


 insertec Furnaces & Refractories	AUTOMATION AND CONTROL DEPARTMENT		 AL INVEST Bridioni, a.s.
	Technical Specification for I&C Cables		


CUSTOMER:	ALINVEST	PREPARED:	INGA
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2. GENERAL DESCRIPTION AND SCOPE

This specification covers the minimum requirement for design, manufacturing, testing, and packing of Instrumentation and Control cables to be provided for Implementation of ALINVEST project.

The proposal submitted should be completely in accordance with the Specification requirements. Alternatives proposed by the Supplier will receive careful consideration if they improve performance and reliability.

Compliance with the provisions of this specification shall not relieve the supplier of responsibility of furnishing equipment and accessories suitable for the specified operating conditions. The supplier shall assume unit responsibility for all equipment and all auxiliary systems included in the scope of supply.

Any deviation from this specification and from all other documents attached to the Inquiry at any stage of the bid or contract shall be clearly stated by the Vendor List and should be approved in written form for the Owner approval.


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3. CODES AND STANDARDS

The instrument cables shall be manufactured & tested in accordance with the latest edition of all relevant international codes and standards including but not limited to the following:

IEC 60502	Power cable extruded insulation for rated voltage 1 KV
IEC 60228	Conductors of insulated cables
IEC 60331	Fire resisting characteristics of electric cables
IEC 60332	Test on electric cables under fire conditions
IEC 60754	Test on gases evolved during combustion of materials from cables
IEC 60811	Common test methods for insulating and sheathing material of electrical and optical cables.
VDE	Generic german standard
DESINA	Describes the standard for the electrical, hydraulic and pneumatic installation of production systems and automated machine tools.

All Codes and Standards referred to here and elsewhere herein, shall mean the latest edition of said Code or Standard, including all amendments, annexes, etc.


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4. OPERATION AND DUTY

All equipment shall be designed and rated to meet the site condition.

5. DESIGN DATA

- Insulation and sheath shall be made of high-quality materials and have excellent resistance to chemicals, oils, heat, and aging.
- Cables shall be suitable for wet and dry industrial locations, for installation indoor and outdoor exposed to direct sunlight, on trays/ladders, racks, in concrete, conduits and direct burial.
- Outer shape of cables shall remain practically circular and if needed suitable inner covering of extruded or lapped shall be used. Lapped inner covering shall be used together with polypropylene yarn.
- No adhesion shall occur between cores and sheath.
- Insulation and outer sheath of cables shall not contain asbestos.
- All cables shall be flaming retardant as per IEC 60332.
- Permissible bending radius and pulling tensions shall be according to standards.
- Cable armour, if required, shall be single layer round galvanized steel wire with 90% nominal coverage. Armour shall be applied spirally over the bedding.
- High resistance temperature cables will be considered for high temperature zones.

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6. CABLE TRAYS AND CABLES INSTALLATION

6.1 CABLE TRAYS

Ventilated trough trays will be used for main building or external and secondary routing for production equipment.

Cable trays will be “mesh wire trus “perforated and galvanised” unless otherwise specified.

Cable trays will be aligned straight and at right angles.

Cable trays will be constructed with standard components, of the same material and assembled with zinc plated nuts (and bolts) Cable trays must under no circumstances be welded.

Cable trays will be continuous across vertical and horizontal direction and level changes. As a preference they will be constructed from prefabricated all custom subassemblies. No interruptions are permitted in cable trays on direction change.

Cable trays should not present rough edges or sharp corners which might damage cables or injure personnel.


Covers over cable trays for mechanical protection will be considered in areas where cable can be damaged.

Main cable trays must separate for:

- Power cables
- Control, instrumentation, and communication cables.

Power cables on secondary cable trays must be separated from all other cables by:

- A space between cables
- Physical separation by installation of additional angled profiles to the cable tray.

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6.2 CABLE TRAY TYPES MAIN CHARACTERISTICS

6.2.1 Wire mesh cable tray



Figure 1. Wire mesh tray.

6.2.1.1 Description

- Metal mesh tray with safety flanges for holding and carrying electrical cables.
- Cover could be used.

6.2.1.2 Advantages

- Safety flanges that prevent damage to cables or installers.
- Manageable "cut, bend and join" system that adapts easily to any installation with savings of over 30%.
- Lightweight construction for maximum ventilation and cleanliness.
- Provides strength and flexibility.
- Its design and structure make it easy to build onsite accessories.

