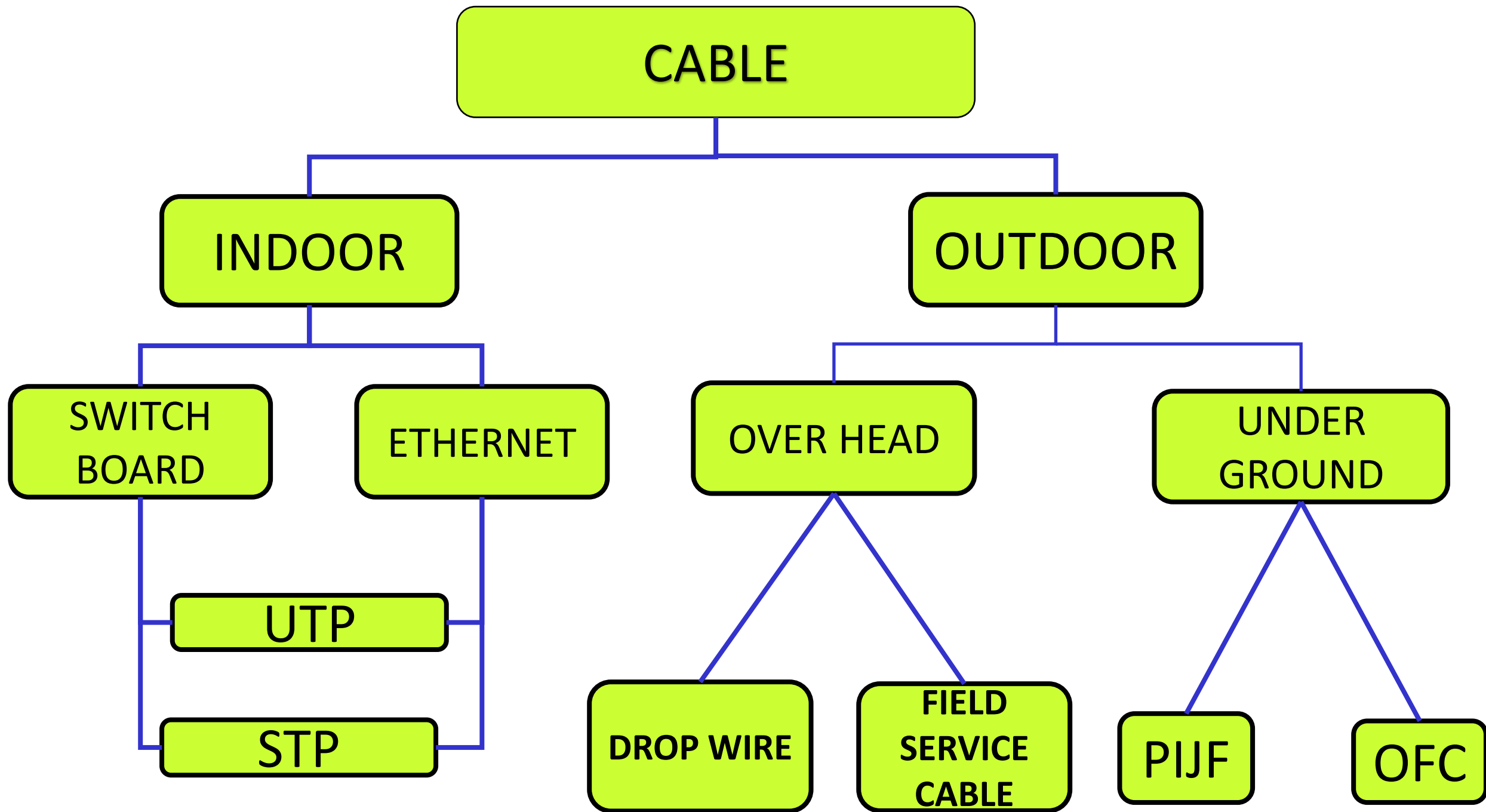


TELECOM CABLES



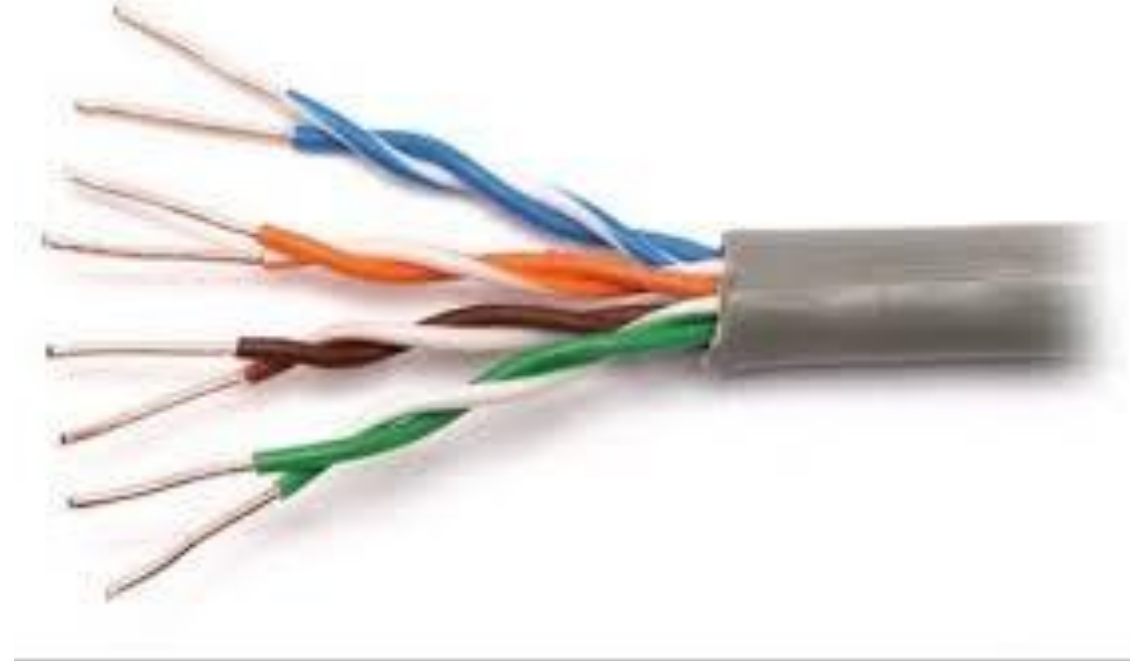
STP CABLE

- Shielded Twisted Pair
- Protected Against Electrical Interference
- More Cost than UTP



UTP CABLE

- Unshielded Twisted Pair
- Unprotected against electrical interference
- Cheaper than STP



DROP WIRE

- Conductor Dia: 0.5mm,
- Type : Single Pair
- Size : 100m , 200m, 500m
- Insulation : PVC
- Joint : Direct pair to pair ,
use sleeve or electric tape
- Used for providing single pair circuit like ADM phone etc
from nearest distribution point (DP)

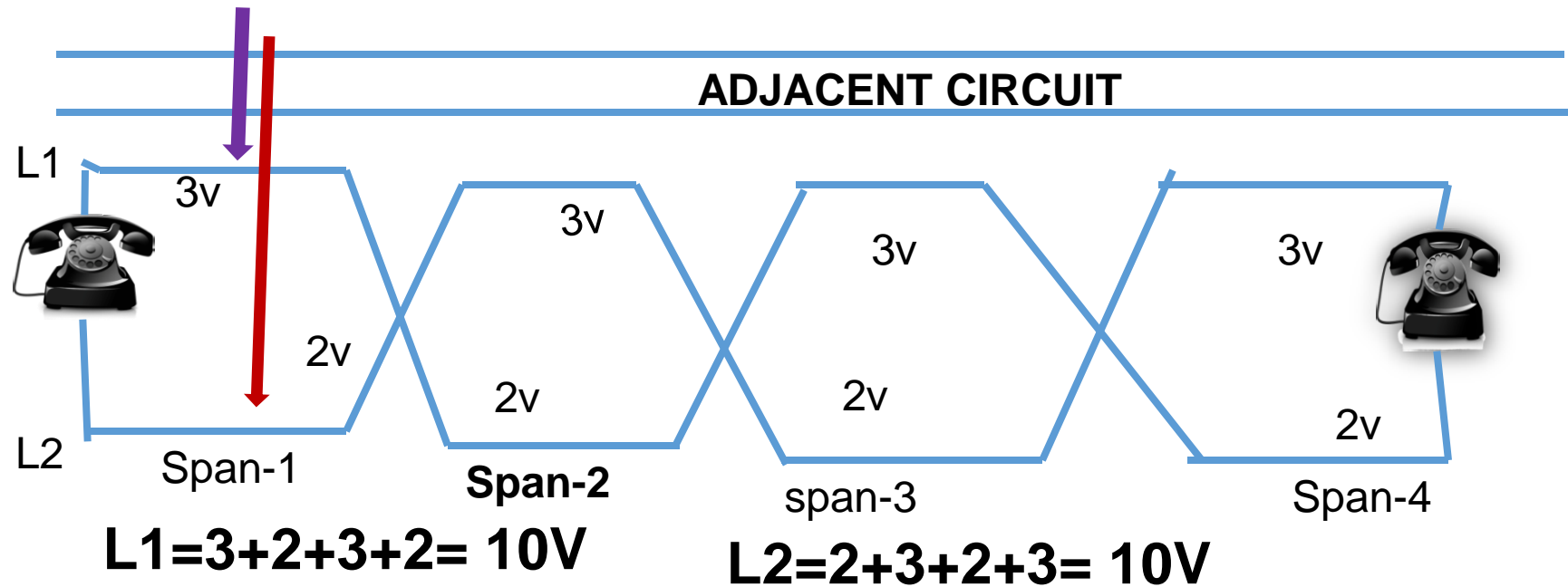


FIELD SERVICE CABLE(D-8)

- Used for temporary extension of a circuit during emergencies like accident, flood etc.
- Supplied in drums of 500m, 1000m
- Contains 4 strands of copper for conductivity and 3 strands of steel for strength(dia 0.375mm).
- Jointing is done straight copper to copper and steel to steel, sleeve or electric tape are used.



How Cross-talk Is Eliminated in Twisted Pair



Net induced voltages on L1&L2 are the same, no potential difference, no current flow at telephone and no cross-talk from adjacent Circuits.

SWITCH BOARD CABLE

- Used for extension of circuits inside a building or between equipment located indoors.
- Rip cord is provided inside to remove PVC sheath easily.
- Comes with 3p, 5p, 10p, 20p, 50p, 100p
- Comes in size of 100m,200m,500m
- Conductor dia is 0.4mm/0.5mm/0.6mm
- After termination of cable pairs soldering shall be done other than krone and wago CTBs.
- Can be UTP or STP type.



