Multimedia Specials Training PPT

Cables Basic 123

Prysmian

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# **Objectives**

Understanding the common terms used for Multimedia Specials related cabling.

- Conductor
- Insulation
- \* Jacket
- Main electrical characteristics
- \* Main mechanical characteristics
- \* Electromagnetic interference
- \* Low Smoke Zero Halogen
- **\*** Fire Performances
- Fire Resistance

# Conductor



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# CONDUCTOR

- Mainly defined under IEC 60228. International standard on conductors of insulated cables.
- Or using the AWG conductor sizes references.
- **Class 1 Solid conductor**
- **Class 2 Stranded conductor; fixed installations**
- **Class 5 Flexible conductor**
- **Class 6 Very flexible conductor**

Key advantage of stranded conductor is flexible but at higher costs. Solid conductor transmit voltage more efficiently and releases lesser heat.





### **Cables Basics 123 - Conductor**

# IEC and AWG has clear definition of the conductor sizes to be used, and both are often interchangeably used.

	International standard wire sizes (IEC 60228)					
	0.5 mm <sup>2</sup>	0.75 mm <sup>2</sup>	1 mm <sup>2</sup>	1.5 mm <sup>2</sup>	2.5 mm <sup>2</sup>	4 mm <sup>2</sup>
	6 mm <sup>2</sup>	10 mm <sup>2</sup>	16 mm <sup>2</sup>	25 mm <sup>2</sup>	35 mm <sup>2</sup>	50 mm <sup>2</sup>
	70 mm <sup>2</sup>	95 mm <sup>2</sup>	120 mm <sup>2</sup>	150 mm <sup>2</sup>	185 mm <sup>2</sup>	240 mm <sup>2</sup>
3	300 mm <sup>2</sup>	400 mm <sup>2</sup>	500 mm <sup>2</sup>	630 mm <sup>2</sup>	800 mm <sup>2</sup>	1000 mm <sup>2</sup>

#### American Wire Guage (AWG)

	Diameter	Diameter	Area	Area
AWG#	(inch)	(mm)	(kcmil)	(mm²)
14	0.0641	1.6277	4.1067	2.0809
15	0.0571	1.4495	3.2568	1.6502
16	0.0508	1.2908	2.5827	1.3087
17	0.0453	1.1495	2.0482	1.0378
18	0.0403	1.0237	1.6243	0.823
19	0.0359	0.9116	1.2881	0.6527
20	0.032	0.8118	1.0215	0.5176
21	0.0285	0.7229	0.8101	0.4105
22	0.0253	0.6438	0.6424	0.3255
23	0.0226	0.5733	0.5095	0.2582
24	0.0201	0.5106	0.404	0.2047



### **Type of metals used for conductors**

Copper

- Most widely used due to high electrical and thermal conductivity, high melting point, resistance to corrosion, wear and fatigue.

Copper covered steel (CCS)

- Combines the conductivity and corrosion resistance of copper with the strength of steel. Usually from bonding or electroplating process.

High Strength Alloys

- More expensive than CCS, usually cadmium-chromium to copper to increase strength and flexibility compared to Steel.

Stainless Steel / Aluminum

- Cheap but poor conductors mainly used for short, redundant transmissions of minimal voltage.

# All our coppers used are 99.9% purity, Graded A in the London Metal Stock Exchange.



# **Cables Basics 123**

### **Conductor Coatings**

#### Bare Copper

- Without any coat, common issue is the forming of copper oxide when copper interacts with oxygen. Oxide film is a poor electrical conductor and hence needs to be removed.
- Suitable for operating temperature up to 100 Celsius.

#### **Tinned Copper**

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- Prevents oxidization, and act as a soldering aid when such terminating method is required. Slightly more expensive than bare copper but can be offset by labor savings from easier terminations.
- Suitable for operating temperature up to 150 Celsius.

#### Silver Coated Copper

- Electroplated onto the copper with min 40 uInches, act as excellent conductor and better protection against oxidization than copper.
- Suitable for operating temperature up to 200 Celsius.







# **Insulation**



# **INSULATION**

- Probably the most important factor in a cable construction.
- Wraps around the conductor to separate from the other.
- Insulation necessary pnly for electrical conductor.
- Separates each conductor physical and electrically.
- Influences the working voltage, velocity of propagation, capacitance, dielectric constant.