6.2.1.3 Certifications

- This product is certified by the AENOR N mark, complying with UNE-EN 61537, Cable tray systems and cable ladder systems for cable management.
- E90 Fire Performance certificate in compliance with DIN 4102-12.
- CE mark in compliance with Low Voltage Directive 2006/95 EC.
- UL Classified Mark, Bycro finish, in compliance with the NEC (National Electric Code) of the USA.

6.2.1.4 Surface protection and resistance to corrosion

Cr^{VI}-free finish in compliance with Directive 2002/95/CE RoHS.

- **Electrogalvanized EZ:** white, according to UNE-EN 12329.
Class 4 protection in compliance with product standard UNE-EN 61537. Electrolytic zinc protection adequate for indoor installations.
- **Electrogalvanized Bycro, ZB:** yellow, in compliance with UNE-EN 12329.
Class 4 protection. Improved resistance to corrosion, especially adequate for demanding indoor installations.
- **Hot-dipped galvanizing:** in compliance with UNE-EN ISO 1461.
Class 5 protection. Appropriate for outdoor installations and aggressive environments.
- **AISI 304 and AISI 316L stainless steel:** in compliance with UNE-EN 10088 standard, with passivated Thermicron treatment.
Class 9 protection. Appropriate for outdoor installations and highly aggressive environments.