Dia	Loop resistance/km
0.4 mm	286 ohm
0.5mm	184 ohm
0.6 mm	128 ohm

SWITCH BOARD CABLE COLOUR CODE(Scheme-1) 20 PAIR

- | | |
|-------------------------------|--------------------------------|
| 1) BLUE -WHITE | 11)BLUE ORANGE-WHITE |
| 2) ORANGE- WHITE | 12)BLUE GREEN -WHITE |
| 3) GREEN - WHITE | 13)BLUE BROWN -WHITE |
| 4) BROWN -WHITE | 14)BLUE SLATE –WHITE |
| 5) SLATE -WHITE | 15)ORANGE GREEN – WHITE |
| 6) BLUE WHITE- WHITE | 16)ORANGE BROWN- WHITE |
| 7) ORANGE WHITE- WHITE | 17)ORANGE SLATE-WHITE |
| 8) GREEN WHITE- WHITE | 18)GREEN BROWN-WHITE |
| 9) BROWN WHITE- WHITE | 19)GREEN SLATE – WHITE |
| 10) SLATE WHITE- WHITE | 20)BROWN SLATE -WHITE |

SWITCH BOARD CABLE COLOUR CODE(Scheme-2)

M A T E C O L O U R S			
W H I T E	R E D	B L A C K	Y E L L O W

M A I N C O L O U R	B L U E	PAIR 1	PAIR 6	PAIR 11	PAIR 16
	O R A N G E	PAIR 2	PAIR 7	PAIR 12	PAIR 17
	G R E E N	PAIR 3	PAIR 8	PAIR 13	PAIR 18
	B R O W N	PAIR 4	PAIR 9	PAIR 14	PAIR 19
	S L A T E	PAIR 5	PAIR 10	PAIR 15	PAIR 20

50 pair Switch board and PIJF cable colour code

Binder

Pair

BLUE

Pair-1 to 10

ORANGE

Pair-11 to 20

GREEN

Pair-21 to 30

BROWN

Pair-31 to 40

SLATE

Pair-41 to 50

BLUE

ORANGE

GREEN

BROWN

SLATE

WHITE

PAIR 1

PAIR 2

PAIR 3

PAIR 4

PAIR 5

RED

PAIR 6

PAIR 7

PAIR 8

PAIR 9

PAIR 10

PAIR NO 32

BROWN
Binder

ORANGE WHITE

100 pair Switch board and PIJF cable colour code

Binder

Pair

WHITE

RED

BLACK

YELLOW

BLUE

Pair-1 to 20

BLUE

PAIR 1

PAIR 6

PAIR 11

PAIR 16

ORANGE

Pair-21 to 40

ORANGE

PAIR 2

PAIR 7

PAIR 12

PAIR 17

GREEN

Pair-41 to 60

GREEN

PAIR 3

PAIR 8

PAIR 13

PAIR 18

BROWN

Pair-61 to 80

BROWN

PAIR 4

PAIR 9

PAIR 14

PAIR 19

SLATE

Pair-81 to 100

SLATE

PAIR 5

PAIR 10

PAIR 15

PAIR 20

PAIR NO 57

GREEN
Binder

ORANGE

YELLOW

TESTING OF SWITCH BOARD CABLE

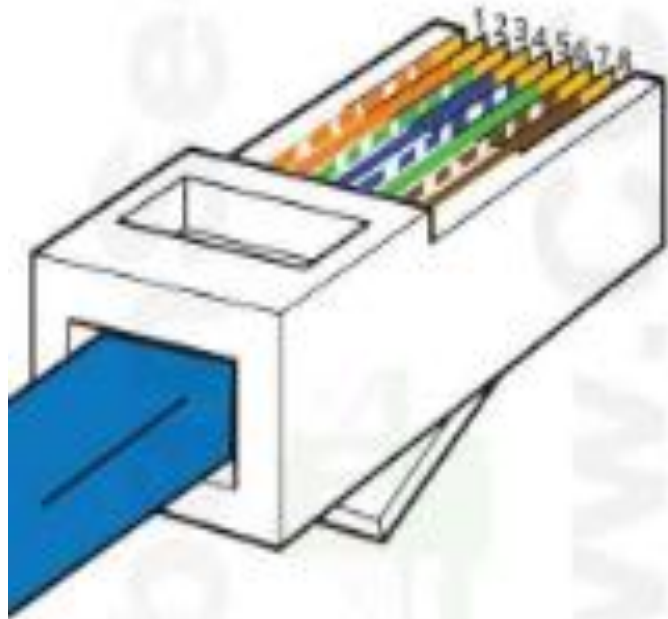
- ALL cables to be tested(end to end) once in year. and record the parameters.
- Insulation resistance value should be more than 50M ohm/km.
- Loop resistance should be tested, value should be in accordance to dia.

Data Cables

UTP Category	Data Rate	Max. Length	Cable Type	Application
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Rink & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)



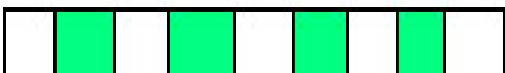

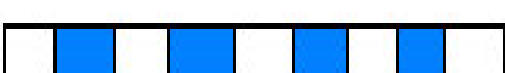



RJ45 Pinout

T-568B



- | | |
|-----------------|----------------|
| 1. White Orange | 5. White Blue |
| 2. Orange | 6. Green |
| 3. White Green | 7. White Brown |
| 4. Blue | 8. Brown |

TIA/EIA 568B Wiring

- | | | |
|---|---|------------------|
| 1 |  | White and Orange |
| 2 |  | Orange |
| 3 |  | White and Green |
| 4 |  | Blue |
| 5 |  | White and Blue |
| 6 |  | Green |
| 7 |  | White and Brown |
| 8 |  | Brown |

PIJF(Polythene Insulated Jelly Filled) Cable

- Advantages

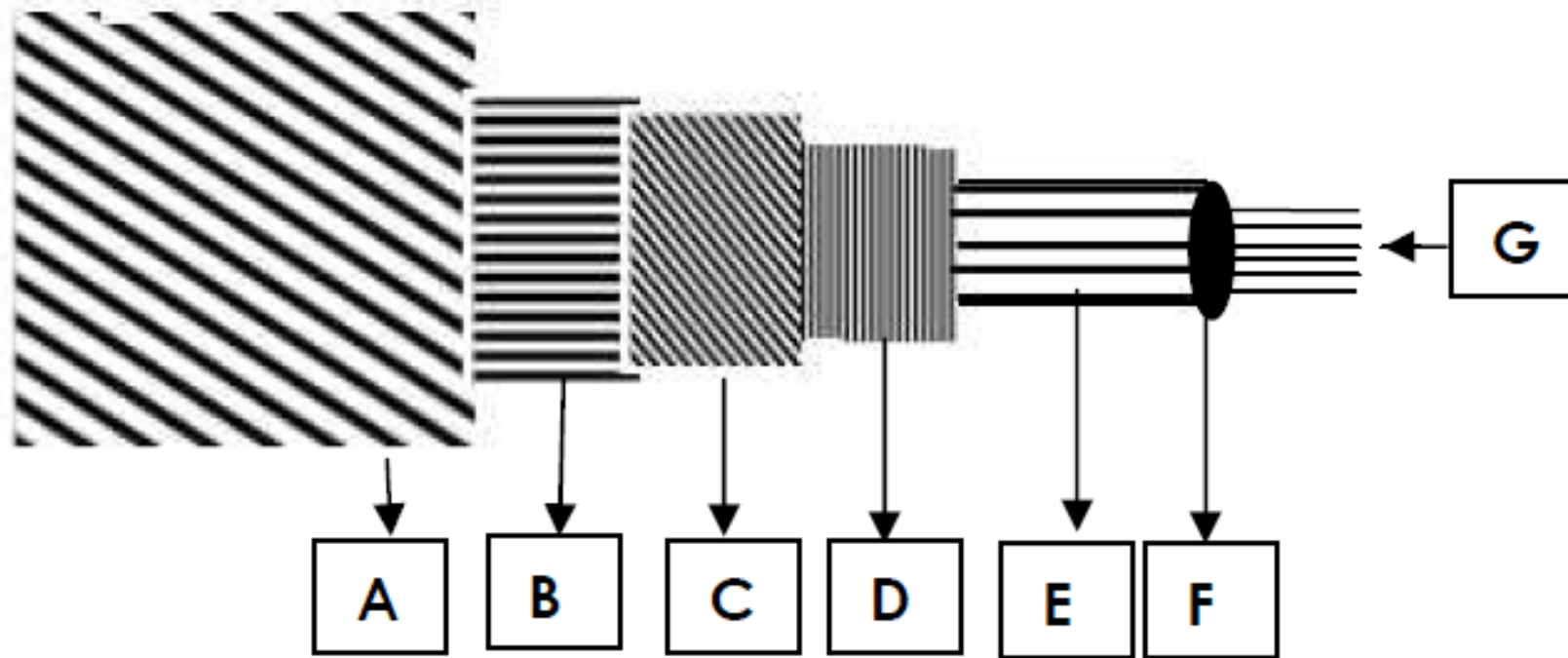
- 1) Counting of Pair is easy and human errors are avoided.
- 2) Failures are less.
- 3) Entry of water is prevented by jelly.
- 4) Cable can be directly terminated to MDF/CTB/Tag block/equipment thus avoiding number of joints.
- 5) Cable life is more.
- 6) Cable is not delicate therefore less chances of damage due to rodent attack.



