# Small-Office Home-Office (SOHO) and Residential Services

# Internal Cabling Guidelines

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## Amendment History

| Date | Issue | Amendment History | Author |
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| July 22, 2011 | Version 1.3 | Residential and SOHO Internal Wiring Guidelines, Designers' Guide for Greenfield Developments in Qatar | ictQATAR/Qtel |
| October 2011 | Version 2.0 | SOHO and Residential Services Internal Wiring Guidelines (includes all the recommendations from Version 1.3, iCT Qatar Document) | Qnbn |
| March 2012 | Version 3.0 | SOHO and Residential Services Internal Wiring Guidelines (incorporating changes discussed and agreed between Qnbn, Qtel and Vodafone) | Qnbn |
| April 2012 | Version 4.0 | Incorporating further changes discussed and agreed between Qnbn Qtel and Vodafone, submitted to ICTQatar for approval | Qnbn (to be approved by ICTQatar) |
| February11, 2013 | Version 5.0 | Revising the front cover of the document to update the Qnbn logo and generally clean up the graphics. | Qtel and Qnbn |
| February28, 2013 | Version 6.0 | Renaming the document to "internal cabling guidelines", removing "Qnbn FTTH Network" from the header, and removing "Qnbn Proprietary" from the footer. | Qnbn and Qtel |

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# 1 Introduction

## 1.1 Purpose and Scope

Licensed Operators have an obligation to provide basic services to all customers with an ICT requirement, be it residential or business. It is also an objective of the operators within Qatar to provide wherever possible state-of-the-art infrastructure and services to help make Qatar a world leading market for ultra high speed internet as well as leading edge products and services.

Licensed Operators within Qatar require landlords, building owners and developers to follow the guidelines within this document to ensure that the best and fastest services may be provided to the customer.

To that end this document sets out to:

1. Set the minimum requirements regarding the provision of internal wiring to support Telecommunications Services in Residential and Small Office Home Office (SOHO) premises in Qatar.
2. Set out a best practice guideline to which all parties involved in the design of internal wiring shall comply.

The guidance provided herein on internal cabling infrastructure is also designed to help “future-proof” the network as far as reasonably possible given the current trends in technology through the use of ducts, Category-6 cable/connector assemblies, and limiting cable span lengths to help maximize transmission performance.

The network demarcation points and licensed operators’ responsibilities are defined in section 3 of this document.

## 1.2 Target Audience

This document has been prepared to provide guidelines that need to be considered during the design stage of internal wiring and civil infrastructure of residential and SOHO premises.

The target audience for this document is wiring designers, network engineers and construction consultants.

# 2 Compliance

While compliance with this guideline may assist to fulfil the legal and regulatory obligations, this document does not constitute legal advice or a comprehensive outline of all legal issues relevant to the provision of premises wiring services in Qatar.

In addition to compliance with this guideline, industry participants are obliged to comply with all applicable laws, regulations and requirements of any government or statutory body, as well as with any other applicable industry and building standards or codes, whether voluntary or otherwise.

In the event of any inconsistency between this guideline and any relevant legislation or any Bilateral Agreement, this inconsistency will be resolved in the following (descending) order of precedence:

1. Any Legislation or relevant regulation
2. This guideline
3. Any Bilateral Agreement

High quality cable installation is needed no matter which cable medium is being placed – fibre or twisted-pair copper cables. Most network problems that occur with high-speed data cable systems can be traced to poor cabling techniques (during construction, installation or maintenance) that damage cable and components. To obtain the reliable high performance design targets for an installed data cable system, various factors need to be controlled.

1. Materials Selection - The cables, connectors, and terminals used shall meet adequate technical specifications such as those in Section 8 and Annex B, C, D and E, as well as references to applicable industry specifications and codes. All the hardware shall be manufactured under a certified Quality Management System (QMS) such as ISO 9000.
2. Engineering Plans - Detailed engineering plans, drawings and general directions including specifying the best or first choice cable path shall be provided for installation.
3. Installation Practices - Minimize physical stress and damage to cable by decreasing exposure of cables, components and individual conductors to kinking, abrasion, twisting, bending and compression.
4. Worker Training - Equip and train installers with adequate knowledge, good M&P (methods and procedures), and the correct tools that are maintained in good working order.
5. Safety - Follow sound safety methods and procedures for both personal safety and protection of equipment.
6. Quality Assurance (QA) - Follow sound QA strategies that include network testing during all phases of the work.

In this guideline, these factors will be addressed to help ensure that the most reliable and high performance data cable network is planned, constructed, installed and maintained. If these factors are addressed effectively and a testing system of checks and balances used during construction and installation, then a highly reliable physical infrastructure will be delivered to support the best possible current and future

broadband communications network for QATAR.