6.2.1.5 Dimensions

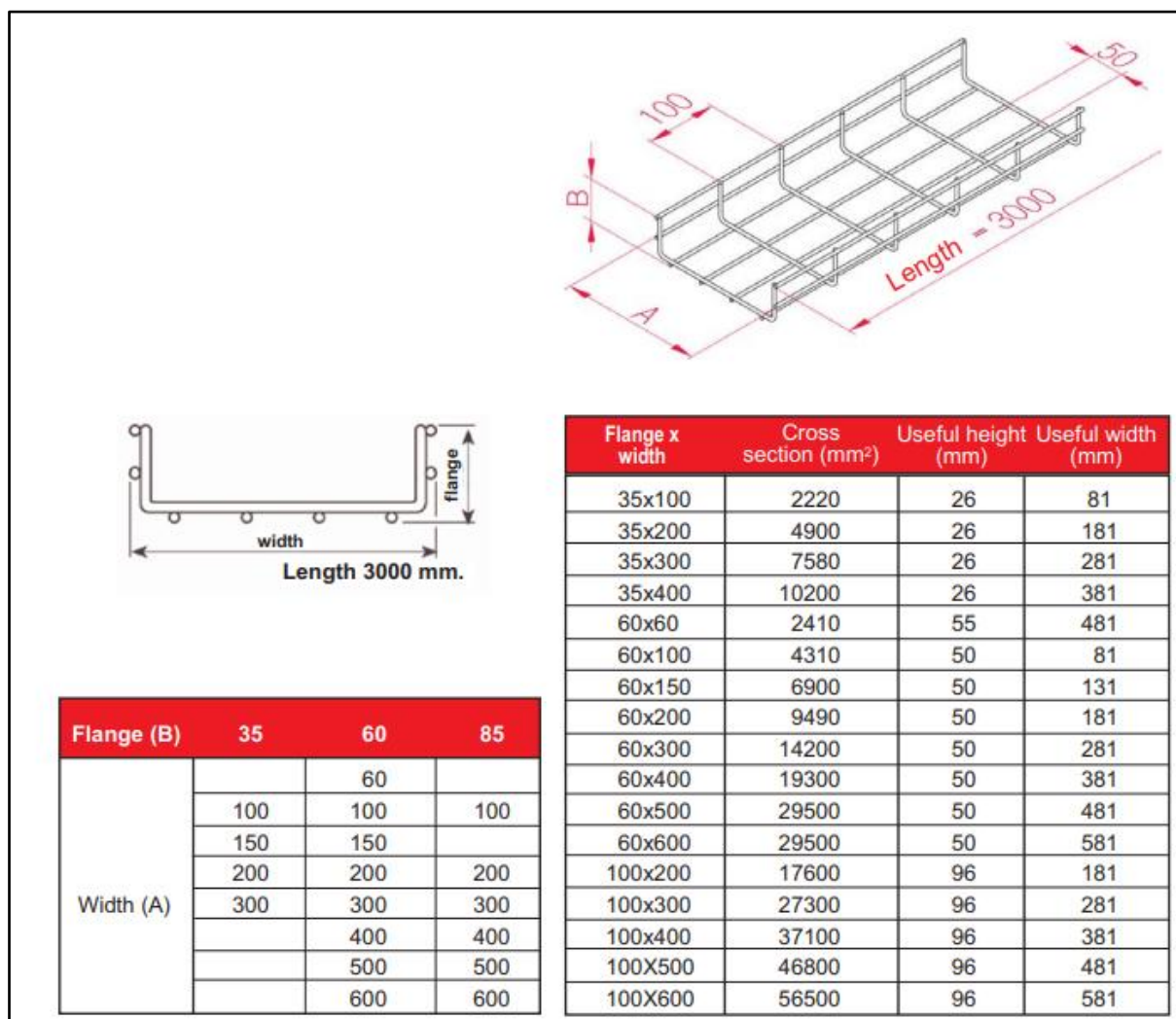



Figure 2. Wire mesh tray dimensions tables.

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6.2.1.6 Technical data

1- Impact resistance	System with impact resistance up to 20J.
2.- Electrical continuity	System provides electrical continuity, in compliance with UNE-EN 61537, which ensures equipotential connection.
3- Fire resistance	Completely free on fire-related risks, fire spreading risk or toxic or opaque smoke emission.
	Classified as non-flammable, M0 according to the Basic Building Standard NBE-CPI/96 and as A1 according to the Technical Building Code.
	Fire resistance classification E90 (90 minutes and 1000 °C) according to standard FIN 4102-12 for fire behaviour of building materials and elements. Fire resistance of electrical cable systems required to maintain circuit integrity, depending on references and installations.
4- Service temperature	-20 °C to 120 °C in compliance with the standard classification.

Table 1. Wire mesh tray technical data.

6.2.2 Ventilated trough cable tray




Figure 3. Ventilated trough tray example.

6.2.2.1 Description

- Metal tray/duct for cable management, made in cold steel plate.
- Cover always is used.

6.2.2.2 Advantages

- The click-on system for straight sections makes assembly easy and does not require accessories.
- The perforated and moulded base increases its transversal and longitudinal strength, improving load capacity. Prevents liquid build up and achieves lower weight.

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- Length in instalments of 3,05 m to allow a better load distribution and economics in labour and joints.
- The support are fixes in place with screws set in the perforations and mouldings of the base.


6.2.2.3 Certifications

- This product is certified by the AENOR mark N, complying with UNE-EN 61537, Cable Tray Systems and cable ladder systems for cable management.
- E60 Fire Resistant certificate in compliance with DIN 4102-12.
- CE mark in compliance with Low Voltage Directive 006/95 CE.
- UL certification for Solid Cable Tray Series 35, 60 85 and 100. NFPA 70, NEMA VE1 Metal Cable Tray Systems.

6.2.2.4 Surface protection and resistance to corrosion

Cr^{VI}-free finish in compliance with Directive 2002/95/CE RoHS.

- **Pre-galvanized:** with standard UNE-EN 10142.
Class 3 protection in compliance with product standard UNE-EN 61537. Zinc protection adequate for indoor installations.
- **Hot-dipped galvanized:** in compliance with UNE-EN ISO 1461.
Class 6 protection. Appropriate for outdoor installations and aggressive environments.

