longitudinally applied aluminum foil, one or both sides plastic-coated	(L)
Braid made of tinned or untinned copper wires over the cable core	C
Wrapping made of copper foil	K
Pair in Metal Foil	PiMF
Triple in Metal Foil	TiMF
Braid of tinned or untinned copper wires over a single cabling element	(C)
Metal sheath	
Sheath made of lead	M
Sheath made of lead alloy	Mz
Armour	
Galvanized round steel wires	SWA
Galvanized round steel wires with counter helix made of galvanized steel tape	RG
Galvanized flat steel wires with counter helix made of galvanized steel tape	FG
Double layer made of galvanized steel tapes	B
Braid made of galvanized round steel wires	Q
Further properties	
Circuit Integrity (resistance to fire)	CI
Increased flame retardancy; meeds requirements for IEC 60332-3-24 (cat. C) fulfilled *	-fl
Cable core filled with petrojelly	F

* *This property is indicated on the outer sheath of PVC-sheathed cables via the marking RP*

Conductors – AWG and metric values by comparison

Solid plain annealed copper conductors

Conductor size				Electrical resistance[2]			
AWG	Metric	No. of wires	Conductor-Ø	EN 50288-7[3]		UL 13[4]	
	mm²		mm	Ω/km	Ω/1000 ft.	Ω/km	Ω/1000 ft.
30	0.051	1	0.254	–	–	361	110
28	0.081	1	0.320	–	–	228	69.3
26	0.128	1	0.404	–	–	154	46.9
24	0.205	1	0.511	–	–	97.6	29.7
22	0.324	1	0.643	–	–	56.3	17.2
–	0.5 [1]	1	0.8	36.8	11.2	–	–
20	0.517	1	0.813	–	–	35.2	10.7
–	0.75 [1]	1	1.0	25.0	7.6	–	–
18	0.82	1	1.02	–	–	22.3	6.8
–	1.0 [1]	1	1.13	18.5	5.6	–	–
16	1.3	1	1.29	–	–	14.0	4.3
–	1.5 [1]	1	1.37	12.3	3.76	–	–
14	2.1	1	1.63	–	–	8.79	2.67
–	2.5	1	1.76	7.56	2.31	–	–
12	3.3	1	2.05	–	–	5.52	1.68
–	4.0 [1]	1	2.26	4.70	1.43	–	–

Stranded plain annealed copper conductors

Conductor size				Electrical resistance[2]			
AWG	Metric	No. of wires	Conductor-Ø	EN 50288-7[3]		UL 13[4]	
	mm²		mm	Ω/km	Ω/1000 ft.	Ω/km	Ω/1000 ft.
24	0.205	7	0.579	–	–	91.1	27.8
22	0.327	7	0.729	–	–	57.6	17.6
–	0.5	7	0.9	36.8	11.2	–	—
20	0.517	7	0.919	–	–	35.8	11.0
–	0.75 [1]	7	1.11	25.0	7.6	–	—
18	0.82	7	1.16	–	–	22.8	6.9
–	1.0 [1]	7	1.29	18.5	5.6	–	—
16	1.3	7	1.46	–	–	14.2	4.36
–	1.5 [1]	7	1.59	12.3	3.76	–	—
14	2.1	7	1.85	–	–	8.94	2.72
–	2.5 [1]	7	2.01	7.56	2.31	–	—
12	3.3	7	2.32	–	–	5.63	1.72
–	4.0 [1]	7	2.58	4.70	1.43	–	–

[1] *Sizes according to EN 50288-7.*

[2] *The value for the electrical resistance is given for 20 °C (68.0 °F).*

[3] *The value for the electrical resistance according to EN 50288-7 is for the finished cables with multi pairs/triples.*

[4] *The value for the electrical resistance according to UL 13 is calculated for "one pair/triple and an assembly of pairs/triples".*

General units

Length				
1	mil	=	0.0254	mm
1	inch (in“)	=	25.4	mm
1	foot (ft.‘)	=	0.305	m
1	yard (yd)	=	0.914	m
1	mile (mi.)	=	1.61	km
1	statute mile (mi.)	=	1.61	km
1	intern. naut. mile (sm)	=	1.852	km

Area				
1	circ. mil (CM)	=	0.0005067	mm^2
1	MCM	=	0.5067	mm^2
1	square inch (in^2)	=	645.16	mm^2
1	square foot (ft^2)	=	0.0929	m^2
1	square yard (yd^2)	=	0.836	m^2
1	square mile (sq.mi.)	=	2.59	km^2