# 3 Scope and Responsibilities

The scope of this guideline is the “internal wiring for residential and SOHO premises”. These internal wiring spans are defined as wherever the cable can be run entirely within a fully enclosed access-way owned by the customer, including any other related elements (e.g., splice boxes and sockets).

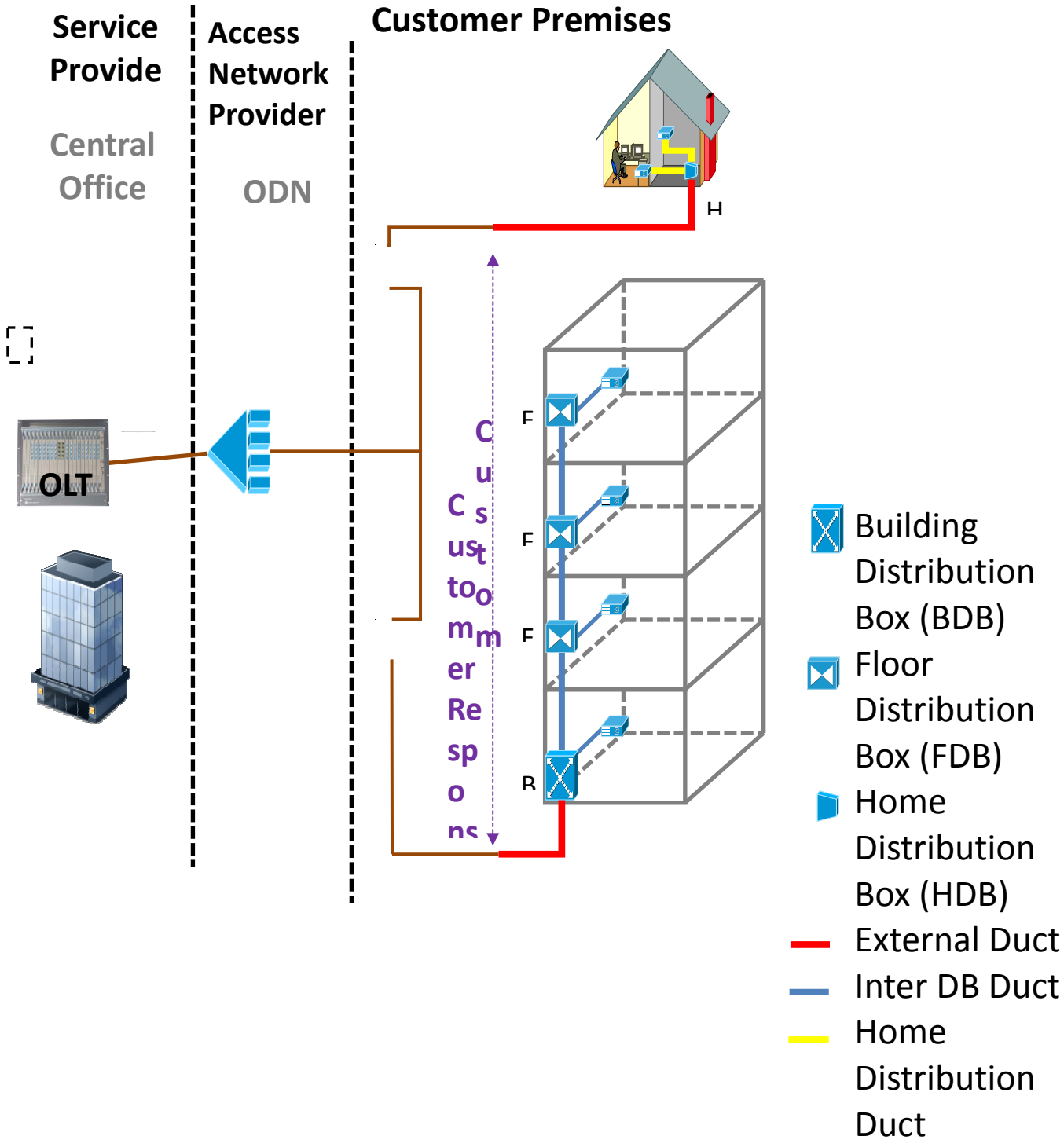
Each residential unit, regardless of whether they are in a Multi-Dwelling Unit (MDU) or a Single Dwelling Unit (SDU), would have 4 fiber optic strands, one for each of the 3 service providers and one spare. The assumptions and guidance with respect to Small-Office-Home-Office (SOHO) retail subscribers would be same as for residential subscribers.

The residential retail subscribers should be able to avail services from all three service providers simultaneously, if they so choose.

Figure **1** shows the demarcation point where the “Customer Responsibility” begins and that designates the scope of this guideline including external duct and all internal ducting and wiring (fibre and copper) from the Service Provider to customer premises, detailing the specific demarcation points that constitute ownership boundaries. The building owner is responsible for the maintenance, repair, and future upgrade requirements of in-building cables.