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6.2.2.5 Dimensions

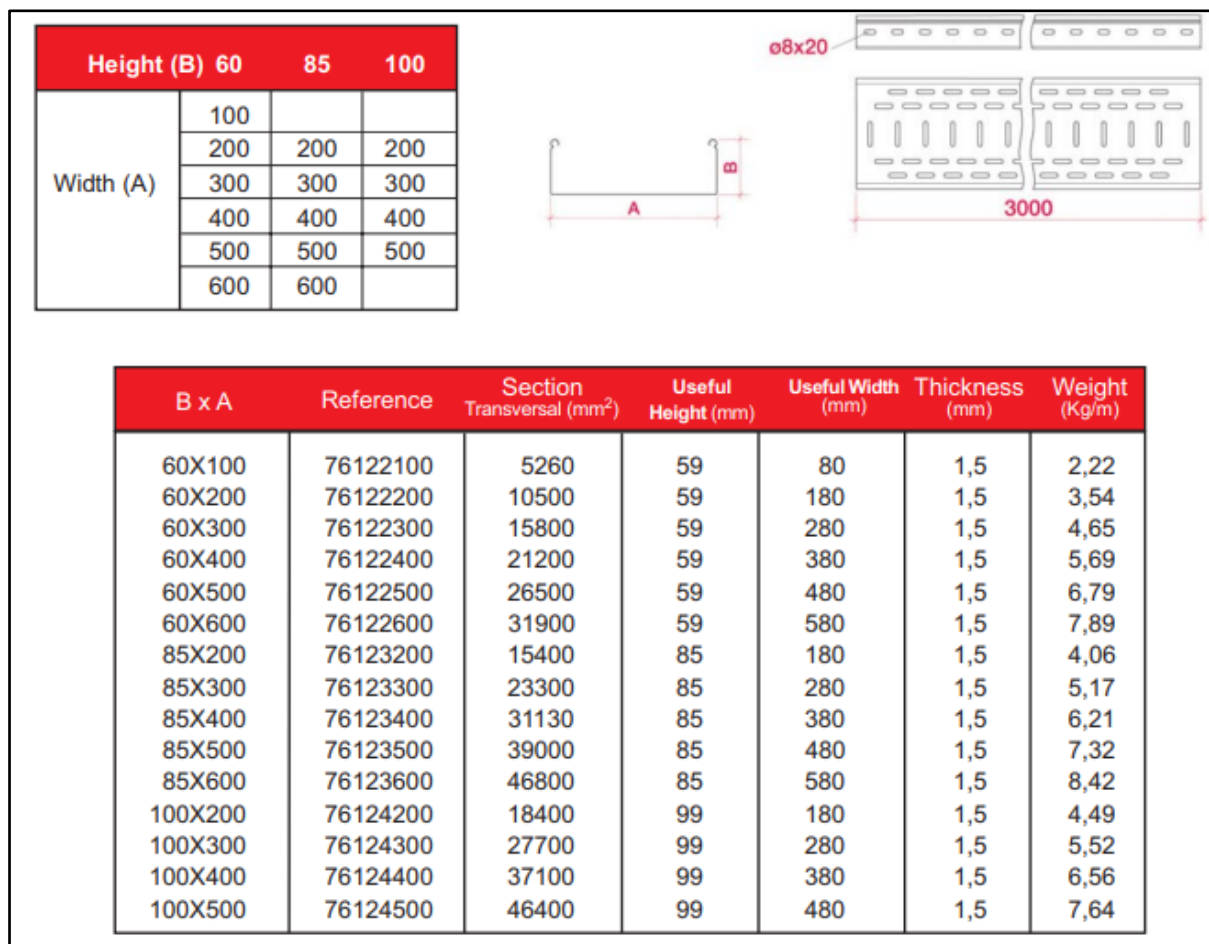


Figure 4. Ventilated trough tray dimensions tables.

6.2.2.6 Technical data

1- Impact resistance	System with impact resistance up to 20J.
2.- Electrical continuity	System provides electrical continuity, in compliance with UNE-EN 61537, which ensures equipotential connection.
3- Fire resistance	Completely free on fire-related risks, fire spreading risk or toxic or opaque emission.
	Classified as non-flammable, M0 according to the Basic Building Standard NBE-CPI/96 and as A1 according to the Technical Building Code.
	Fire resistance classification E60 (60 minutes and 950 °C), and up to E90 (90 minutes and 1000 °C) according to standard FIN 4102-12 for fire behaviour of building materials and elements. Fire resistance of electrical cable systems required to maintain circuit integrity, depending on references and installations.
4- Service temperature	-20 °C to 120 °C in compliance with the standard classification.

Table 2. Ventilated trough tray technical data.

6.3 CABLE TRAYS SUPPORTS

Cable tray supports will be constructed in:

- Prefabricated sections should have the same protection characteristics as cable trays.
- Sections constructed in situ should be of industrial quality.

The required number of supports will be calculated for a maximum linear cable load with an extra 50% security margin.

The minimum distance between two overlaid cable trays must be 300 mm.