PIJF CABLE(Paired)

Application	Telephone connection to subscribers, Local lead/ last mile connectivity for voice and data circuits.
Conductor dia	0.5mm , 0.63mm
Pairs	5p, 10p, 20p, 50p, 100p
Drum length	500 m, 1000m
Loop resistance	184 ohm(0.5mm dia), 128 ohm(0.63mm dia)
Insulation	5000 Mega ohm per km
Characteristic Impedance	600 Ohm
Minimum Bending Radius	15 X cable dia

PIJF CABLE CONSTRUCTION(Paired)

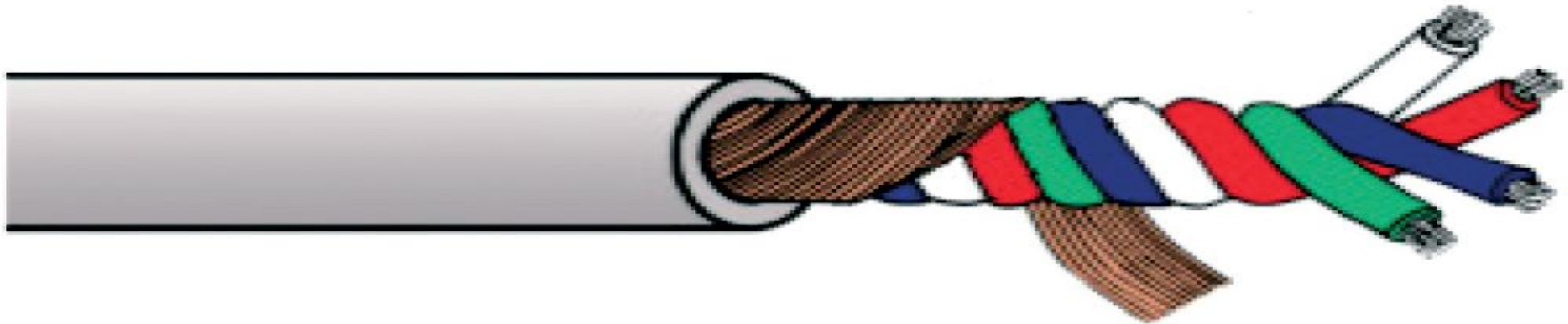


- A** : Polythene Outer jacket **B** : Galvanised Steel Tape **C** : Polythene Tape
D : Polythene Inner sheath **E** : Poly-Al-Laminated Tape
F : Core wrapping (Polyester) tape **G** : Polythene Insulated Copper Conductor

Polythene Outer jacket	Protects cable armour from chemical reactions/rusting, external temperature
Galvanized Steel Tape	Mechanical protection from jerks
Polythene Tape	Isolation between armour and inner sheath
Polythene Inner sheath	Protection of Poly-Al laminated sheath
Poly-Al-Laminated Tape	Protection from electromagnetic induction, also prevents moisture to enter
Core wrapping (Polyester) tape	For filling up petroleum jelly
Polythene Insulated Copper Conductor	For conduction (colour of insulation are for pair identification)

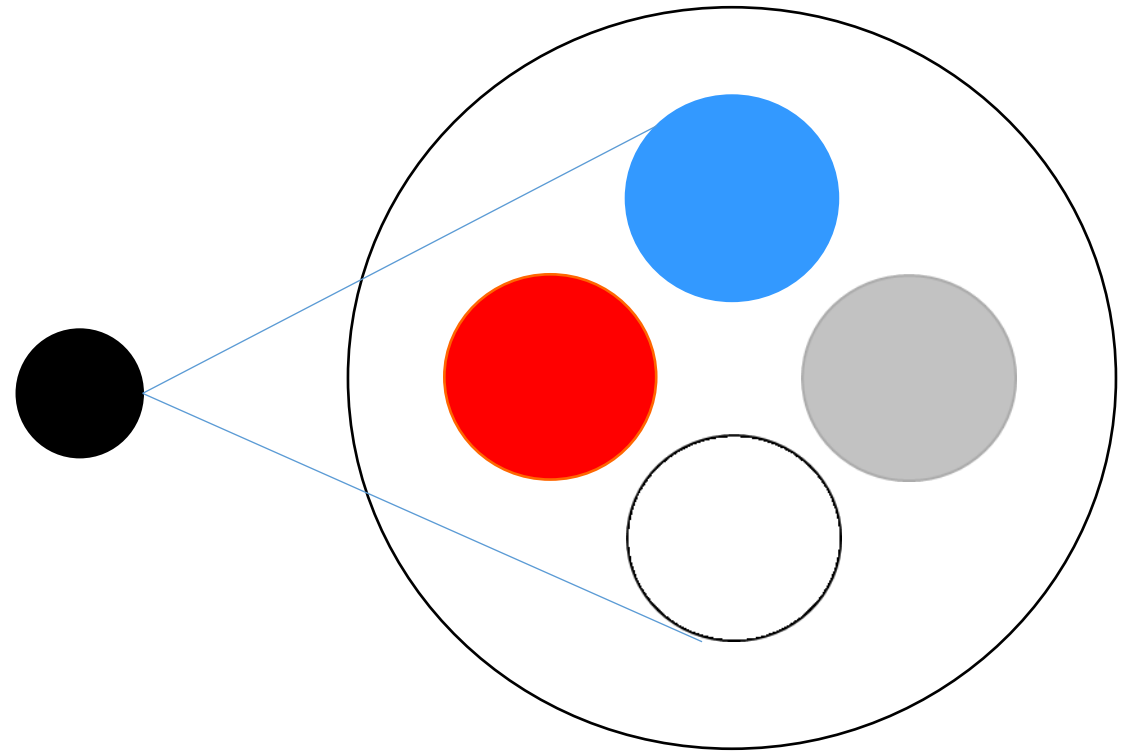
QUAD CABLES

- “STAR QUAD” is Four conductor balanced cable, four wires form a tighter, more consistent pack than two wires can and can resist even more noise.

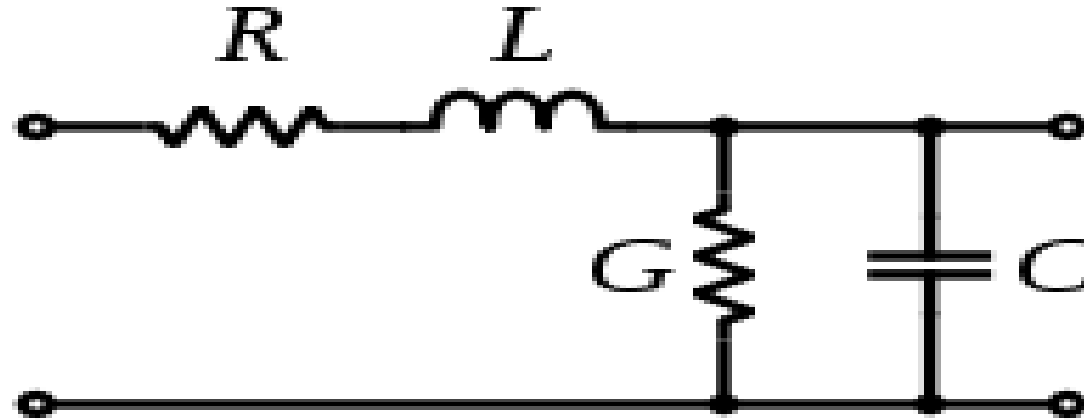


QUAD CABLES

- Blue and white wires are vertically opposite and form a pair of wires
- Red and Slate wires are vertically opposite and form another pair.
- Same amount of interference reaches to blue and white wires but slightly different amount to Red and Slate wires, but as all 4 wires are twisted together combined induction will be same for all 4 wires.



Schematic representation of the elementary components of a transmission Line.



where

R -is the resistance per unit length, L - is the inductance per unit length, G - is the conductance of the dielectric per unit length, C -is the capacitance per unit length,

For no attenuation $RC=LG$

Value of RC is greater in cable, therefore to achieve $RC=LG$, inductor(loading coils) of value 118 mH are connected in series with each pair. The distance between two consecutive loading coils is called loading section and it is 2000 m. However it is seldom used now as Quad cable is not being used for long distance circuits.

UNLOADED QUAD CABLE IMPORTANT POINTS

- 1) Conductor Dia - 0.9mm
- 2) Loop Resistance : 56 Ohm/km
- 3) Transmission Loss: 0.63dB/ km at 800Hz, 1.2dB/km at 2kHz(for axle counter) , must not exceed 30dB for a block section
- 4) Insulation Resistance: 10M ohm for block section
20 M ohm for block section (For axle counter)
- 5) Characteristic Impedance: 470 ohms

COLOUR CODE & QUAD ALLOCATION of 6 QUAD CABLE

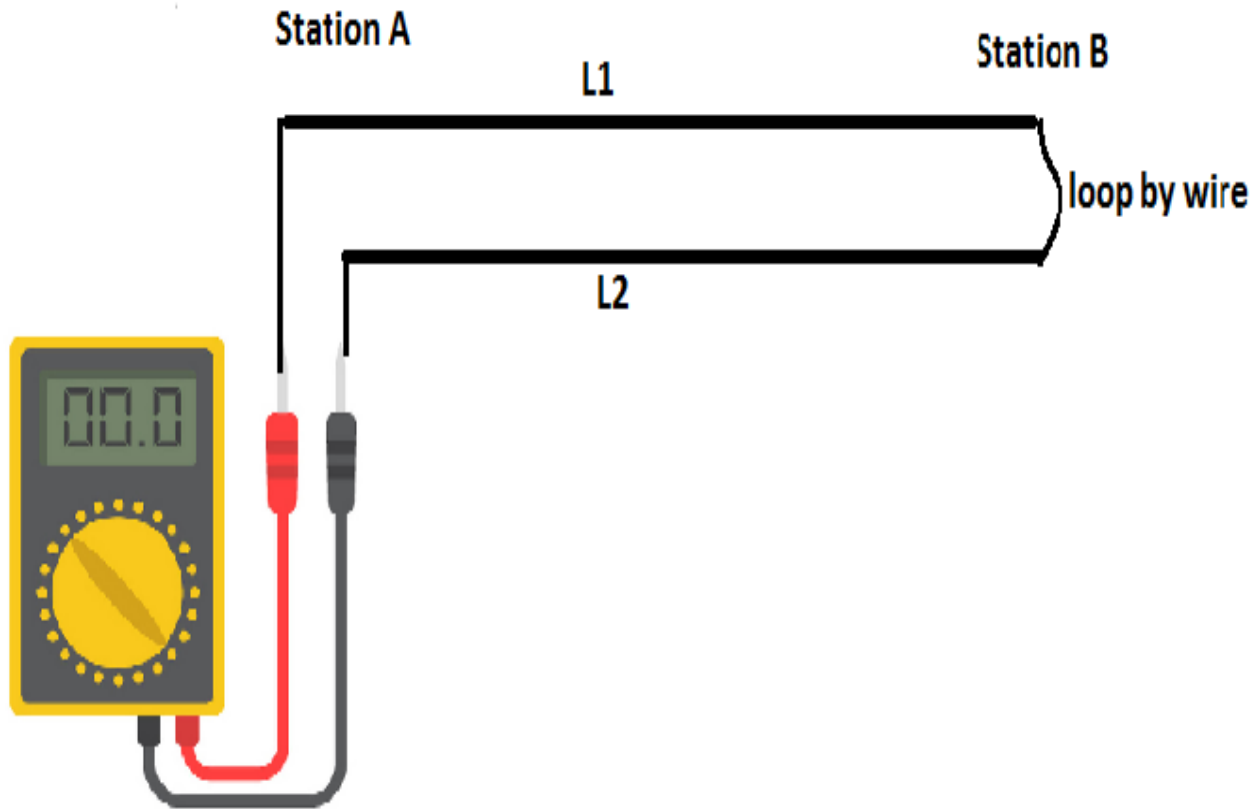
QUAD No	COLOUR OF INSULATION				CIRCUIT	
	A-Wire	B-Wire	C-Wire	D-Wire	With OFC	Without OFC
1	Orange	White	Red	Grey	Block Instrument	Block Instrument
2	Blue	White	Red	Grey	Spare for Block	Section Control
3	Brown	White	Red	Grey	E.C CKT	E.C CKT
4	Green	White	Red	Grey	4/1-LC GATE 4/2- BPAC	4/1-BPAC 4/2--LC GATE
5	Yellow	White	Red	Grey	BPAC(Block Proving by axle counter)	BPAC
6	Black	White	Red	Grey	TAWS(Train automatic warning system)	TAWS