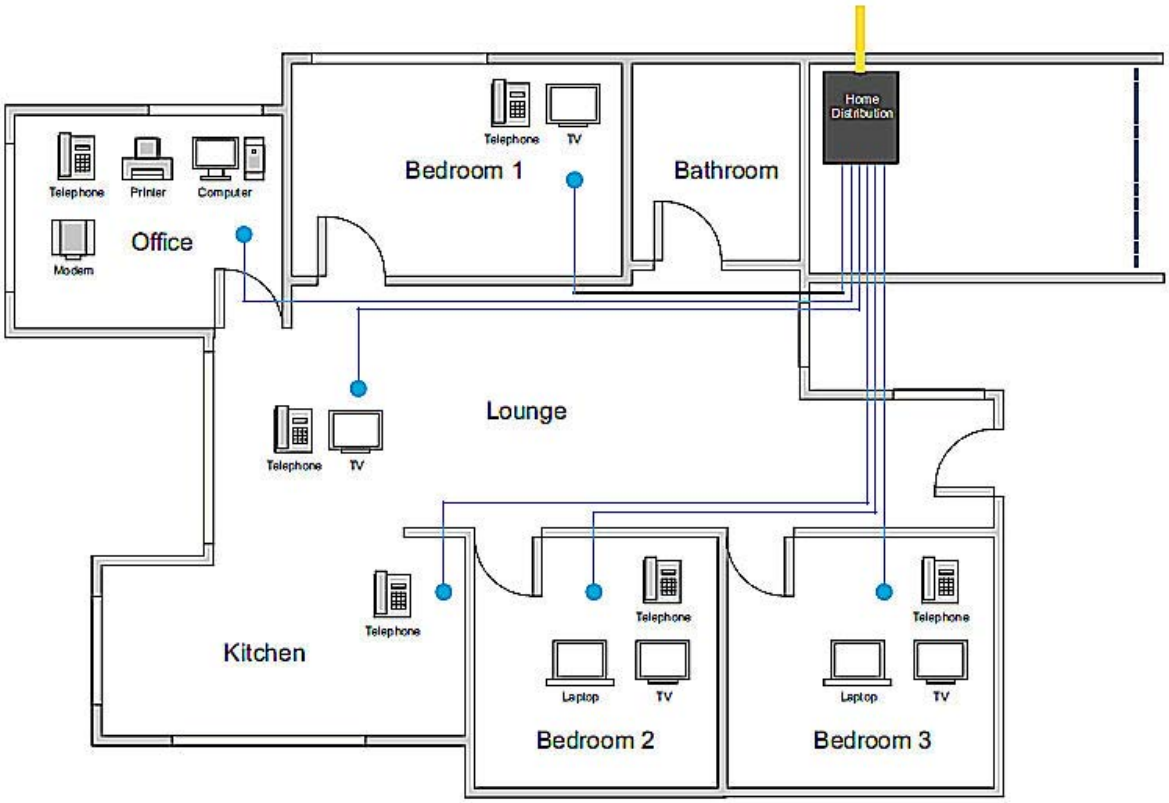
To provide telecom services, the internal concealed pipe and other associated requirements vary for the different building types. The various types of buildings are grouped as commercial buildings, residential towers, ware houses, medium high-rise buildings, shopping complexes, retail houses, row houses, independent villas, Campus villas, labour camps, mosques, petrol pumps, etc. The building owners, builders, property developers, consultants and contractors are advised to provide the various in–building requirements, as applicable, to ensure timely provision of services.

Figure 1 Scope of this Guideline



Building owners are also responsible for any additional internal wiring as well as any special requirements for other non telecommunications services (BMS, CCTV, etc). Additional internal wiring would include wire spans from the Home Distribution Box (HDB) and the individual pieces of customer equipment (laptop, PC, telephone terminals) along with power cables for the equipment. Figure 2 illustrates some of the additional internal wiring possibly required within the living area. Within these spaces, individual building and dwelling owners will make very different choices on exact cable pathways and locations based on their immediate needs and desired flexibility for the future. Such additional internal wiring must not adversely impact the quality of the installation of wiring to support telecommunications.