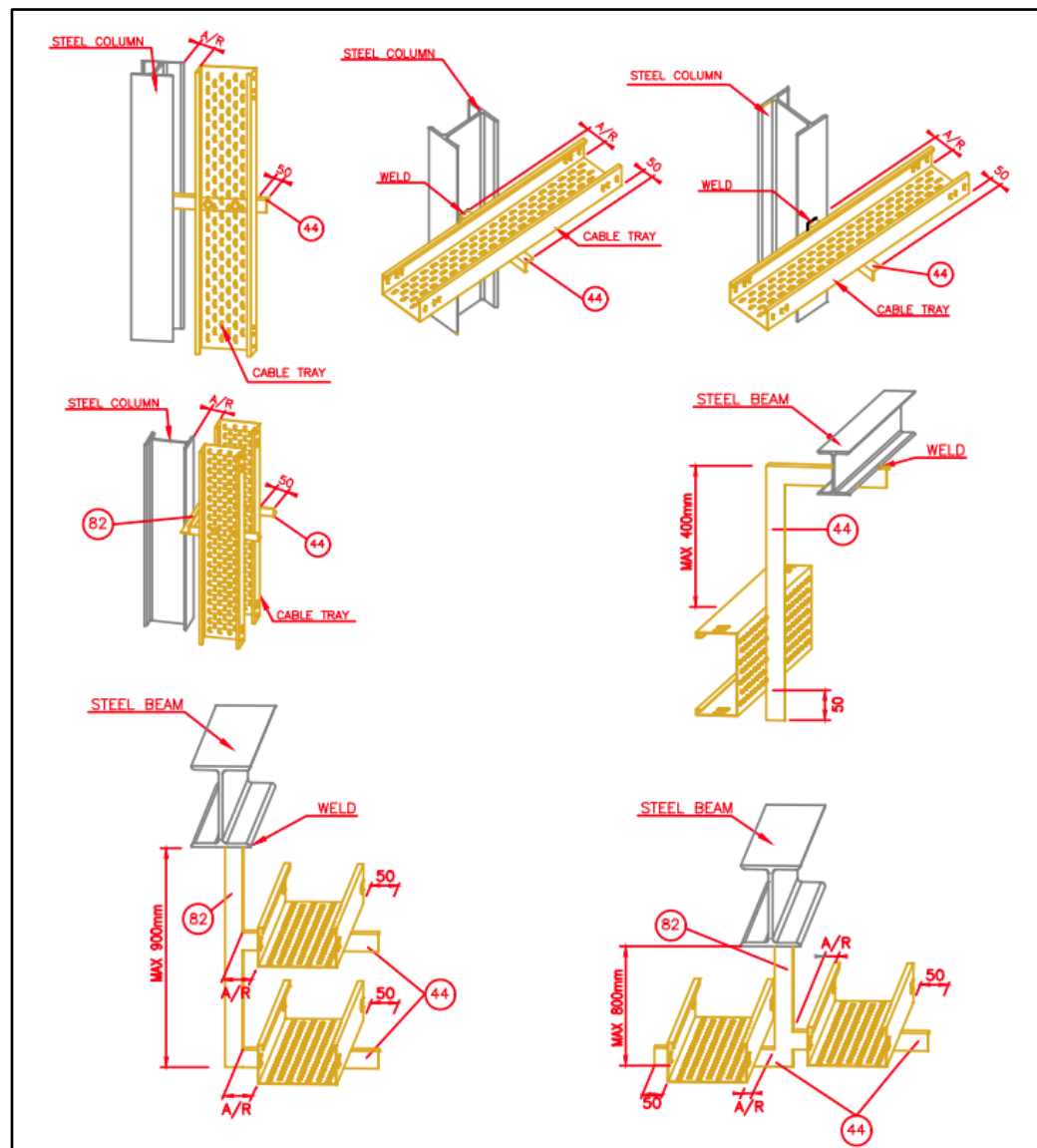



Figure 5. Cable tray installation examples.

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6.4 DIMENSIONING (LOAD DESIGN) OF CABLE TRAYS.

The dimensioning of cable trays will be based on:

- The diameter of cables laid.
- The type of cable
- The number of cables
- The acceptable level of heating permitted.
- The packing density

The packing density of cable trays will not exceed 0.7 in order to retain 30% free space for possible additions after installation and the maximum height of cables laid on cable trays will not exceed the height of the side flanges.

6.5 UNDERGROUND TUBES

Cables laid in underground tubes must adhere to the following guidelines / rules.

- No more than 30% of the available space in the tube must be filled.
- Cable feeds will exit tubes at a minimum height of 100 mm from the bottom of the tube.
- Tubes will have a curve radius of 3 times their nominal diameter with a minimum of 300 mm.
- Metal pipelines must be welded.