Schedule of Testing & Measurements in Quad Cable

1. Loop Resistance Test	Monthly
2. Checking Attenuation	Monthly
3. Checking Cross Talk Level	Quarterly
4. Checking Noise Level	Quarterly
5. Insulation Resistance Test	Yearly
6. Earth Resistance measurement-	Half yearly

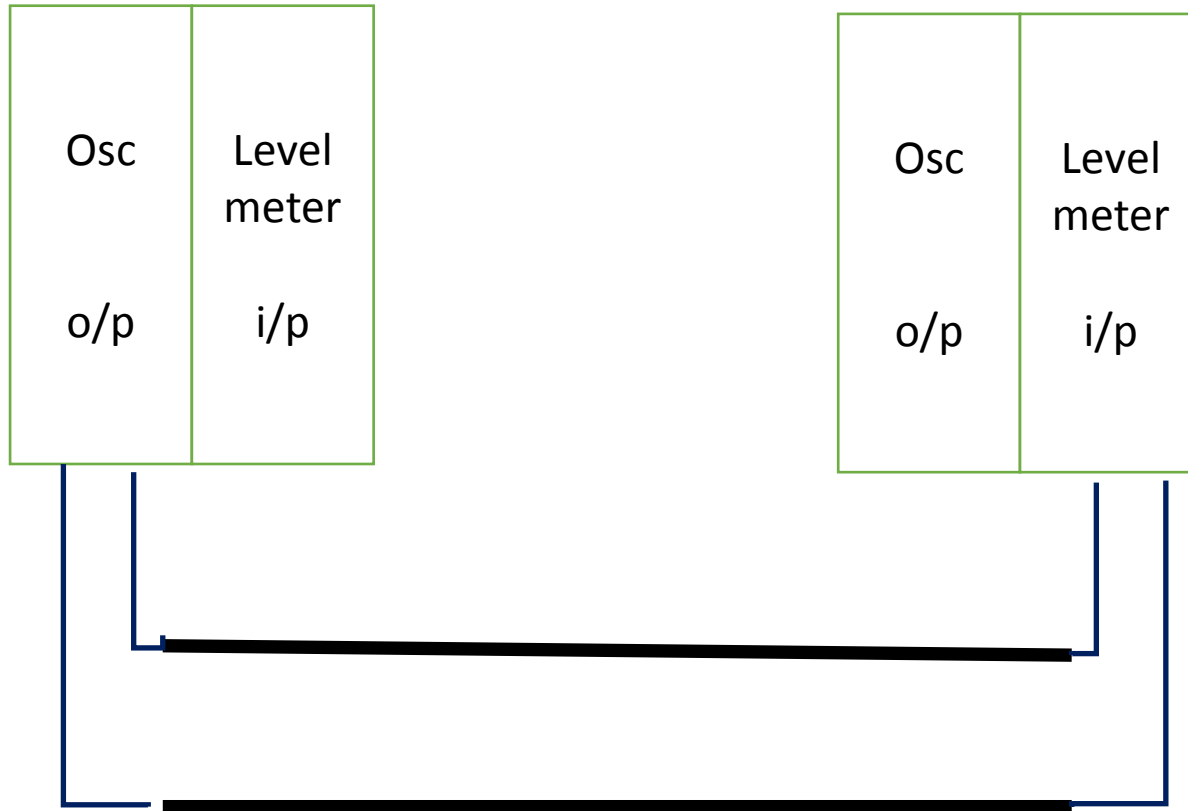
Test should be carried out when proper disconnection is accepted by control

CONDUCTION TEST



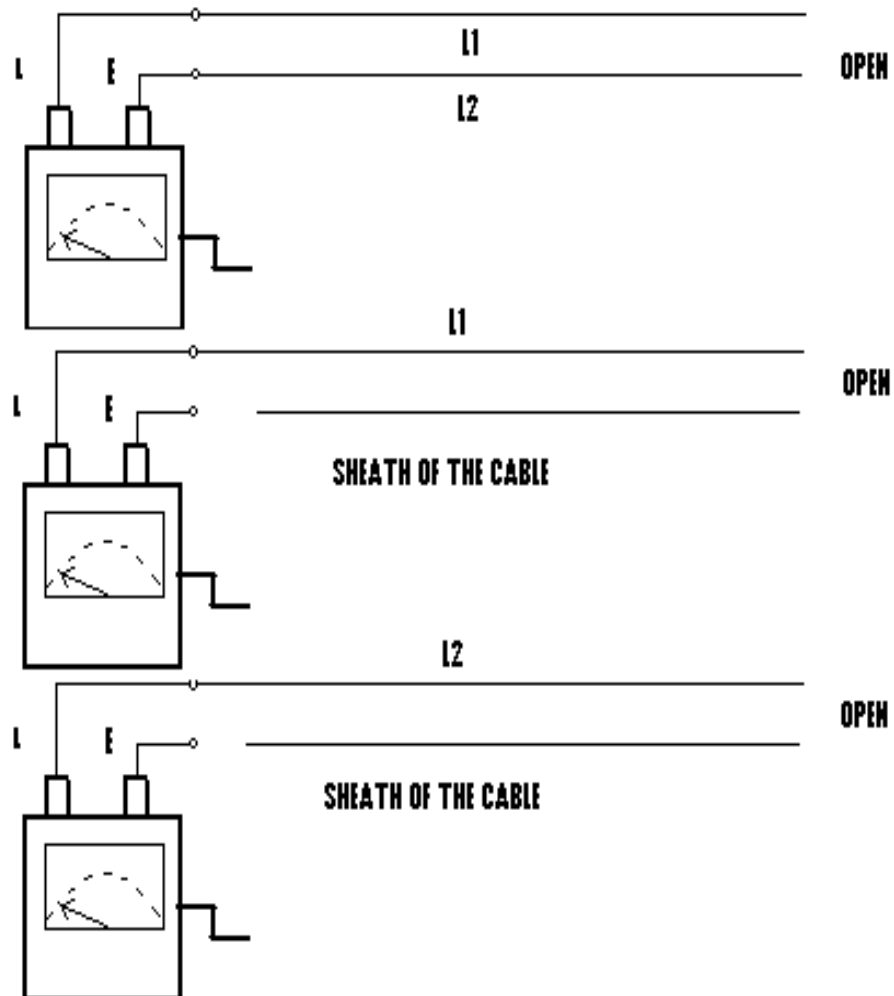
- a) Purpose : to measure the loop resistance of conductors which indicates the condition of joints.
- b) Measuring instrument used: Ohm meter or Multimeter
- c) Periodicity: Monthly
- d) Standard value: $56\Omega/\text{km}$

TRANSMISSION LOSS TEST



- a) Purpose : To measure the dB loss of the system (cable).
- b) Instrument used: TMS
(Transmission measuring set).
- c) Periodicity: Monthly
- d) Standard Value: 0.63dB/km at 800Hz
1.2dB/km at 2kHz

INSULATION RESISTANCE TEST



a) Purpose : To know the proper insulation of the conductor.

b) Instrument used: 100V DC meggar

c) Periodicity: Annual

d) Standard Value: 10 MΩ for block section
20 MΩ for block section
(for axle counter)

Note : All other conductors of the cable shall be shorted with armour(Earth) during test

Checking Cross Talk Level

A) Purpose : To Check Crosstalk From Other Pair

B) Meter Used: Oscillator And Level Meter

C) Periodicity: Quarterly

D) Standard Value: Better Than -55 dB

For NEXT And FEXT

Checking Noise Level

A) Purpose : To Check Level Of Noise

B) Meter Used: Psophometer

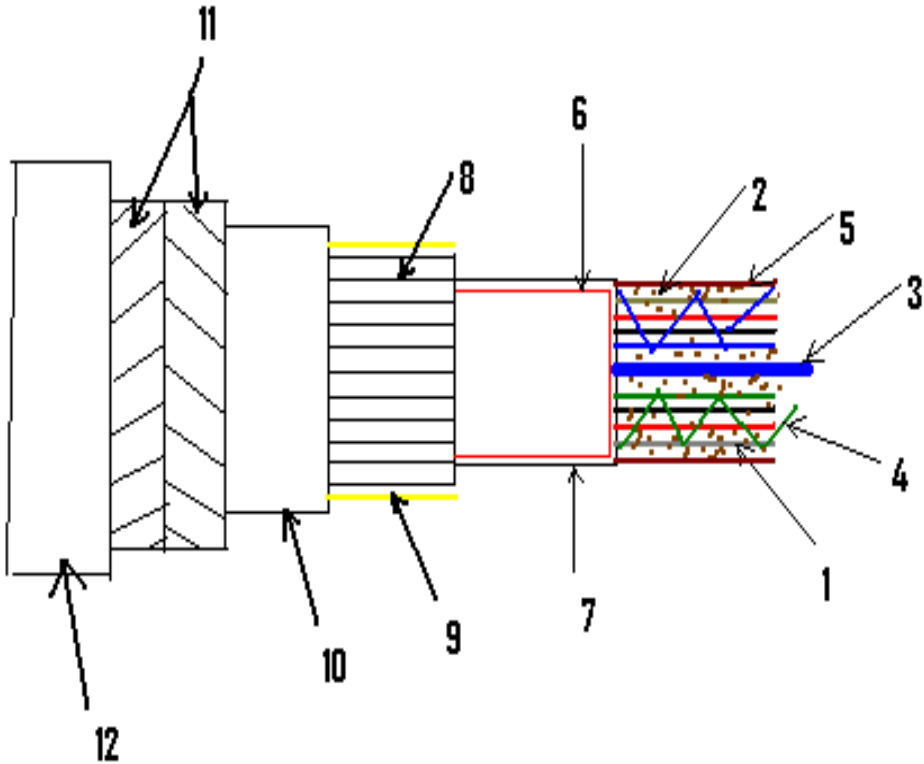
C) Periodicity: Quarterly

D) Standard Value: Less Than 2mV

Earth Resistance at Armour : Shall be less than 1 Ohm

CONSTRUCTION OF 6Q CABLE

1. Conductor
2. Petroleum jelly
3. Dummy tube
4. Binder
5. Polyester tape
6. Poly aluminum tape
7. PVC inner jacket
8. Aluminum wire screen
9. Woven tape(yellow color)
10. PVC intermediate jacket
11. G.I. Steel armour
12. PVC outer jacket



Induced Voltage in RE area

- In RE area induced voltage in Quad cable due to electrostatic and electromagnetic coupling from 25kv catenary can be very high (approx. 87.5V/km). This voltage adds up with increase in length.
- To reduce this; Armour, Al screen and Poly aluminum tape all three must be earthed (< 1 ohm) at both ends (stations). This reduces the induced voltage to 8.75V/km making quad cable safe for working. Continuity of Armour, Al screen and Poly aluminum tape must be ensured at all joints.
- Continuity should be checked during routine cable test.