Figure 2 Plan View of Scope (example)

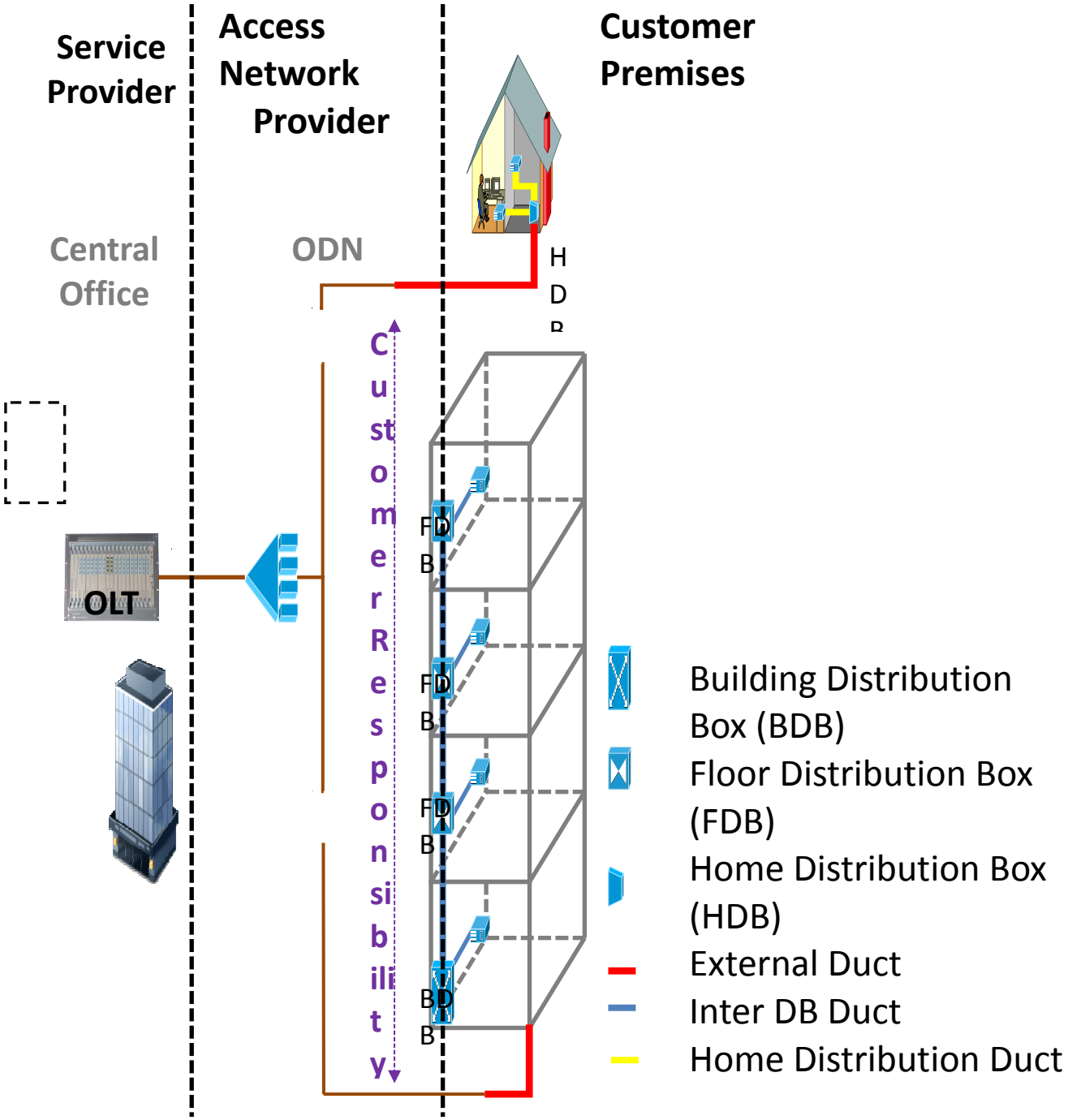



### 3.1 Demarcation Points

A summary of the key network demarcation points and areas of responsibility are described below:

- From property line of the home or building to the PHDB or BDB - The responsibility for this section of plant will often be shared between the ANP and home/building owner. It is desirable that details of responsibility be explicitly included in the contractual service agreement between ANP/service provider and the customer (building/home owner). Such agreements should address issues of accessibility for servicing and repair, as well as physical security to help prevent or limit damages from accidents and intentional attacks.
    - Villas and multi-dwelling unit (MDU) complexes often having substantial outer walls which can not only protect but also create access problems.
    - In some cases the wall of the building may be a more useful demarcation line then the property line – e.g., when PHDB or BDB is located inside the building structure.

- Building Owner - owns, manages and is responsible for the internal wiring from building side of the BDB or PHDB to the HDB located inside the living space. The building owner is responsible for all wiring located inside wall cavities.
- Homeowner or Dwelling Unit Owner - owns, manages and is responsible for the internal wiring inside the living space



# 4 Telecommunications Services

The PON with in-building twisted pair cabling and facilities infrastructure described herein is intended to support the full range of current residential and enterprise services available as well as applications and services that can be reasonably expected to develop over the next decades. This would include, but not be limited to, the following:

- Voice Services
- Video Delivery Services
  - Subscription television: IPTV (Internet Protocol Television)
  - Video-on-Demand (VoD)
- Data Services including IP VPN and VPN Services
  - Internet Protocol Virtual Private Networks (IP VPNs) support multiple data, voice and video applications on a shared network infrastructure. These shared networks may be within a single building/complex or across a wide geographic area.
- High Speed Internet services

These services provide broadband Internet connectivity and download speeds which are many times faster than a dial-up connection.