6.6 INSTALLATION IN TUBES


- Secondary conduits used for insulated cables must be in galvanised steel.
- Flexible tubes will be laid precisely, the ends of tubes should be burred and protected by an insulating cap.

6.7 INSTALLATION IN CABLE DUCTS

This method of installation will be used mainly for secondary routing to auxiliary automation systems and machine room control consoles.

Metallic cable ducts will be used when cables require physical protection. Cables will feed out of ducts through cable glands.

PVC ducts will only be used in dry environments where there is no risk of cables being damaged

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7. CABLE TYPES

7.1 LOW VOLTAGE POWER CABLES (CWP)

The construction of cables shall be such as the general conditions and properties of cables shall not be altered in any way, with respect to the environmental conditions. The place of cable installation, which the following specification is based on, will be via conduit banks or on cable ladder/tray in open areas, trenches, or tunnels.

For all cases no less than 2,5 mm² (≤14 AWG) will be used.

7.1.1 Regular type power cables (CWP01)



Application	For DOL/RDOL starting types, electrical panels supply, etc.
Conductor material	Copper
Isolation	XLPE
Composition	Insulated conductors laid up together.
Inner Sheath	N/A
Outer Sheath	PVC (Polyvinyl chloride)
Operating voltage	600V/1000V AC
Operating temperature	Dry ambient: -40°C, + 90°C / Wet ambient: -40°C, + 75°C
Conductor identification	To be based on the applicable normative
Shield	No
Standards	IEC 60502-1; Ref. for construction/drawing IEC 60332-1; Flame Retardant
Appearance	

Table 3. Power cables. Regular type power cables characteristics.

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7.1.2 Shielded type power cables (CWP02)



Application	For VFD commanded motor starting types, Thyristor groups fed heaters, etc.
Conductor material	Copper
Isolation	XLPE
Composition	Up to 10mm ² : Insulated conductors laid up together. From 16mm ² : 3x + 3G configuration, the protection core Yellow/Green is divided in three cores
Inner Sheath	N/A
Outher Sheath	PVC (Polyvinyl chloride)
Operating voltage	600V/1000V AC
Operating temperature	Dry ambient: -40°C, + 90°C / Wet ambient: -40°C, + 75°C
Conductor identification	To be based on the applicable normative
Shield	Aluminium/polyester tape + Tinned copper wire braid (80%) Total coverage:100%
Standards	IEC 60502-1; Ref. for construction/drawing IEC 60332-1; Flame Retardant
Appearance	

Table 4. Power cables. Shielded type power cables characteristics.

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7.1.3 Flexible power cables (Chain cable) (CWP03)



Application	Power cable designed for use in industrial processes. Extraflexible and with high resistance to abrasion and flexion in dynamic installations, especially recommended for use in cable chains when good electromagnetic protection is required.
Conductor material	Copper
Isolation	Polyolefin
Composition	Up to 12 conductors: In concentric crowns.
Inner Sheath	N/A
Outher Sheath	Polyurethane Grey
Operating voltage	1000V AC (Sections > 1,0 mm ² or AWG18)
Operating temperature	Dry ambient: -40°C, + 80°C
Conductor identification	Black numbered + Yellow/Green
Shield	If applicable
Standards	According DESINA. IEC 60332-1; Flame Retardant IEC 60754-1); Halogen free
Appearance	

Table 5. Power cables. Flexible type power cables characteristics.

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7.1.4 Regular type power cables high temperature (CWP04)



Application	For DOL/RDOL starting types, electrical panels supply, etc
Conductor material	Copper
Isolation	Silicone rubber
Composition	Insulated conductors laid up together.
Inner Sheath	N/A
Outher Sheath	silicone rubber
Operating voltage	300/500V AC
Operating temperature	Dry ambient: -50°C, + 180°C
Conductor identification	To be based on the applicable normative
Shield	If applicable
Standards	Flame-retardance: VDE 0482-332-1-2/IEC 60332-1-2 Halogen-free: IEC 60754
Appearance	

Table 6. Regular type power high temperature cables characteristics

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7.2 INSTRUMENTATION AND CONTROL CABLES (CWC)

7.2.1 Regular type instrumentation and control cables (CWC01)



Application	Instrumentation Supply, solenoid valves, limit switches and discrete signalling.
Conductor material	Copper
Isolation	PVC
Composition	Insulated conductors laid up together
Inner Sheath	N/A
Inner Sheath	N/A
Outer Sheath	PVC (Polyvinyl chloride); grey RAL 7001
Operating voltage	300/500V
Operating temperature	-40°C, + 70°C
Conductor identification	Black numbered + Yellow/Green
Shield	No
Standards	Flame-retardance: VDE 0482-332-1-2/IEC 60332-1-2
Appearance	

Table 7. Instrumentation and control cable. Regular type cable.