Note : Any fault/negligence will buildup high voltage up to several hundred volts which is fatal for workmen and equipments.

Cable Markers

RCC cable markers shall normally be provided at a distance of every 50 meters on the cable route, at derivations and also to be provided at all types of cable joints. They should be of standard RCC with letters "**IR / 6 QUAD CABLE**" and logo engraved and painted. They shall be painted with **green** when placed at joint locations and painted with **red** for normal indication.

Typical 6 Quad cable failures & their causes

1. Cable burnt at joint due to lightning and all circuits failed- Armour connectivity at joint is given up.
2. Cable is noisy while train passing in the section BPAC circuit frequently failing- improper earthing of cable armour.
3. Cable cuts and thefts- Ensure the cable laid with in Railway Boundary, avoid the exposing of cable, implement the Railway Board JPO for Earth Digging works by Engg. Dept, Update the cable route diagrams and upload to web page for easy access to concerned dept.
4. Codal life of Cable- Plan for replacement of cable with in codal life(20 years).

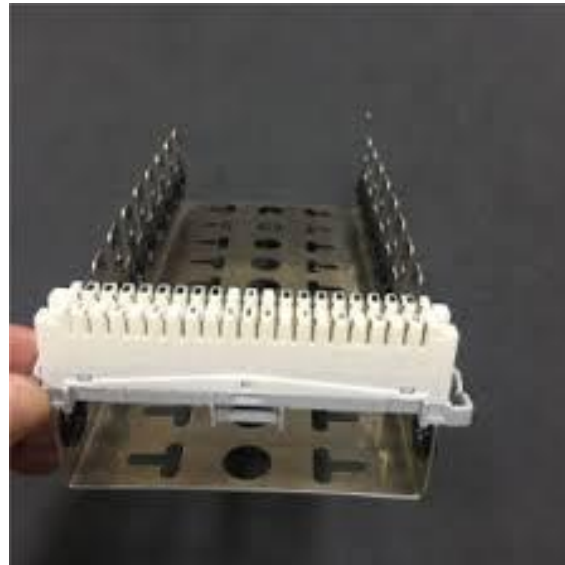
Marking on Cable

- a) Name/Trade mark of the manufacturer
- b) IRS Specification number
- c) Year of manufacture
- d) Length (Sequential marking)
- e) Cable drum number
- f) No. of pairs/conductor size (Example: 20 pairs/0.63mm)

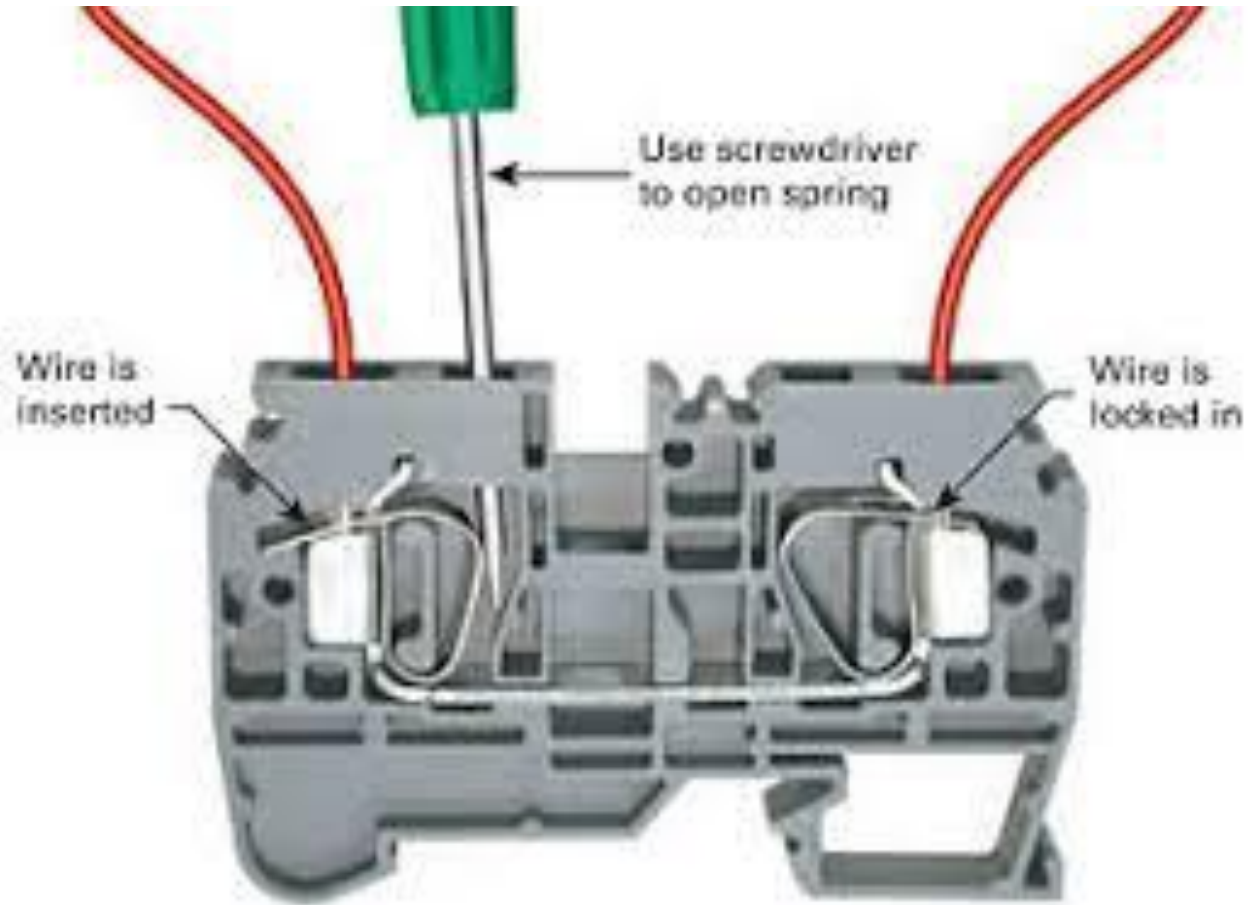
This marking exists throughout the length at intervals of one metre.

Connectors used for Cable Termination

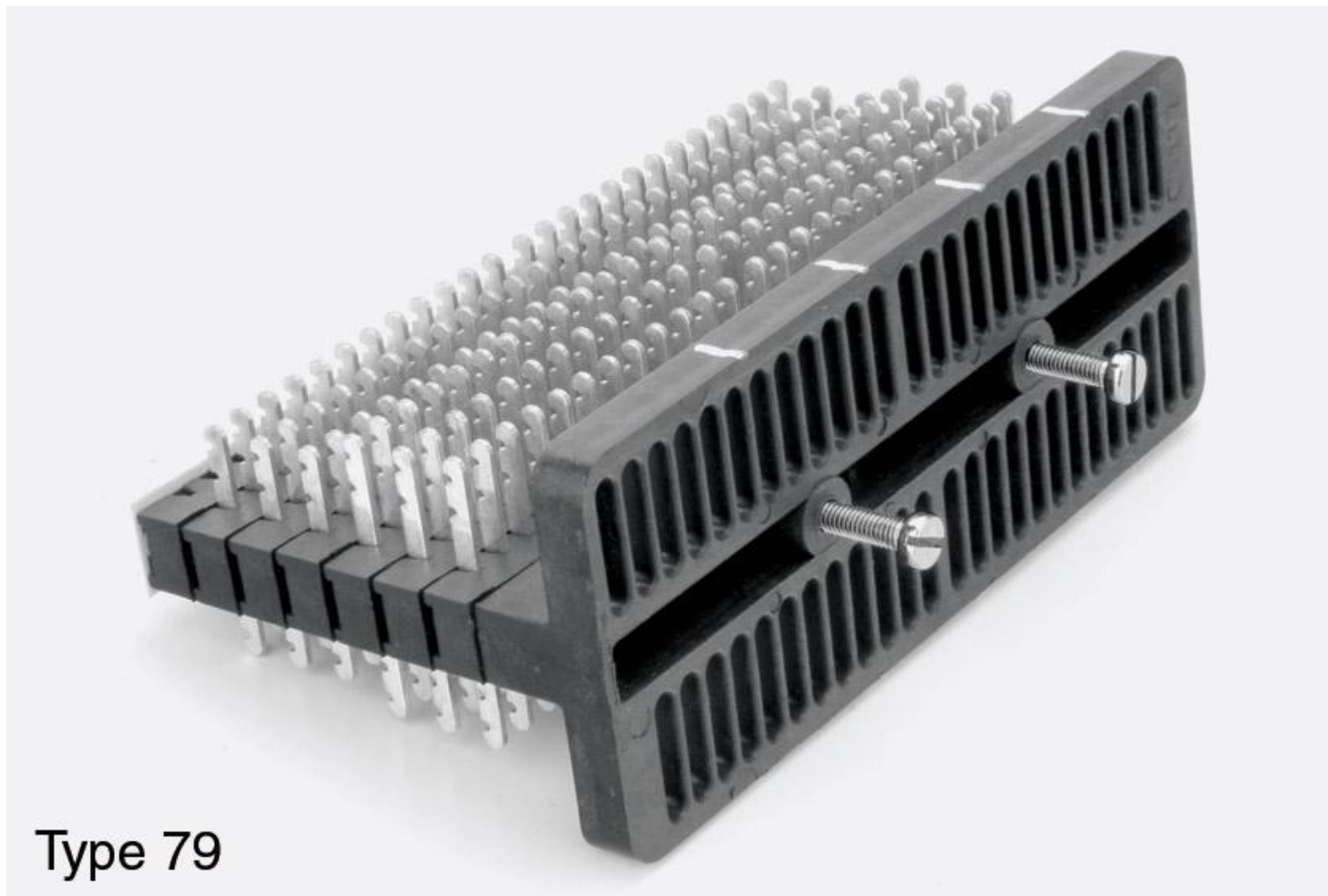
Krone type connector



Wago



Tag Block



CT box for Quad cable



OFC(Optical Fiber Cable)

It is a method of transmitting information from one place to another by sending light through hair thin optical fiber, generally made of silica, using the principle of Total Internal Reflection.