The network infrastructure described here will need to support a large variety of SOHO and residential services that involve not only large amounts of streaming video and other graphic applications but also the rapidly expanding demand for simultaneous delivery of multiple communications services involving large amounts of network traffic in both the upstream and downstream directions.

# 5 General Design Considerations

1. All designs shall support a multi-operator environment of up to three operators. When this document does not specifically mention multi operators, and where diagrams within this document do not show specifics for a multi-operator environment, it is the duty of the designer to ensure that support for up to three operators is provided in their specific design(s).
2. The number of fiber cables to each unit or dwelling may vary, but the number of independent fibres shall be at least four (4).
3. All copper cable elements (twisted copper pairs) must be rated at Category-6 or better.
4. Wherever an UTP (unshielded twisted pair) cable termination is required, all UTP cable pairs must be terminated.
5. All wall-mounted DBs (Distribution Boxes) must be installed at least 1.2m above the finished surface level.
6. All UTP cables must be laid in star topology with no exceptions.
7. Cable span between Patch Panel and Socket shall not exceed 90m in length. This is to allow for 10m of patching.
8. Spans between equipment running Ethernet protocol shall not exceed 100m in length.
9. All Optical Fiber elements must be Single Mode (SM) and at least compliant with ITU-T G.657.A2.
10. All fibre splices in internal wiring are to be “Fusion Spliced”. Typical splice attenuation shall not exceed 0.05dB
11. The minimum bending radius, expressed as a multiple of the overall cable diameter shall be 20 times overall diameter for Single Mode fiber cables.
12. As a minimum requirement, the power measurement shall be taken between the ODF, located in a Telecom Room (TR) and the FTB (Fibre Termination Box) at 1310, 1550 and 1650nm after installation. A copy of the test results is to be provided and left with the installation documentation and certification.
    a. It is advisable that the fiber characterization documentation and certified data package includes OTDR (Optical Time Domain Reflectometer) scans and power loss measurements for the complete optical span from the ODF/OLT in the Telecom Room to the FTB.
    b. Such OTDR and power measurements should be made at appropriate and convenient times during the construction and installation process to help provide interim quality checks on the splicing, placement and connectorization activities that can degrade the fiber performance.
13. All CAT6 spans must be continuous - middle joints are not allowed.
14. All elements of internal wiring must be labelled properly to simplify operation and maintenance work. Labels on elements must match the label in the documentation and the labels at each end of single span shall correlate in description and color. Various methods and strategies of identification can be used including printing on cable jackets along with printed or colored tags at cable/fiber termination points.
15. In any villas or compounds having more than 100 connections and in all multi dwelling units (MDU) complexes, a Telecom Room must be provided.

16. In any MDU complex, if the total number of connections is more than 100, a Telecom Room Type A must be provided.
17. In any MDU complex, if the total number of connections is less than or equal to 100, a Telecom Room Type B must be provided.
18. For all outlets supplying power for any telecommunications service, the use of UPS is the recommended back-up powering option.
19. Only components that have been independently certified to meet applicable UL or TUV safety criteria (or equivalent requirements) by a recognized independent body shall be used.
    a. UL - Underwriter's Laboratories
    b. TUV - Technischer Überwachungs-Verein (Technical Inspection Association)
20. All Category-6 rated cables are to be tested and certified as meeting Category-6 transmission standards (TIA-EIA 568 criteria) through testing with a calibrated Industry Standard Category-6 test set. A certified copy of the compliance test results is to be provided and left with the installation documentation and certification.
21. Any design based on this document must clearly document that and specify which version/date of this document is being followed.

### 5.1 In-Process Installation Quality Checks

The installation methods and procedures used to build the physical plant is a critical component of creating a quality network service. The functional performance of a good quality ITU 957 bend-resistant fiber cable (ITU G.657, "*A Characteristics of a Bending Loss Insensitive Single-Mode Optical Fibres and Cables for the Access Network*") can be quickly compromised by bad or improper installation methods and procedures during the construction work. A Category 6 cable connected improperly to a Category 6 terminal block can easily result in a service that is well below the acceptable and expected Category 6 performance.

Typical statistics for cabling network infrastructure show that

- Cabling costs about ~10% of the total network infrastructure
- Typical cabling systems last 16-20 years usually outlasted only by the shell of the building
- 60-80% of the network problems have root causes in poor cabling techniques that damage cable and/or cable component problems.