# **Types of Insulations**

- Solid
- Foam or Cellular
- Semi-Solid with air gap





# Solid

- LD/MD/HD PE , LSHF, PVC
- Easiest to apply and hence most common
- Most dense, hence better mechanical strength
- Normal data comms cables ie Category, Speaker

# Foam (Cellular)

- LD/MD PE,
- Chemical Foam or Gas Injected (Better)
- ~50% are air gaps
- Hig velocity of propagation up to 70~85%
- Dielectric constant of 1.64
- High performance comms cables ie Bus cables

# Semi-Solid (Air Gap)

- Mostly air, hence excellent insulation effects.
- Lowest dialectic constant of 1.4
- Seldom used in cable construction
- Reduced mechanical strength but better flexibility
- Coaxial ie RG 8, RG 62









### Most commonly used Insulation material - PLASTICS

#### Polyvinyl Chloride (PVC)

Affordable and easy-to-use material used as cables insulation in diverse applications. The temperature range is -55° C to 105° C and it is flame, moisture, and abrasion resistant. PVC insulated wire holds up against gasoline, ozone, acids, and solvents and is safe for medical and food related purposes as it is odorless, tasteless, and non-toxic (when not burnt).

#### Semi-Rigid PVC (SR-PVC)

A form of PVC cable insulation, this is mainly used as a primary insulation and is very abrasion resistant. Semi-rigid PVC is resistant to heat, water, acid, and alkali, as well as being flame retardant.

#### Plenum Polyvinyl Chloride (Plenum PVC)

Plenum PVC, yet another polyvinyl chloride wire insulation material, is great for use in building spaces behind dropped ceilings or raised floors, which are left open to allow for air circulation. Plenum PVC has much higher flame retardant properties compared to PVC.

#### Polyethylene (PE)

Most commonly used on coaxial and low capacitance cables. It carries exemplary electric qualities, although it is flammable. Widely used due to being affordable and can reduce the dielectric constant, making it a good option for cables requiring high-speed transmission. PE can also be cross-linked (XLPE) to produce high resistance to cracking, cut-through, soldering, and solvents. PE can be used in temperatures ranging anywhere from -65° C to 80° C. All densities of Polyethylene are stiff, hard, and inflexible.



# **Cont' - PLASTICS**

#### Polypropylene (PP)

Very similar to polyethylene, polypropylene has a wider temperature range of 30° C to 80° C. This wire insulation is used primarily within thin walls.

#### Polyurethane (PUR)

From extremely low to very high temperatures, polyurethane is known for its extreme toughness, flexibility, and flex life. Because of the excellent ratings for chemical, water, and abrasion resistance, this material works well in retractile cord applications and can be a good option for salt-spray and low-temperature military purposes.

#### Chlorinated Polyethylene (CPE)

Commonly found in power and control cables as well as industrial power plant applications, CPE cable insulation displays very good heat, oil, and weather resistance. More times than not, CPE serves as a lower cost and more environmentally friendly alternative to chlorosulfonated polyethylene.

#### Nylon

Nylon, very flexible wire insulation, is usually extruded over softer insulation compounds. It serves as a tough insulation, exhibiting strong abrasion, cut-through, and chemical resistance, but highly flammable.

#### The other 2 most common used material families are Fluoropolymers and Rubber but reserved mainly for very specialized applications, hence not discussed here.



#### **Dielectric properties as insulation**

- Below is table showing standard comparisons of the most common dielectric materials used as insulations.
- It is important to know how such materials affects the resilience of the cables as well as cost.

	PRIMARY DIELECTRIC S				
	POLYETHYLENE (PE)	FOAMED POLYETHYLENE (PE)	Fluorinated Ethylene Propylene (FEP)	Poly Tetrafluoroethylene (PTFE)	BUTYL RUBBER
Maximum operating temperature °C	-65 to 80	-65 to 80	-65 to 200	-65 to 260	-40 to 80
Average tensile strength psi (1,000)	1.9	2.2	3.6	2.7	1.1
Flexibility	good	good	excellent	good	excellent
Cut-thru resistance	good	poor	good	fair	excellent
Water Resistance	excellent	poor	excellent	excellent	good
Resistance to organic solvents	poor	poor	excellent	excellent	good
Resistance to acids and alkalies	excellent	excellent	excellent	excellent	good
Remarks	for use under 80°C maximum	for use under 80°C maximum	for high temperature use to 200°C	for high temperature use to 260°C	for pulse cables and extreme flexibility



# Jacket



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# JACKET

- Serves as the final construction and physically protects the inner constructions of the cable.
- Improves cable's appearance and provides protection from the environment, installations wear & tear and flame retardancy.

