Cable Selection Guide for Process Instrumentation

Cable selection for process instrumentation has been complicated by the variety of instruments now in use in process plants, their increased sensitivity to electrical interference and the drive for more exact information regarding the process parameters.
In selecting a cable for a particular application a number of factors have to be considered, some of which are discussed below.

- Type of instrument to be installed
- Length of cable run
- Degree of electrical interference present in the area where the cable is installed
- Environmental conditions

Instrument Type

The type of instrument normally dictates the type of Cable circuit to be employed. For example a thermocouple probe would require a thermocouple (pairs) extension cable, the type of which is dictated by the probe type. Similarly a Resistance Temperature Device (RTD) would require a triad configuration.

Length of Cable Run

The selection of conductor size is largely dependent upon allowable volt drop within the circuit. In addition other parameters such as Mutual Capacitance and L/R ratio may also be of equal importance.

Electrical Interference

Electrical interference, often termed EMI, is an extremely complex subject and is perhaps the least understood. In this section no attempt will be made to provide complete solutions, however guidelines will be given.

Electrical interference is any spurious voltage or current arising from external sources that appears in the signal transmitting circuit. When this voltage becomes too large and the signal to noise ratio is exceeded, errors occur in the measurement/control circuit.

Sources of electrical interference can be categorised into three fields viz:

- Magnetic coupling from AC fields eg motors, power cables.
- Electrical (capacitive) coupling with adjacent circuits
- Direct coupling eg; earth current loops involving two or more earth points or a common return lead for more than one circuit.

Methods of minimising interference in transmission circuits are explained below:

- **Magnetic coupling**
  - Use of twisted pair/triad cores
  - Route measurement cables away from AC fields or vica-versa; signal and power cables or wires **<u>should not</u>** be in the same conduit, tray or junction box.
  - Eliminate the source of interference.
  - Install measurement cables in suitably earthed steel conduits or covered trays.

- **Electrical (capacitive) coupling**
  - Screen each twisted pair/triad.

- **Direct coupling**
  - use a high quality insulation eg XLPE
  - reduce risk of moisture ingress into cables
  - earth screens at one point only
  - use one pair/triad per circuit ie; avoid the use of "**<u>sharing</u>**" leads in different circuits.

Environmental Conditions Identification

- maximum operating conditions
- presence of chemicals/moisture
- abrasion and/or cut through resistance
- fire retardancy
- installation route ie; duct, direct burial, tray etc. (See table below.)

Direct Burial

Outer sheath material must be compatible with soil conditions.

Soil Containment	PVC	PE
Acids – diluted	E	E
Acids – Concentrated	G	G
Alcohols – aliphatic	G	E
Aldehydes	G	G
Bases/Alkali	E	E
Esters	N	G
Hydrocarbons – aliphatic	G	F
Hydrocarbons – aromatic	N	N
Hydrocarbons – halogenated	N	N
Ketones – aromatic	F	N
Oxidizing Agents - strong	G	F

Standard and Barrier Sheath Cables

Cable Design

CBI Telecom offers a broad range of cables including Control, Instrument and Thermocouple. These products are available in a number of configurations each dependant upon the required application.

These cables are reviewed frequently to take advantage of developments in material technology.

Copper conductors are manufactured in three sizes each in a multi-wire bunched configuration to provide increased flexibility. Thermocouple extension cable conductors are manufactured in solid form in two sizes as per American Wire Gauge (AWG) standard.

The standard insulation material is cross-linked polyethylene (XLPE) which provides greater mechanical strength, more stable high temperature performance and lower capacitance which is specifically important for intrinsic applications. The use of this compound covers virtually all process cable requirements and eliminate the use of other materials for special applications.

The screening method used is aluminium/polyester foil tape applied with it's own bunched tinned copper drain conductor for ease of termination. Each tape is electrically isolated from the other and are applied with a suitable overlap in order to maintain 100% cover once the cable is bent following installation.

Two barrier sheath constructions are available in cases which moisture/chemical ingress is likely. In both cases an aluminium co-polymer laminate tape is folded longitudinally around the bedded cable and the overlap sealed. A sheath is then extruded over the tape providing a good bond. Selection of the sheath material is dependant upon the area where the cable will be installed. In the case where fire retardancy is necessary the sheath shall be either black UV resistant, fire retardant PVC or LSZH otherwise black UV resistant PE shall be applied. Fire retardancy of the PVC or LSZH sheathed cable shall comply with IEC60332-3-24 Cat. C and are suitable for overhead rack and tray installations.

Packaging

All cables are supplied on sturdy non-returnable wooden cable drums constructed from timber which has been treated with a preservative. Both ends of the cable fitted with end caps to prevent moisture ingress to the cable. The free end of the cable is fastened to a drum flange to prevent uncoiling during transportation. Wooden lags are nailed side by side over the rims of the drum flanges to protect the cable. Steel strapping is then applied around the lags to keep them in place.

Transport

Drums must be transported in accordance with all the requirements of SANS 10198 – The selection, handling and installation of electric power cables of rating not exceeding 33kV.

Drums must only be rolled in the direction indicated by the arrow painted on the flange.. Preferably, drums must be moved by forklift or crane using a suitable steel shaft and slings with spreader to prevent damage to the flanges.

On no account should drums be laid flat on their flanges. Drums shall be secured to the truck with either suitable wooden chocks or slings or chains fed through the spindle holes in the drum flanges. Use must be made of a fork lift or crane to offload the drums from the truck. Drums should never be rolled off the truck onto the ground.

Storage

Always store drums with their flanges in a vertical position and adjacent drums with their flange(s) touching. If drums are stacked on top of one another, make sure that each end drum of the bottom row are suitably chocked. The storage surface should be hard and well drained. If a length of cable is cut from a drum, the end on the drum should be sealed again with an end cap to prevent moisture ingress.

Installation

All cables must be installed in accordance with SANS 10198 as far as it is applicable to instrumentation and/or control cables. Failure to do this will invalidate CBI Telecom Cables' product warranty.

Electrical Characteristics of Instrumentation Cables with XLPE Insulation

Conductor Area (mm^2)	Cable Element	Nominal Mutual Capacitance (nF/km)	Maximum DC Resistance (Ω/km)	Nominal Inductance (mH/km)	Maximum LR Ratio (µH/Ω)
0.5	Core/core ind & oa screen	95	39.6	0.72	25
	Core/ind screen	190			
	Core/core oa screen	60			
	Core/oa screen	120			
1.0	Core/core ind & oa screen	115	19.5	0.64	25
	Core/ind screen	230			
	Core/core oa screen	75			
	Core/oa screen	150			
1.5	Core/core ind & oa screen	130	14.4	0.63	40
	Core/ind screen	260			
	Core/core oa screen	80			
	Core/oa screen	160			
Note:	Multi pair cables with overall screen > 4 pair, "**core/core oa screen**" figures apply. Multi pair cables with overall screen ≤ 4 pair, "**core/core ind & oa screen**" figures will apply.				