As discussed earlier in Section 2 above and elsewhere in this guide, the process checks to achieve the desired quality assurance and reliable performance of the network include various factors including:

1. Quality materials selection through adequate functional performance specifications for products (see Section 8, Annex B-C-D-E) coupled with a manufacturing process that follows good Quality Management Systems (QMS) such as ISO 9000. A 5-year warranty for the major plant elements shall be required to help ensure long-term reliable performance of plant.
2. Engineering Plans - Detailed engineering plans, drawings and general directions to

help specify the best cable path shall be provided.

3. Installation Practices - Minimize physical stress and damage to cable by decreasing exposure of cables, components and individual conductors to kinking, abrasion, twisting, bending and compression.
4. Worker Training - Equip and train installers with adequate knowledge, good M&P (methods and procedures), and the correct tools that are maintained in good working order.
5. Safety - Follow sound safety methods and procedures for both personal safety and protection of equipment.

To help ensure adequate quality of workmanship during construction (Items 3 and 4 in the above list), agreements covering in-process quality checks along with training requirements and certifications for construction and installation workers need to be established and followed. Having quality checks and processes in place during the installation will help avoid repair time, remedial costs and future problems. Having post-construction performance tests are baseline requirements.

The installation/construction company is required to show that industry best practices have been followed and their installation crews have been both (a) properly and adequately trained, and (b) that materials and tools used (e.g., cables, connectors, and crimping tools) are well-maintained and compatible with each other.

Testing of the cable, connection, termination and other network element equipment is a vital step in evaluating system performance and needs to be completed at the several points during installation and construction activities. To maximize the reliable lifetime of the communications facilities, the network operator and building owner should ensure by physical plant and transmission testing that the system performance is met.

The final acceptance performance tests for the installed system shall be documented and certified to characterize the transmission profile for the network and for individual termination points. Separate profiles of transmission performance of the key spans will be provided and include:

- OSP segment = Fiber link from the CO (OLT) to building demarcation point (BDB or PHDB).
- Inside Building Span = Fiber or copper cable link from the building demarcation point (BDB or PHDB) to FDB and HDB
- Home Span = Copper cable link from HDB to individual connection point (e.g., wall jack or socket).

These records need to be easily assessable during re-configuration of the network, adding data stations and troubleshooting any future problems to help locate and repair any problems. All test sets used to characterize these spans shall be independently calibrated and have labels detailing calibration date and status.

Qualification testing shall be completed for all new plant after it has been built or for older plant immediately after it has been modified. The qualification test record is used not only to certify the network as meeting contractual agreements, but also it will become the reference point for any future examination and troubleshooting of the network. This testing should include frequency sweeps to characterize the network fully.

See Section 9 and 10 for more discussions and details on the appropriate guidelines and procedures for qualification testing of the in-house plant.

# 6 Internal Wiring Functional Components Overview

Internal wiring elements can be grouped into five functional groups:

1. Telecom Rooms (TR)
2. Entry Box and Pipe
3. Distribution Boxes (DB)
4. Optical Fiber Components
5. Copper Components
6. Ducting System

These functional groups contain the following components:

## 6.1 Telecom Room (TR)

In any internal wiring scenario, there are THREE (3) different types of Telecom Room (TRs) that may be used. For technical specifications of a particular type, please refer to section "8 *Technical Specifications*" and "12 - *Annex A*" below.

### 6.1.1 Telecom Room Type A (TR-A):

TR-A is used in scenarios having more than 100 connections. Its functions are:

a) To house Building Distribution Box (BDB),
b) To house any other service providers' active and/or passive components.
c) To connect to ANP over segregated routes by providing multiple external ducts and terminating them to the BDB.
d) To house backup power systems (rectifiers and batteries). It is desirable that the power systems are contained within a separate compartment of the BDB box.

### 6.1.2 Telecom Room Type B (TR-B):

TR-B is used in scenarios having less than or equal to 100 connections. Its functions are:

a) To house Building Distribution Box (BDB).
b) To house any other service providers' active and/or passive components.
c) To connect to ANP over a single route by providing external ducts and terminate them in the BDB

### 6.1.3 Floor Aggregation Point (FAP):

FAP is used in MDU scenarios on floors other than ground floors. Its functions are:

a) To house Floor Distribution Box (FDB).
b) To house any other service providers' active and/or passive components
c) To connect HDB to Telecom Room

## 6.2 Distribution Boxes (DB)

In any internal wiring scenario, there are FOUR (4) different types of Distribution Boxes (DBs) that may be used. For technical specifications of a particular type, please refer to section "8 *Technical Specifications*" and "12 - *Annex A*" below.