#### Thermoplastic

- PVC
- Polyethylene
- Polypropylene
- Polyurethane
- FEP
- Nylon

#### Thermoset

- Natural Rubber
- Neoprene
- Silicon rubber



## Thermoplastic

- Most commonly used
- Formable by heat and hence will melt when hot enough
- Lower in cost
- Lighter weight
- Easier to color
- Chemical resistance



### Thermoset

- Does not melt when heated
- Non recyclable once "cured" into jacket.
- More flexible at room and lower temperature
- Higher temperature resistance



### **Common Jacket (Sheath) Materials Properties**



# Main Electrical Characteristics



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#### **Main Electrical Characteristics**

- Most critical performing factors of a cable.
- Below are electrical characteristics typical of a data communications cables which are more complex when compared with a power cable only to transmit voltage.
  - Capacitance
  - Attenuation
  - Velocity of propagation
  - Dielectric constant

- Working voltage
- Dielectric strength
- DC resistance
- Characteristic Impedance



## Capacitance

- A measure of the insulation's ability to store electrical energy
- Measured in picofarads per ft (pf/ft).
- Slows down and interferes with the signal being transmitted.
- Typically lower capacitance means better performance cable especially in higher frequency.
- 25pf.ft and below typically refer to as low capacitance cables.

# Attenuation

- A measure of the cable's loss of electrical energy whether as in Voltage or Signal strength.
- Measured in V (Voltage) or dB/unit length (Signal)
- Lower attenuation is always better for any cables.



### **Velocity of Propagation**

- A measure of the electrical signal's transmission speed through a length of cable compared to speed of light.
- Referenced as a % of the speed of light.
- The higher velocity % means lower signal lost.
- Typical for high performance data cables ie Profibus, coaxials
- Higher velocity achieved by using Foam PE as insulation.

# **Dielectric Constant**

- A measure of the overall property determining capacitance, VOP, impedance and relating performances of the insulation.
- Very important for data/electronics cables
- Lower Er = Lower capacitance, higher impedance & lower attenuation.
- Air is best dielectric constant = 1, adding air lowers Er.



# **Working Voltage**

- Maximum voltage allowable by IEC or UL to be applied to the cable.
- Measured in AC volt(V)
- Determines by the quality of conductor (material & size) and insulation.
- Typically Data comms cables are limited to 300V/500V max.

# **Dielectric Strength**

- Measure of the insulating material ability to withstand voltage breakdown.
- Measured in Volts (V)
- Decreases with higher operating voltage
- More in concern with power cables due to higher voltage range and operating temperature.



## **DC Resistance**

- Measure of the total resistance through two conductors looped at one end of the link.
- Measured in Ohms
- DC resistance increases proportionately with the length of the cable tested
- Has less effect on a signal than insertion loss, but plays a major role if power over Ethernet is required.

# **Characteristic Impedance**

- Main electrical characteristic that determines the level of power transfer and attenuation along the cable length, and also controls the amount of reflected and standing waves..
- Measured in Ohms
- Most standard in use are the 50, 75, 150 Ohm
- Compatibility on the impedance load of the active equipment.



# Main Mechanical Characteristics



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#### **Main Mechanical Characteristics**

- Determines the physical condition of the cables
- Influenced by the operating environment, installation process and cable lasting requirements.
- Below are typical physical characteristics of a cable.
  - Elongation
  - Tensile strength
  - Crush strength
  - Temperature rating

- Flexibility
- **Flammability**
- Resistance
- Proofs / Armoring



# **Cables Basics 123 – Main Mechanical Characteristic**

# Elongation

- Shows how far a material will stretch before breaking.
- Measured in %, meaning extension from current density.
- More commonly seen for FO cables

# **Tensile Strength**

- Shows how much longitudinal (pulling) force it takes to break the insulation or jacket material.
- Measured in PSI or Newtons/m
- More commonly for cables requiring machine pulling.