The process of communicating using fiber-optics involves the following basic steps:

- Creating the optical signal using a transmitter(Laser diode or LED)
- Transmitting the signal along the fiber.
- Receiving the optical signal and converting it into an electrical signal(Photo Transistor)

Merits of OFC

- Huge Bandwidth
- No Electromagnetic and Electrostatic interference
- Low attenuation (0.25 db/km at 1550 nm)
- Self healing rings under NMS control
- No cross talk
- Safety and Signal security
- Less chance of theft
- Flexibility in system upgradation

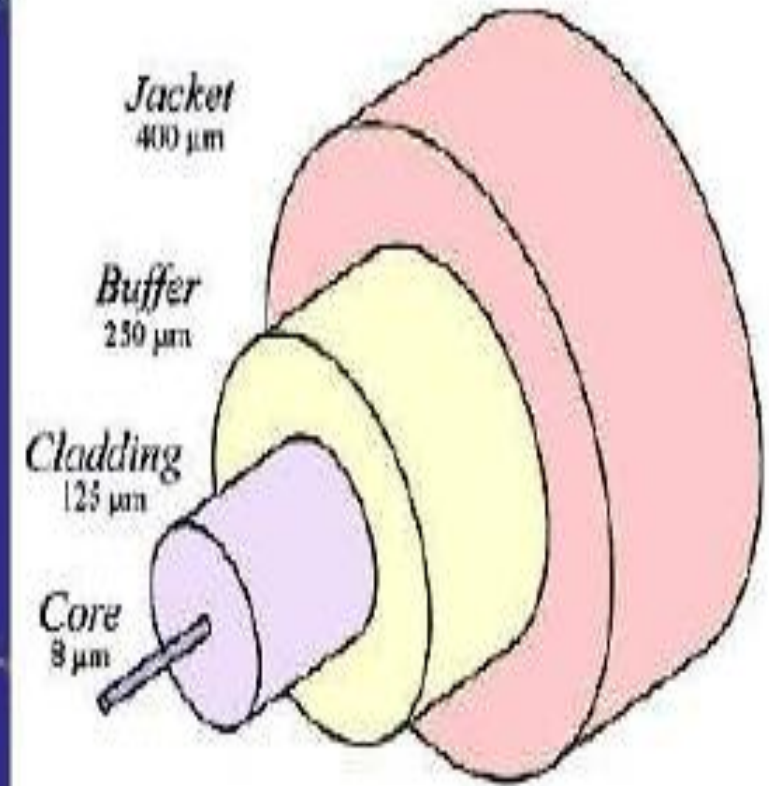
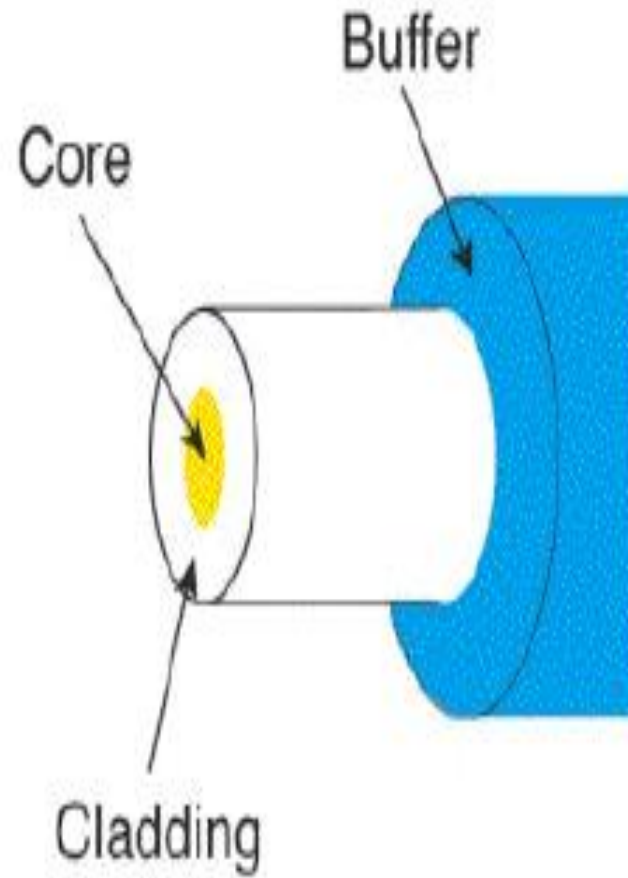
Demerits of OFC

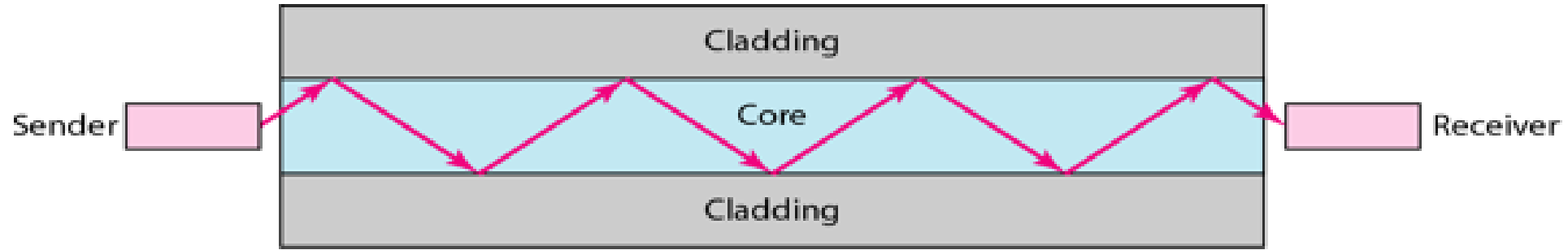
- Difficulty in Jointing (splicing)
- Highly skilled staff would be required for maintenance
- Precision and costly instruments are required
- Tapping for emergency and gate communication is difficult.
- Negligible resale value
- Special interface equipments required for Block working

Application OF OFC IN RAILWAYS

- All data communication networks(PRS & UTS,FOIS)
- Railnet
- Trunk connectivity
- Control communication
- Vital signaling circuits (Axle counter, UFSBI, Data logger)

DESIGN OF OFC

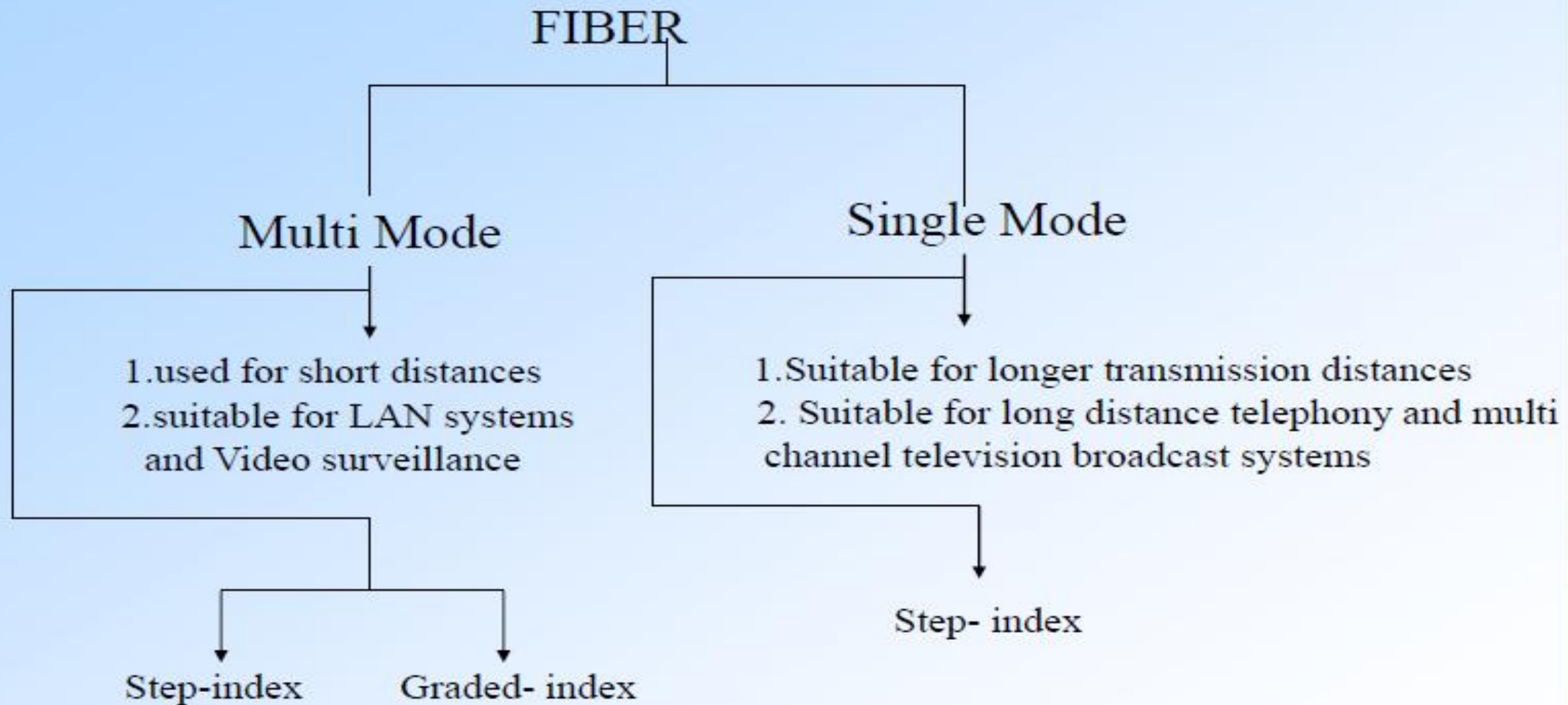




- $RI \text{ of Core} > RI \text{ of cladding}$

- Works on the Principle of Total Internal Reflection.
- Angle of incidence $>$ critical angle
- Refractive index of Core is more than Cladding as core is denser medium and clad is rarer medium.

MODES OF FIBER



Difference between Single (SM) & multimode(MM) fiber

<u>SM</u>	<u>MM</u>
Core dia= 8-10 μm	Core dia= 50-62.5 μm
Clad dia= 125 μm	Clad dia= 125 μm
Signal quality higher	Signal quality lower
Bandwidth higher	Bandwidth lower
Step index only	Step & graded index both
Smaller core diameter	Larger core diameter
Suitable for long distance	Suitable for shorter distance

Colour code of 24-F OFC

RDSO spec no.IRS:TC55-2006,REV-1 WITH AMENDMENT 1.1

24F armoured cable

- Normally used for under ground laying
- Loose tubes shall be placed in circular format as given below.