Volume				
1	cubic inch (m^3)	=	16.39	cm^3
1	cubic foot (ft^3)	=	0.0283	m^3
1	cubic yard (yd^3)	=	0.765	m^3
1	barrel	=	159	l
1	US gallon (US gal)	=	3.79	l
1	UK gallon (UK gal)	=	4.55	l

Electrical Unit per Length				
1	µ f per mile	=	0.62	µ F/km
1	MΩ per mile	=	1.61	MΩ x km
1	decibel per mile	=	0.62	dB/km
1	pf per foot	=	3.28	pF/m
1	decibel per 1000 ft.	=	3.28	dB/km
1	Ω per 1000 ft.	=	3.28	Ω/km

Force				
1	poundal (pdl)	=	0.1 38	N
1	pound-force (lbf)	=	4.448	N
1	Brit. ton-force	=	9964	N

Mass				
1	ounce (oz)	=	0.0284	kg
1	pound (lb)	=	0.454	kg
1	Brit. ton (long ton)	=	1016	kg
1	US ton (short ton)	=	907	kg

Power				
1	horsepower (H.P.)	=	0.746	kW

Energy				
1	Brit. therm. unit (B U)	=	1055	J
1	Brit. therm. unit	=	0.000293	kWh

Pressure						
1	bf/in^2 (psi)	=	0.06895	bar	=	6.895 N/m^2
1	lbf/ft^2	=	0.000479	bar	=	47.9 N/m^2
1	lbf/yd^2	=	0.0000532	bar	=	5.32 N/m^2
1	lbf/in^2 (psi)	=	0.703	kp/cm^2	=	0.0703 at

Abbreviations for multiples and submultiples

prefix	abridged	multiple		prefix	abridged	sub multiple	
	mark	power	name		mark	power	**name**
Tera	T	10^{12}	billion *	Piko	p	10^{12}	billionth *
Giga	G	10^9	milliard *	Nano	n	10^9	milliardth *
Mega	M	10^6	million	Mikro	µ	10^6	millionth
Kilo	k	10^3	thousand	Milli	m	10^3	thousanth
Hekto	h	10^2	hundred	Zenti	c	10^2	hundredth
Deka	da	10^1	ten	Dezi	d	10^1	tenth

**In USA 109 indicates a billion and 1012 indicates a trillion*

Data sheets – examples

LEONI

ICON Instrumentation Cable — EN 50288-7

Flame Retardant, Sunlight Resistant — 70 °C / 500 V

Multi-Triple, PE-Insulation, Individual & Collective Screen, Armour, PVC Sheath

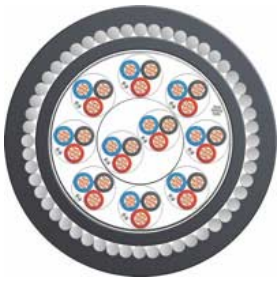
RE-2Y(St)YSWAY-fl TiMF

Application

For transmission of analogue and digital signals in instrument and control systems; allowed for use in zone 1 and zone 2 group II classified areas (IEC 60079-14); not allowed for direct connection to low impedance source, e.g. the public mains electricity supply.
Recommended for indoor and outdoor installation, on racks, trays, in conduits, in dry and wet locations; for direct burial.

Construction

Conductor	plain annealed copper wire, 7 stranded, size 0.5 mm^2, 0.75 mm^2, 1 mm^2, 1.3 mm^2, 1.5 mm^2
Insulation	polyethylene PE
Colour code	black / blue / red, continuously numbered on blue core (1, 2..) for multitriples
Individual screen	24 µm aluminium PETP tape over solid tinned copper drain wire, 0.6 mm Ø, plastic tape under and above screen
Wrapping	at least 1 layer of plastic tape
Collective screen	24 µm aluminium PETP tape over 7-stranded tinned copper drain wire, 0.5 mm^2
Inner sheath	polyvinylchloride PVC, black
Armour	galvanised round steel wires
Outer sheath	polyvinylchloride PVC, black; blue for intrinsically safe systems
Cable marking	LEONI KERPEN ICON INSTRUMENTATION CABLE 500 V RP EN 50288-7 CE PLC LM