# **Crush Strength**

- Shows how much lateral (impact) force it takes to break the insulation or jacket material.
- Measured in PSI or Newtons/m
- More commonly for direct buried cables.



#### **Temperature Rating**

- Range of temperatures at which the cable can be used without degradation. Ie -20C  $\sim$  +80C
- Sharp attenuation will occur if operating out of temp range.

# Flexibility

- Shows the ability of cable to bend.
- Usually expressed as No of Times of cable diameter
- Ie  $5 \sim 10 \times OD$  for standard cable, 15 x OD for armored cable

# Flammability

- Shows the ability of a cable to burn.
- Determine mainly by the jacket used.
- International industry standards applies ie IEC 30332
- IEC 60332-1 , least stringent single cable test
- IEC 30332-3-24, typical higher standard for data comms cables, testing bunch of cables instead of single.

# **Resistance (Anti)**

- Chemical resistance, usually by HDPE, PVC
- UV resistance, simplest by adding carbon into sheath (Black) or addictive. Red is most prone to UV degradation.
- Termites resistance, by adding addictive (non ROHS).
- Rodent resistance, by adding addictive (non ROHS).
- Water resistance, by HDPE or water blocking tape/yarns/Jelly.

# **Proofs / Armoring**

- Proofing a cable against environmental effects means adding additional protection to the cable construction.
- Steel wire braiding for outdoor installations, better crush resistance (stepping).
- Steel wire armoring for outdoor/direct buried, rodents, high crush resistance.
- Nylon for chemical / termite / oil proofing, but flammable.



# **Cables Basics 123 – Main Mechanical Characteristic**

# Our strength is being able to provide all sorts of armoring.

	Applications	Туре	Cost	Assistin Water Blocking	Crush Resistance	Assistin Flame Retardant	Flexibility	Rodent Proof	Termite Proof
Steel Tape (CT)	Telephone Cables	Metallic							
Corrugated Steel Tape (CST)	Fibre Optics Cables	Metallic							
Steel Wire Braid (SWB)	All Cables > 6mm OD	Metallic							
Steel Wire <u>Armour</u> (SWA) (0.9mm)	All Cables > 10mm OD	Metallic							
Steel Wire <u>Armour</u> (SWA) (1.2mm)	All Cables > 12mm OD	Metallic							
Aluminum PE Laminate (APL)	All Cables > 6mm OD	Metallic							
Nylon (PA 12)	All Cables > 6mm OD	Non- Metallic							
Glass Yams	Fibre Optics Cables	Non- Metallic							
Water Blocking Tape	Fibre Optics Cables	Non - Metallic							
Copper Wire Braid (CWB)	Cat Cables, Marine Applications	Metallic							



Electromagnetic Interference



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# **ELECTROMAGNETIC INTERFERENCE**

- EMI (electromagnetic interference) is the unwanted effects in the electrical system due to electromagnetic radiation and electromagnetic conduction.
- It can arise from any electrical or electronic disturbance, man-made or natural, ie switches, generators, transmitters, other cables, ac motors, power supplies, etc.
- EMI can be conductive or radiative.
- Most common solution is electromagnetic shielding.





# **Types of shielding**

- Each application requires individual considerations given that parameters such as cable lengths, noise frequency, signal frequency and cable termination methodology impact the final result. Improperly cable shielding can actually increase noise coupling and thus make the problem worse.
- 2 main types of shielding.

#### Foil

- Aluminum
- Good against RFIs
- Higher frequencies
- Overall shielding
- Drain wire
- Higher frequencies
- Can be use alone

### Braiding

- Aluminum or Copper
- Good against EMI
- 50% to 85% coverage
- Lower frequencies
- Often used with foil

## **Cables Basics 123 – Electromagnetic Interference**

### **Types of shielding**

- Individual pair screen, overall foil screen, overall foil with individual pair screen, overall foil with braid, overall foil with braid and individual pair screen.





Low Smoke Zero Halogen



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### Low Smoke Zero Halogen

- Many different abbreviations in the industry, but meaning the same properties.
- Low smoke determined by meeting or exceeding the IEC 61034 standards.
- Halogen free determined meeting or exceeding the IEC 60754-1 standards. Represents amount of halogen released.
- Higher halogen free standard set by IEC 60754-2. Represents acidity of halogen released.
- All above tests done during cable burnt.