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7.2.2 Shielded type instrumentation and control cables (CWC02)

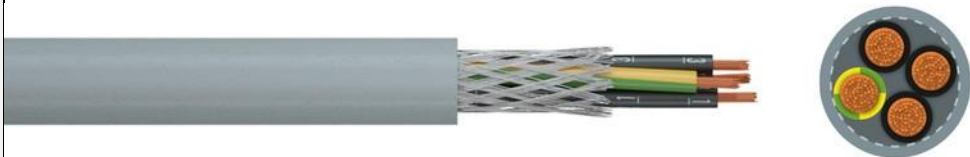

Application	Analogue signals and shielded requirement applications
Conductor material	Copper
Isolation	PVC
Composition	Insulated conductors laid up together in concentric layers
Inner Sheath	N/A
Outher Sheath	PVC (Polyvinyl chloride); grey RAL 7001
Operating voltage	300/500V
Operating temperature	-40°C, + 70°C
Conductor identification	Black numbered + Yellow/Green
Shield	Braided screen of tinned copper wires, approx. Coverage 70%
Standards	Flame-retardance: VDE 0482-332-1-2/IEC 60332-1-2
Appearance	

Table 8- Flexible and control cables shielded.

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7.2.3 Thermocouple type cables (CWC03)



Application	Thermocouple signals
Conductor material	Depending on TC type: For example: Type K: <ul style="list-style-type: none"> (+) Fe (Iron) (-) Copper - Nickel (Constantan)
Isolation	PVC
Composition	Conductors in parallel
Outer Sheath	<ul style="list-style-type: none"> For electrical cabinet: <ul style="list-style-type: none"> PVC For field installation: <ul style="list-style-type: none"> PVC HR (High Resistance) with mechanical protection by mesh stainless steel
Operating voltage	30V
Operating temperature	<ul style="list-style-type: none"> For electrical cabinet: <ul style="list-style-type: none"> PVC, Max +80°C For field installation: <ul style="list-style-type: none"> PVC HR, +105°C
Conductor identification	Depending of TC type and destination country normative.
Shield	Tin-plated copper braiding
Standards	N/A
Appearance	

Table 9. Thermocouple type cables (Type K)

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7.2.4 Flexible cables (Chain cables) (CWC04)



Application	Power cable designed for use in industrial processes. Extraflexible and with high resistance to abrasion and flexion in dynamic installations, especially recommended for use in cable chains when good electromagnetic protection is required.
Conductor material	Copper
Isolation	Polyolefin
Composition	Up to 12 conductors: In concentric crowns.
Inner Sheath	N/A
Outer Sheath	Polyurethane Grey
Operating voltage	1000V AC (Sections > 1,0 mm ² or AWG18)
Operating temperature	Dry ambient: -40°C, + 80°C
Conductor identification	Black numbered + Yellow/Green
Shield	If applicable
Standards	According DESINA. IEC 60332-1; Flame Retardant IEC 60754-1); Halogen free
Appearance	

Table 10. Instrumentation and control chain cables

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7.2.5 “High voltage” cables for ignition transformers (CWC05)



Application	Instrumentation and control cables designed for ignition between spark plug and high voltage transformer.
Conductor material	Flexible tinned copper rope
Isolation	Silicone rubber
Composition	Single conductor.
Operating voltage	10 kV
Operating temperature	-60°C a +180°C
Conductor identification	N/A
Shield	No
Section	1,5 mm ²
Standards	UNE-EN 60332-1, UNE-EN 60754-1, UNE-EN 60754-2, UNE-EN 61034 etc.
Appearance	

Table 11. Instrumentation and control chain cables

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7.2.6 Regular type instrumentation and control high temperature cables (CWC06)



Application	Instrumentation Supply, solenoid valves, limit switches and discrete signalling.
Conductor material	Copper
Isolation	PVC
Composition	Insulated conductors laid up together
Inner Sheath	N/A
Inner Sheath	N/A
Outer Sheath	PVC (Polyvinyl chloride); grey RAL 7001
Operating voltage	300/500V
Operating temperature	-40°C, + 70°C
Conductor identification	Black numbered + Yellow/Green
Shield	No
Standards	Flame-retardance: VDE 0482-332-1-2/IEC 60332-1-2
Appearance	

Table 12. Regular type power high temperature cables characteristics.