Loose Tube No.	Loose Tube colour
1.	Blue
2.	Orange
3.	Green
4.	Brown
5.	Slate
6.	white

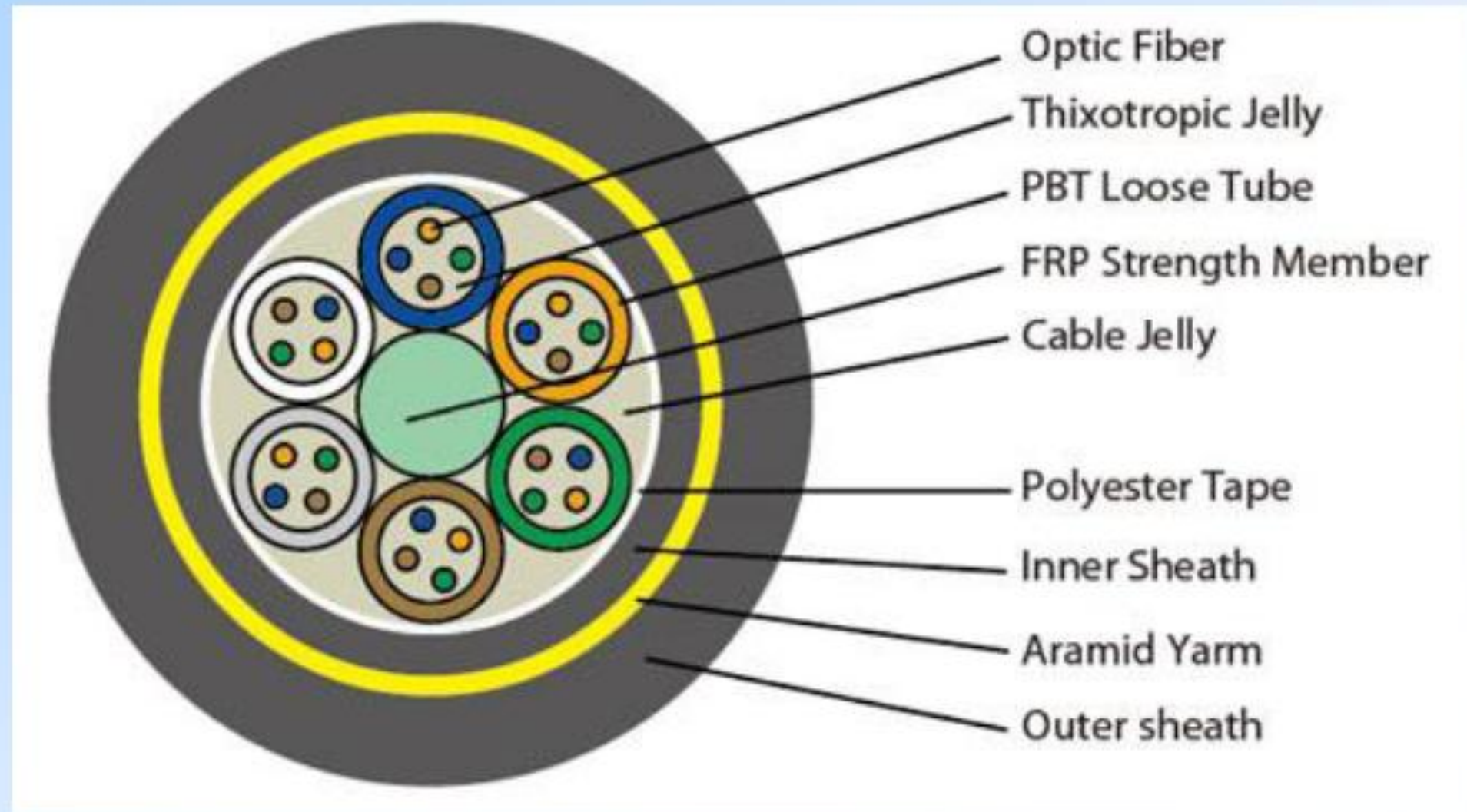
Each loose tube contains 4 fibers

Blue, Orange, Green, Natural

Colour code of 24-F OFC

Tube Colour				
1-Blue	1-Blue	2-org	3-green	4-Natural
2-Orange	5-Blue	6-org	7-green	8-Natural
3-Green	9-Blue	10-org	11-green	12-Natural
4-Brown	13-Blue	14-org	15-green	16-Natural
5-Slate	17-Blue	18-org	19-green	20-Natural
6-White	21-Blue	22-org	23-green	24-Natural

Cross-sectional view of 24 Fiber cable



Fibre-reinforced plastic (FRP) , Poly Butylene Terephthalate(PBT)

Transmission Loss in OFC

At 1310 nm wavelength: 0.35dB/km

At 1550nm wavelength: 0.25dB/km

Attenuation in OFC is Caused by

- **Scattering** : Due to impurities or irregularities present in the physical construction of Fiber light rays scatter in various directions.
- **Absorption** : Hydroxyl ions (OH^- ions, water) in the silica absorb energy of the transmitted signal
- **Macrobending loss**: Caused by the bending of entire fiber axis. (To avoid Bending radius should be more than 30 X dia of cable)
- **Microbending loss** : Due to micro deformation in fiber axis
- **Dispersion** : Spreading of transmitted light , unit is picosecond/nm-km

Splicing

- Max. permitted splice loss in case of fusion splicing is 0.1dB.



Steps for Fusion Splicing

- Remove Outer jacket, Armor and sheath using splitter.
- Clean loose tubes using cotton.
- Remove loose tubes using stripper.
- Remove Primary coating using stripper.
- Clean the fibers using isopropyl and tissue paper.
- Cut fibers at 90 degrees using cleaver.
- Put sleeve on individual fibers.
- Place and align fibers between electrodes of splicing machine.
- Using Splicing machine Fuse the fibers with electric arc ensure loss below 0.1dB if not then break the joint and repeat the process of splicing.
- Cover spliced portion with sleeve and apply heat in heat chamber.
- Arrange the fibers in tray.

Tools for fusion splicing

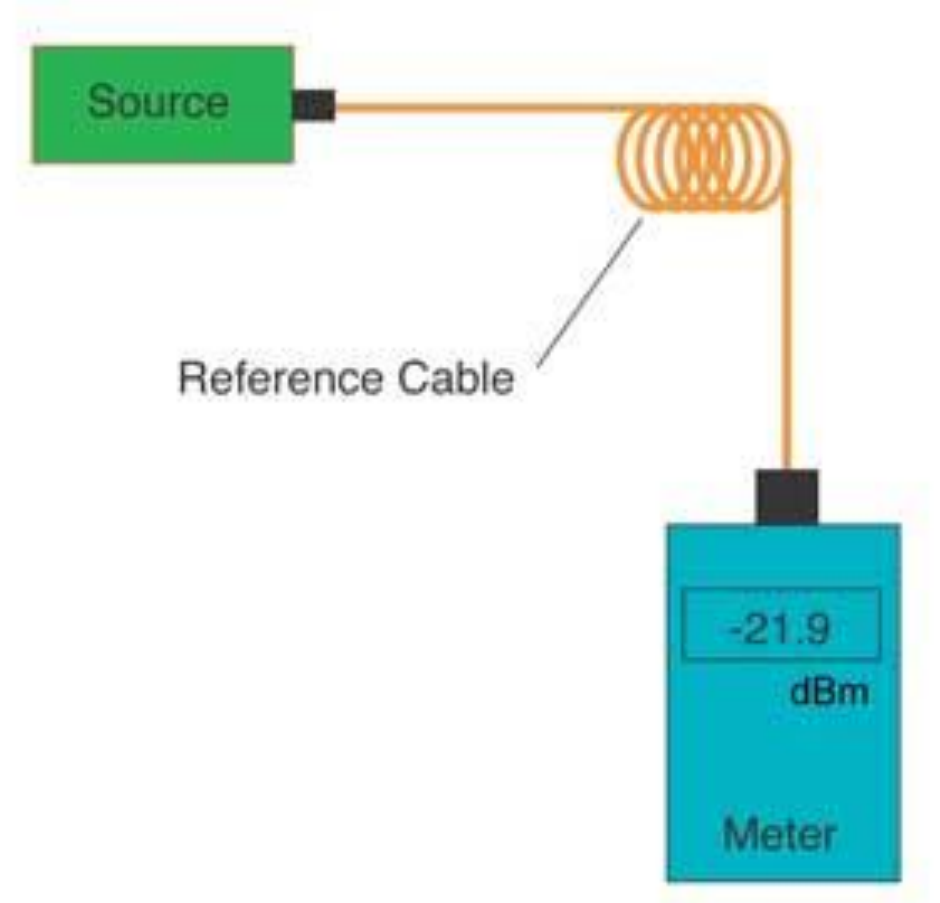
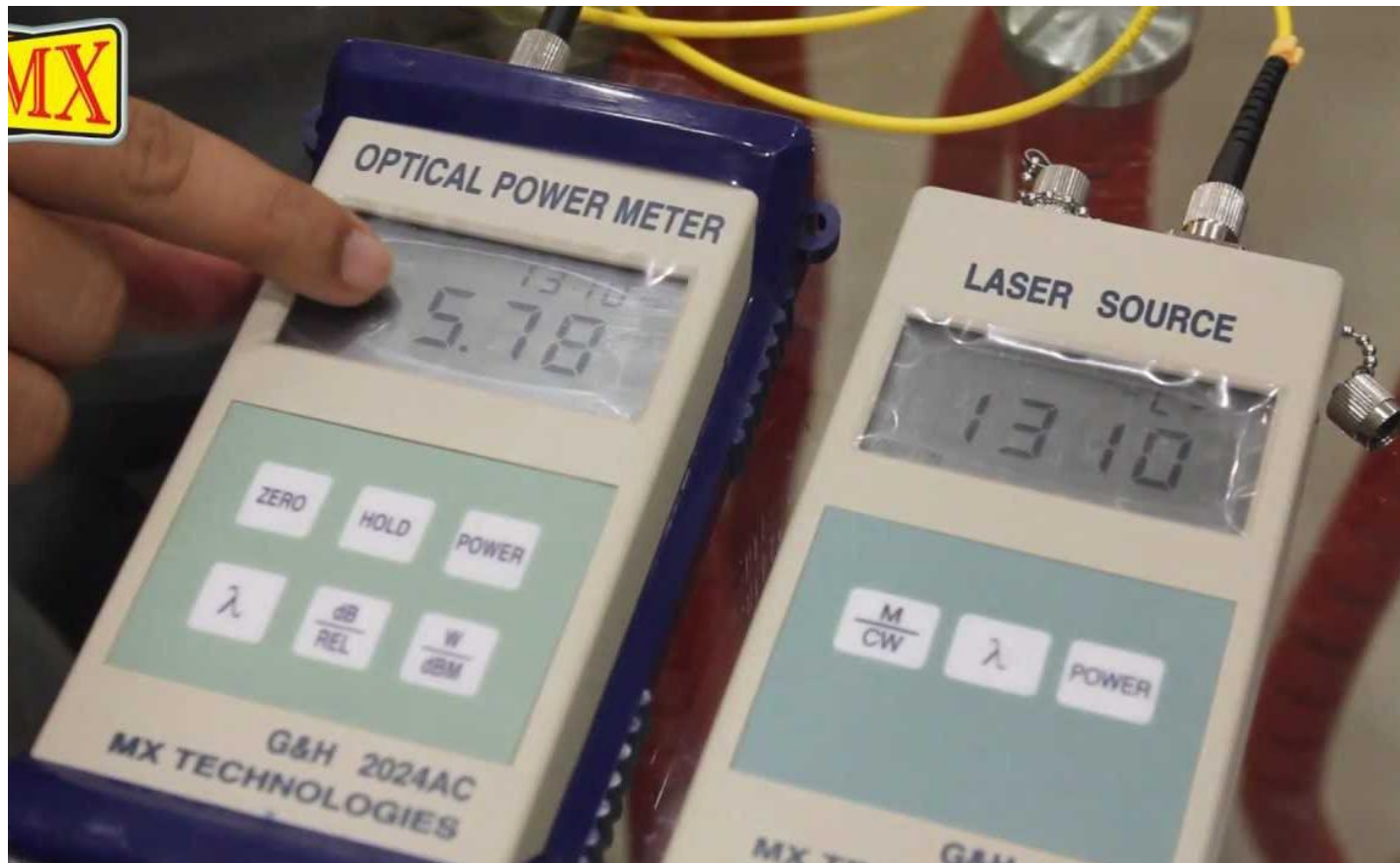
S.No	Name of tool	Function
1	Fibre Stripper	To strip the plastic cover coating of the fibre
2	Fibre Cleaver	To cut the fibre end perpendicular to the axis
3	Tissue Papers	To clean the fibre after stripping
4	Cleaning liquid	To clean the fibre and splicing machine's lens, V groove etc.
5	Jewellers Screw	To adjust some potentiometer in fusion splicing machine
6	Cotton swab	To clean the fibre and splicing machine's lens, V groove etc.
7	NO-NIK Tool	To remove white colour coating of tight buffer tube
8	Flash Light	To test the pig tails (tight buffer tube)