Abbreviation	Meaning
LSZH	Low smoke, zero halogen
LSF	Low smoke, fume
LSOH	Low smoke, zero halogen
LSHF	Low smoke, halogen free
LSNH	Low smoke, nonhalogen
NHFR	Nonhalogen, flame retardant
HFFR	Halogen free, flame retardant
FRNC	Fire retardant, noncorrosive
LS	Low, limited smoke
ST	Smoke test (limited smoke)
FRLS	Fire resistant, low smoke
RE	Reduced emissions
LC	Low corrosivity
LH	Low halogen

Prysmian Group To ensure a cable is qualified Low Smoke, many international test standards are available while the most commonly used is IEC.

Name	Description
ASTM D5424	Smoke obscuration of insulating materials in a vertical tray configuration
ASTM E662	Specific optical density of smoke generated by solid materials
BS EN 61034	Measurement of smoke density of cables burning under defined conditions
C22.2 No. 0.3	Test methods for electrical wires and cables
Def Stan 02-711 (formerly NES 711)	Smoke index of the products of combustion from small specimens
IEC 61034	Measurement of smoke density of cables burning under defined conditions
NFPA 262 (formerly UL 910)	Flame travel and smoke of wires and cables for use in air-handling spaces
UL 1685	Vertical-tray fire-propagation and smoke-release test
UL 2556	Wire and cable test methods



### **Halogens Vs Non Halogens**

#### HALOGENS

- Efficient process
- Good electricals
- Good dieletrical
- Good physical
- Harden
- Easy to compound
- Processable

#### **NON- HALOGENS**

- Inefficient
- Poor electricals
- Poor dielectric
- Big effect on physical
- Soften
- Low smoke
- No acid



# Cables Basics 123 - LSZH

Typical halogen content of common wire and cable materials, PE treated with halogen free flame retardants is the most used.

Polymer	Halogen Content (% by weight)
XLP (cross-linked polyethylene)	< 0.02
with halogen-free flame retardants	< 0.02
with halogenated flame retardants	7—17
EPR (ethylene propylene rubber)	< 0.02
with halogenated flame retardants	9—14
PU (polyurethane)	< 0.02
PE (polyethylene)	< 0.02
with halogen-free flame retardants	< 0.02
CSPE (chlorosulfonated polyethylene)	13—26
CPE (chlorinated polyethylene)	1428
PVC (polyvinyl chloride)	22—29
FEP (fluorinated ethylene propylene)	62–78
< 0.02 generally considered zero halogen	

# **Fire Performances**



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#### FIRE PERFORMANCES

Cable burning issues are started by the distinctive features of cables which affect their ability to cause and sustain fire.

Taking note that cables,

- Usually contain organic combustible materials
- Usually routed throughout the building acting as a fire medium when burnt, bringing the flames from one point to another.
- May be installed in vertical shafts which may act as air pumps (chimney effect) in case of fire.
- May ignite in case of short circuit.
- May release toxic and corrosive fumes during burning



### Cables Basics 123 - FP

The required level of flame retardancy is based on the way the cables are installed and is verified by different flame-tests. Different standards have different test methods but the most widely worldwide are the IEC and CENELEC standards:

IEC	CENELEC EN	Test Method
60332-1	50265-2-1	Vertical sample Single cable Single 1 kW Flame 1-8 minutes
60332-3-21	50266-2-1	Vertical ladder >35 mm2 Cond. 7 Liter CM/m cable Ribbon Burner 40 minutes
60332-3-22	50266-2-2	Vertical ladder <35 mm2 Cond. 7 Liter CM/m cable Ribbon Burner 40 minutes
60332-3-23	50266-2-3	Vertical ladder 3.5 Liter CM/m cable Ribbon Burner 40 minutes
60332-3-24	50266-2-4	Vertical ladder 1.5 Liter CM/m cable Ribbon Burner 20 minutes
60332-3-25	50266-2-5	Vertical ladder 0.5 Liter CM/m cable Ribbon Burner 20 minutes





## **Understanding the American Terms**

Cable Type	Test Type	UL Test Standards	Remarks	Applications
СМХ	Vertical Wire Flame	UL 1581	Not tested for toxic or smoke density, similar to IEC 60332-1	Limited usage, single cable in conduit.
CM / CMG	Vertical Tray Flame	UL 1581 / UL 1685	Not tested for toxic or smoke density except for 1685 (Limited Smoke), similar to IEC 60332-3-24	Single floor, cannot be installed in vertical pathways
CMR	Riser Flame	UL 1666	Not tested for toxic or smoke density, similar to IEC 60332-3-24	For vertical shafts
СМР	Plenum Flame	NFPA-262 (ex UL910)	Not tested for toxic but tested for smoke density, similar to IEC 60332-3A/22	High retardant properties. Air ventilation ducts and plenum ducts.