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7.3 COMMUNICATION CABLES (CWE)

7.3.1 Fieldbus communication cable (Inside the cabinets) (CWE01)

Application	Communication cable used inside the electrical cabinet for all the communication protocols used to communicate main processing unit and all the field equipment.
Conductor material	Copper
Isolation	Polyolefin (UL-CSA Standards)
Composition	Conductors twisted in pairs
Outer Sheath	PVC Y (UL-CSA Standards) Green Ral 6018
Operating voltage	30V or 300V (600V on request)
Operating temperature	Dry ambient: -20°C, + 80°C
Conductor identification	White – Yellow – Blue – Orange
Shield	Aluminum/Plastic Tape and Tinned Copper Braid Coverage $\geq 85\%$ according to EMC 2014/30/EU
Conductor section	0,38mm/22AWG
Ethernet category	5e
Standards	UL 758 – General marking UL VW-1 – Nonflammable. UL 1581 – Oil and Water resistant
Appearance	


Table 13. Communication cables (Inside the cabinets).

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7.3.2 Fieldbus communication cable (Outside the cabinets) (CWE02)

Application	Communication cable used outside the electrical cabinet for all the communication protocols used to communicate main processing unit and all the field equipment.
Conductor material	Copper
Isolation	Polyolefin (UL-CSA Standards)
Composition	Insulated conductors laid up together.
Outer Sheath	PVC Y (UL-CSA Standards) Green Ral 6018
Operating voltage	30V or 300V (600V on request)
Operating temperature	Dry ambient: -20°C, + 80°C
Conductor identification	(Blue - White/Blue) - (Orange - White/Orange) (Green - White/Green) - (Brown - White/Brown)
Shield	Aluminum/Plastic Tape and Tinned Copper Braid Coverage $\geq 85\%$ according to EMC 2014/30/EU
Conductor section	24AWG
Ethernet category	6
Standards	UL 758 – General marking UL VW-1 – Nonflammable UL 1581 – Oil and water resistant
Appearance	

Table 14. Communication cables (Outside the cabinets).

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7.3.3 Optic fibre (communication beyond 100m) (CWE03)










Application	Communication from the main electrical cabinet for all the communication protocols used to communicate with field equipment when distances are beyond 100m, and Ethernet cables are discarded.
Type	Multimode optic fibre cable (50/125)
Conductor material	Optic fibre
Isolation	Polyolefin (UL-CSA Standards)
Composition	Insulated conductors laid up together.
Outer Sheath	Halogen-free compound
Operating temperature	Dry ambient: -30°C, +70°C
CPR rating	Dca-s2,d2,a1
Standards	EN 50173, ISO/IEC 11801, IEC 60794-1 CPR Class: UNE-EN 50575 Flame Propagation: UNE-EN 60332-1 (IEC 60332-1) Halogen-free: UNE-EN 60754-1 (IEC 60754-1) Low fumes emission: UNE-EN 61034 (IEC 61034)
Appearance	 <div>  no propagador llama  libre de halógenos  baja corrosividad gases  humos baja opacidad  resistente a UV  RoHS  CPR </div>

Table 15. Communication cables – Optic fibre

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7.4 FIREPROOF SLEEVING FOR CABLES



Application	Applicable for all those cables that could be installed near high temperature locations.
Material	Fiberglass Fiber
Coating material	Silicone
Instantaneous temperature	+1150 °C
Operating temperature	-50 °C to +500 °C
Color	Red/Orange
Appearance	


Table 16. Fireproof Sleeving for Cables

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7.5 CABLE MARKING FOR CABLE VENDOR

The outer sheath shall be clearly marked using a permanent long lasting printed marking. In case of poor resistance of marking against the sun light and/or environmental situation, using the thermal marking is preferred.

The markings shall be repeated every 1000 mm, along the cable entire length and durability shall be checked by the test given in IEC 60227-2.

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