### 6.2.1 Building Distribution Box (BDB):

A BDB is located inside a telecom room in compounds having more than 100 connections and in all multi dwelling units (MDU). Its functions are:

a) To be the main aggregation point for all cables running inside the building.
b) To be the last point under customer responsibility, in which an ANP will terminate its cable.
c) To house all service providers' active and/or passive components.
d) To house all customer active and/or passive components, if required.

### 6.2.2 Floor Distribution box (FDB):

A FDB is used in FAP whenever SP's active or passive elements are to be used. Its functions are:

a) To be the aggregation point for all cables running in a particular floor (horizontal cables).
b) To be the link between PHDBs and BDBs.
c) To house all service providers' active and/or passive components.
d) To house all customer active and/or passive components, if required.

### 6.2.3 Primary Home Distribution Box (PHDB)

A PHDB is used in flats and in ground floors of villas. Its functions are:

a) To be the aggregation point for all cables running in the flat or in the ground floor within a villa.
b) To be the aggregation point for all SHDBs.
c) To house all service providers' active and/or passive components.
d) To house all customer active and/or passive components, if required.

### 6.2.4 Secondary Home Distribution Box (SHDB)

An SHDB is used only in villas in floors other than the ground floor. Its functions are:

a) To be the aggregation point for all cables running in a particular floor within a villa.
b) To be the link between sockets and PHDBs.
c) To house all service providers' active and/or passive components for that particular floor, if required.
d) To house all customer active and/or passive components, if required.

## 6.3 Optical Fiber Components

In any internal wiring scenario, there are FIVE (5) different types of optical components that may be used. For technical specifications of a particular type, please refer to section "8 *Technical Specifications*" and "13 - *Annex B: Optical Fibre Cable Specifications*" below.

### 6.3.1 Optical Cable (Internal Optical Fiber Cable):

This component is used only in multi dwelling units (MDU). Its function is to extend the optical signal from BDB up to PHDB, either by:

a) Direct optical cables passing through FAP,
b) Splicing inside FSB, or
c) Patching inside the FDB.

### 6.3.2 Fiber Patch Panel (ODF):

This component is used inside BDBs and, if required, inside FDBs. Its functions are:

a) To terminate optical cable(s).
b) To give an easy interface to the optical fiber network through patching to permit rapid and trouble-free re-configuration of operators and services to individual homes (HDB).

### 6.3.3 Fiber Splicing Box (FSB):

This component is used inside FAP whenever SP's active or passive elements are not to be used. Its functions are:

a) To be the aggregation point for all cables running in a particular floor (horizontal cables).
b) To house splices between horizontal optical cables and vertical cable.
c) To be the link between PHDBs/BDBs and individual HDBs.

### 6.3.4 Fiber Termination Box (FTB):

This component is used inside BDBs and HDBs in all installations. Its functions are:

a) To terminate optical cable(s) (ANP or internal cable(s)).
b) To give an easy interface to the optical fiber network through patching.

### 6.3.5 Fibre Patch Cord:

a) This component is used in all installation scenarios. Its function is to cross-connect between two optical fiber components.

## 6.4 Copper Components

In any internal wiring scenario, there are FOUR (4) different types of Copper components that may be used. For technical specifications of a particular type, please refer to section "8. *Technical Specifications*" and "14. - *Annex C: Category-6 Copper Cable Specifications*" below.

### 6.4.1 UTP (Unshielded Twisted Pair) Cable:

This component is used in all installations. Its function is to extend the electrical signal from an HDB (PHDB or SHDB) to Copper Termination Points (sockets).

### 6.4.2 Copper Patch Panel or Cross-Connect Box:

This component is used inside HDBs in all installations. Its functions are:

a) To terminate UTP cables in a PHDB or SHDB.
b) To give an easy interface to the copper network through patching for necessary re-configuration and testing of individual services.

### 6.4.3 Copper Termination Point (Socket or Jack):

This component is used in all installations. Its functions are:

a) To terminate a UTP cable extended from a PHDB or SHDB.
b) To give an easy interface and access to the copper network at wall sockets (jacks) points that permits disconnection/connection of different customer premises equipment as required.

### 6.4.4 Copper Patch Cord:

This component is used in all installations. Its function is to cross-connect between two copper components while having minimum loss in signal power (low resistance) and maintaining data capacity levels at a minimum of Category 6 transmission performance.

## 6.5 Ducting System

In any internal wiring scenario, there are THREE (3) different types of ducting systems that may be used. For technical specifications of a particular type, please refer to section "8 *Technical Specifications*" and "15. - *Annex D"* and *"16. - Annex E"* on external and internal ducting below.