# **Fire Resistance**



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#### FIRE RESISTANCE CABLES

There is a vast difference between Flame Retardant (FRT) & Fire Resistance (FR) Cables.

**FIRE RESISTANCE Cables** maintains its function in the event of fire (being burnt) ie transmission is still ongoing for a specific period of time. This is possible by the unique fire barrier protection in the cables construction. A high quality FR cables also combines the properties of FRT and is Low Smoke Zero Halogen (LSZH) compliant.

Achieved by using fire barrier mica tape, non flammable compound and combining with LSZH sheaths.

**FLAME RETARDANT Cables** limits the propagation of flame burning on the cables so that it does not spread any fire easily. These cables may lose transmission fast upon burning due to its lack of fire barriers protection. A high quality FRT cables is also LSZH compliant.

Achieved by using flame retardant sheath, ie PVC-FR, LSZH



### **Cables Basics 123 - FR**

Governing IEC Standards	PRYSMIAN GROUP	Others
FIRE RESISTANCE - FR		
IEC 60332-1-25 (750°C for 90 mins)	Exceed	Fulfill
BS 6387 (950°C for 180 mins)	Fulfill	Often not
BS EN 50200:2000 Class PH120	Fulfill	May not Meet
(Mechanical Shock & Water Spray)		
Flame Retardant - FRT		
IEC 60332-1 (Single Cable)	Exceed	Meet
IEC 60332-24 (Multiple Cables)	Fulfill	May not Meet
Low Smoke - LS		
	Fulfill due to 100%	May not meet, PVC used
IEC 61034	LSZH used	instead of LSZH. CM/ CMR &
		CMP generally not LSZH.
Halogen Free - ZH , HF, OH		
	Fulfill due to 100%	May not meet, PVC used
IEC 60754-1 (Zero Halogen)	LSZH used.	instead of LSZH. CM/ CMR &
		CMP generally not LSZH.
	Fulfill due to 100%	May not meet, PVC used
IEC 60754-1 (Low Acidity)	LSZH used.	instead of LSZH. CM/ CMR &
		CMP generally not LSZH.



#### We have the probably the best fire resistance cables range to meet all standard applications, and can cater to special applications for customizations.

#### Fiber Optical Cables

- Firetuf <sup>™</sup> range
- Unitube & Loosetube

#### Speaker and EMC Cables

- Firetuf<sup>™</sup> and Maxfoh <sup>™</sup> range
- 1.5~4mm2

#### Data Cables

- Firetuf<sup>™</sup> range
- 1P, 2P or 4P

12-96 Core Firetuf<sup>™</sup> I10S Fire Resistant Fibre Optic Cable, LSZH

#### Firetuf<sup>™</sup> OFC-UT-CST Fire Resistant Armoured Central Tube Cable

Indoor/Outdoor steel tape armoured (CST) double LSHF-FR sheathed optical cable with 2 - 24 fibres. VDE: A/I-DO(ZN)H(SR)H



#### Firetuf<sup>™</sup> OFC-UT-NM Fire Resistant Universal Central Tube Cable Indoor/Outdoor non-metallic LSHF-FR sheathed optical cable with 2 - 24 fibers. VDE: A/I-DO(ZN)H



MAX-FOH<sup>™</sup> Flexible PAGA & Control Cable Public Address General Alarm, Data Control Cable, Fire Resistance



IE Firetuf<sup>™</sup> DATA 1P, 2P or 4P S7H-FR

IE SF/UTP 4x2xAWG22/1 cable with circuit integrity behaviour



#### Cables Basics 123 - End

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For more information on our Multimedia Specials products, request for our MMSpecials catalogue (right) or visit our MMS dedicated website, <u>www.DRAKAUC.com</u> now.



For further enquiries, please email to mms.asia@prysmiangroup.com

End