Tools for cable preparation for fusion splicing

S.No.	Name of tool	Function
1	Cable cutter	To cut the cable in full
2	Jacket remover	To remove outer jacket
3	Utility knife	To cut narrow jacket circumferentially
4	Scissors	To cut rip cord, Aramid yarn, Binders, fibres etc.
5	Diagonal cutting pliers	To cut central members, fillers etc.
6	Sheath Ripper	To cut the polythene binders
7	Vinyle insulation tape	For proper marking of cable
8	Gel off paper	To clean the jelly
9	Towel cloth	To clean the cable
10	Number Book	For cable and buffer tubes identifications
11	Measuring Tape	For different length measurements
12	Buffer Stripper	To strip the buffer tubes
13	Paint Marker	To mark on cable

Measurements in OFC

Optical light source and Optical Power meter



OTDR(Optical Time Domain Reflectometer)

- Used to evaluate parameters such as splice losses, fiber attenuation etc.
- Works on the principle of Fresnel reflection and Rayleigh backscatter .
- Gives very accurate location of cable cut/fiber break or defective joints.

YOKOGAWA  A07270
OPTICAL TIME DOMAIN REFLECTOMETER

OPTICAL PORT

No Tabr
Data wron
Next, worse

MENU

F1

F2

F3

F4

F5

ESC

FILE


SCALE

SETUP

REAL
TIME

AVG



2009/01/27 11:25 Tryb: Kreator Srednia 100% LSA Plynny  =AC=

SdB/div

Nazwa pliku: 1310nmCENT SZPIT GIZYCKO-G10013a.SOR

40.000dB

Naglowek:

OTDR

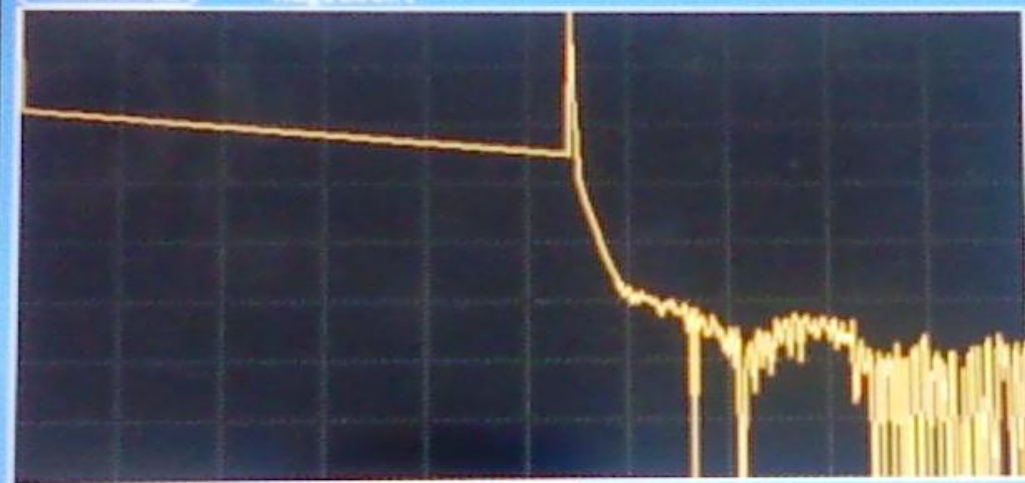
Marker

Analiza
Zdarzenia

Makro

Info.Ustaw
Pomiar.

Nastepny
1/2



0.00000ka

2ka/div

SWP: 50cm

20.00000ka

Kursor :
Dlugosc fali: 1310 nm
Zakr. Pom: 20 km
Szer. Impul: 100 ns
Tlumienie: Auto
Okres usr.: 3 min
IOR: 1.46000

Tlum. spawu :
Straty odbic. :

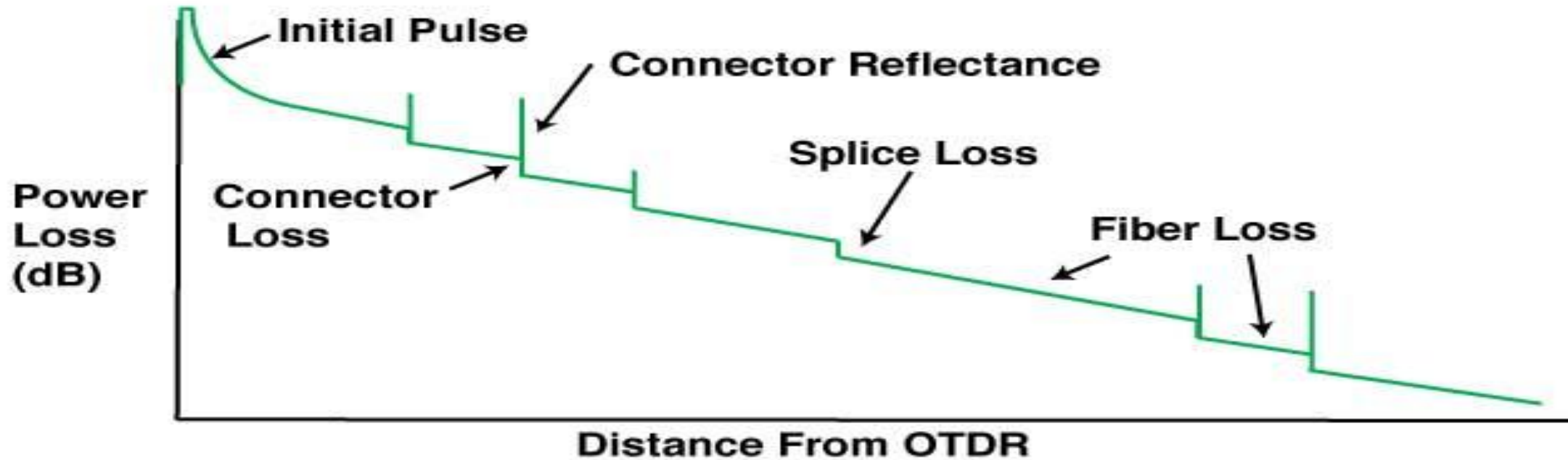
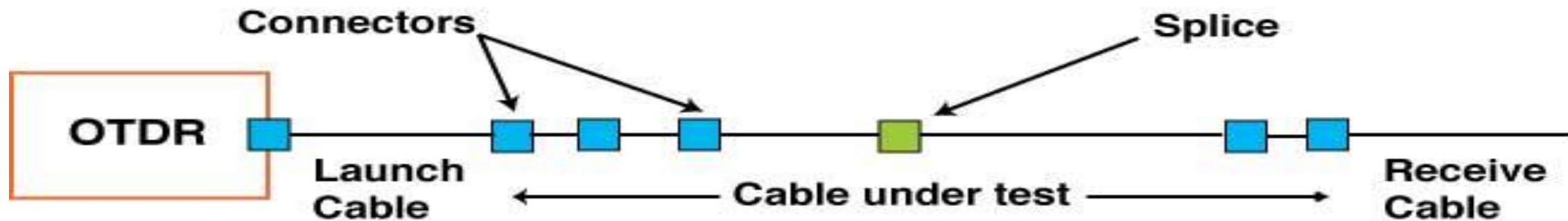
①-②

②-③

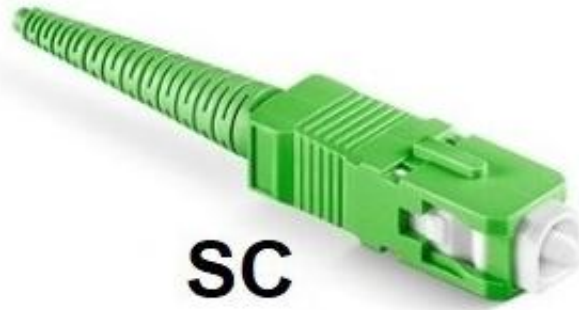


Pomiar start/stop: [REAL TIME] lub [AVG]. Ustaw pomiaru: [SETUP]

OTDR Trace Information



OFC Connectors



Attenuators



FDMS(Fiber Distribution and management System)



THANKS