Technical data

Flame propagation	
Test on single cable	IEC 60332-1-2
Test on bunched cables	IEC 60332-3-24 (Cat. C)
Sunlight resistance	UL 1581 section 1200
Oil resistance	ICEA S-73-532

Temperature range:
-30 °C up to +70 °C (during operation)
-5 °C up to +50 °C (during installation)

Min. bending radius:
10 x cable-Ø

Abbreviations

RE-	Instrumentation Cable
2Y	insulation of PE
(St)	collective screen
Y	inner sheath of PVC
SWA	steel wire armour
Y	outer sheath of PVC
-fl	reduced flame propagation
TiMF	triple in metal foil
PLC	Production Lot Code
LM	LENGTH MARKING

Electrical data at 20 °C

Conductor	nom.	mm^2	0.5	0.75	1	1.3	1.5
Conductor resistance	max.	Ω/km	36.7	25.0	18.5	14.2	12.3
Insulation resistance	min.	MΩ x km			5000		
Mutual capacitance	max.	nF/km			100		
Inductance	max.	mH/km			1		
L/R (ratio)	max.	µH/Ω	25	25	25	40	40
Test voltage U_{rms} (core : core)		V			2000		
Test voltage U_{rms} (core : screen)		V			2000		
Operating voltage		V			500		

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LEONI

ICON Instrumentation Cable — EN 50288-7

Flame Retardant, Sunlight Resistant — 70 °C / 500 V

Multi-Triple, PE-Insulation, Individual & Collective Screen, Armour, PVC Sheath

RE-2Y(St)YSWAY-fl TiMF

Geometrical data

No. of elem.	RT of insul. nom. (mm)	RT of inner sheath nom. (mm)	Ø over inner sheath (mm)	Ø of armour wire nom. (mm)	RT of outer sheath nom. (mm)	Overall diameter (mm)	Cable weight approx. (kg/km)	Part. No. Colour black
0.5 mm²/7								
2	0.55	1.0	11.2	0.90	1.4	15.8	419	7093F481
4	0.55	1.1	13.1	0.90	1.5	17.9	510	7093F484
5	0.55	1.1	14.5	0.90	1.5	19.3	605	7093F487
6	0.55	1.2	16.6	0.90	1.5	21.4	828	7093F490
8	0.55	1.2	17.7	1.25	1.6	23.4	927	7093F493
10	0.55	1.3	20.2	1.25	1.7	26.1	1080	7093F496
12	0.55	1.4	21.1	1.25	1.7	27.0	1170	7093F499
16	0.55	1.4	23.9	1.25	1.8	30.0	1400	7093F502
20	0.55	1.5	26.5	1.25	1.8	32.6	1813	7093F505
24	0.55	1.6	29.0	1.60	1.9	36.0	2074	7093F508
0.75 mm²/7								
2	0.55	1.1	12.1	0.90	1.5	16.9	457	7093F511
4	0.55	1.1	14.0	0.90	1.5	18.8	589	7093F514
5	0.55	1.2	15.6	0.90	1.5	20.4	784	7093F517
6	0.55	1.2	17.6	1.25	1.6	23.3	920	7093F520
8	0.55	1.3	19.1	1.25	1.7	25.0	1054	7093F523
10	0.55	1.4	21.8	1.25	1.7	27.7	1240	7093F526
12	0.55	1.4	22.5	1.25	1.8	28.6	1327	7093F529
16	0.55	1.5	25.7	1.25	1.8	31.8	1805	7093F532
20	0.55	1.6	28.6	1.60	1.9	35.6	2085	7093F535
24	0.55	1.7	31.1	1.60	2.0	38.3	2384	7093F538
1 mm²/7								
2	0.55	1.1	12.8	0.90	1.5	17.6	495	7093F541
4	0.55	1.1	14.8	0.90	1.5	19.6	642	7093F544
5	0.55	1.2	16.6	0.90	1.6	21.6	878	7093F547
6	0.55	1.2	18.7	1.25	1.6	24.4	1022	7093F550
8	0.55	1.3	20.3	1.25	1.7	26.2	1169	7093F553
10	0.55	1.4	23.1	1.25	1.8	29.2	1377	7093F556
12	0.55	1.5	24.1	1.25	1.8	30.2	1482	7093F559
16	0.55	1.5	27.3	1.25	1.8	33.4	2045	7093F562
20	0.55	1.7	30.6	1.60	2.0	37.8	2378	7093F565
24	0.55	1.8	33.3	1.60	2.0	40.5	2709	7093F568

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