### 6.5.1 External Ducting:

This component is used in all installations to help protect the cable and facilities against mechanical and environmental stresses that can occur in the OSP and internal

building applications. Its main function is to provide a cabling channel between ANP plant and customer premises. External ducting is terminated in a PHDB for villas and in a BDB in Multi Dwelling Units. In the case of large scale ducting requirements such as in Mega Projects, Urban Metro style ducts should be provided.

### 6.5.2 Inter-DB Ducting:

This component is used in all installations. Its function is to provide a cabling channel between DBs that supplies physical support for cable elements and protects the cable from mechanical compression and abrasion stresses that occur during installation and operation of the communications services.

### 6.5.3 Home Ducting:

This component is used in all installations. Its function is to provide a cabling channel between an HDB (PHDB or SHDB) and sockets that supplies physical support for cable elements and protects the cable from mechanical compression and abrasion stresses that occur during installation and operation of the communications services. Home ducting can also provide some protection to the UTP communication cable from induction effects of nearby or adjacent power supply cables.

## 6.6 Segregation of services

In order to avoid interference by induction (EMI) and electrical hazard through conduction or contact, telecommunications cables should always be installed with a permanent minimum radial physical separation of 50cm from electrical cables and a minimum of 1m from fluorescent bulbs, dimmer switchers or similar light fixtures to reduce EMF/EMI field effects induced by such devices. The only allowable exception is where a certified non-conductive rigid barrier is in place.

### 6.6.1 Conduction Avoidance:

Telecommunications cables should be at least 50mm from all electrical cables. It is recommended that 300mm spacing between cables be maintained to ensure minimal electrical hazard through power induction or potential conduction. Telecommunications outlets should be at least 200mm from any mains electrical outlets. Where practical, a distance of 300mm should be maintained. All telecommunications cabling should cross electrical cables at an angle of 90 degrees (i.e., a right angle) while maintaining the spacing of at least 50mm.

### 6.6.2 Induction avoidance:

To ensure no interference from electrical induction, telecommunications cables should not be run in parallel to electrical cables with a spacing of less than 100mm. Where cables are within 100mm, the parallel run should be no more than 3m. At no

time shall a spacing of less than 50mm acceptable. All telecommunications cabling should cross electrical cables at an angle of 90 degrees (a right angle) while maintaining the spacing of at least 50mm.

### 6.6.3 Rigid barriers:

Rigid barriers include partition walls where the spacing between each surface is at least 200mm and solid wall linings of non conductive material at least 50mm in depth.

In severe or difficult situations, the rigid barriers can include conductive home ducting products (metallic conduit or duct). As an alternative, communications cables containing copper, aluminium or other metallic shields or foils can be used as shielding to help maintain electrical isolation and minimize electrical noise from causing service disruptions.

### 6.6.4 Intersystem Bonding for Earthing (Grounding)

Where power and communications facilities are in close proximity, then the grounding systems of both utilities need to be coordinated and harmonized through appropriate earthing (grounding) and intersystem bonding practices. Such grounding and bonding practices between metallic elements of the network shall be designed to maximize electrical safety of workers and public.

The appropriate local building, fire and electrical codes for SOHO and residential buildings shall be followed. Metallic closures or metallic components of shielded/armoured cables shall be solidly electrically bonded to the ground electrode system of the building either at or through the FDB or BDB. Note that the design of customer powered premises equipment served by the communications cable will usually be equipped with intersystem bonding and grounding capability with the CPE and no additional action is needed from the communications installation crew.

## 6.7 Under Floor or Raised Floor Scenarios

Telecommunications cables should not be run under floors where there is any risk of wet surfaces, water runoff, excessive dampness, or where unintended water leakage may occur (under bathrooms, laundries water tanks or water pipes etc.). The only allowable exception is where the cable sheathing has been specifically rated for such purposes. Additionally, telecommunications cables that are placed beneath floors or inraised floor plenums:

a) Shall be in secure ducts or trays where practical – the ducts, conduit or raceway shall be closed and sealed to prevent water entry.
b) Shall be easily accessible at entry and exit points and at points along the cable length.
c) Shall be secured at any point where changes in direction occur; where there is potential for movement; to avoid sagging or contact to groundwork.
d) Shall have large cable looms/coils secured to an anchor cable or cable tray.

## 6.8 Ceiling Void or Plenum Scenarios

Telecommunications cables should not be laid on surfaces where there is risk of damage or movement. This includes, but is not limited to surfaces used for storage; where there is risk of persons standing or kneeling; around chimneys/ flues, heating ducts or plumbing. Additionally, telecommunications cables placed in these void or plenum spaces should:

a) Be placed in secure ducts or trays where possible.
b) Be secured at any point where changes in direction occur; where there is potential for movement; to avoid sagging.
c) Have large cable looms/coils secured to an anchor cable or cable tray.
d) Not be placed above joists and sills.
e) Be placed away from insulation or other surfaces that may retain moisture

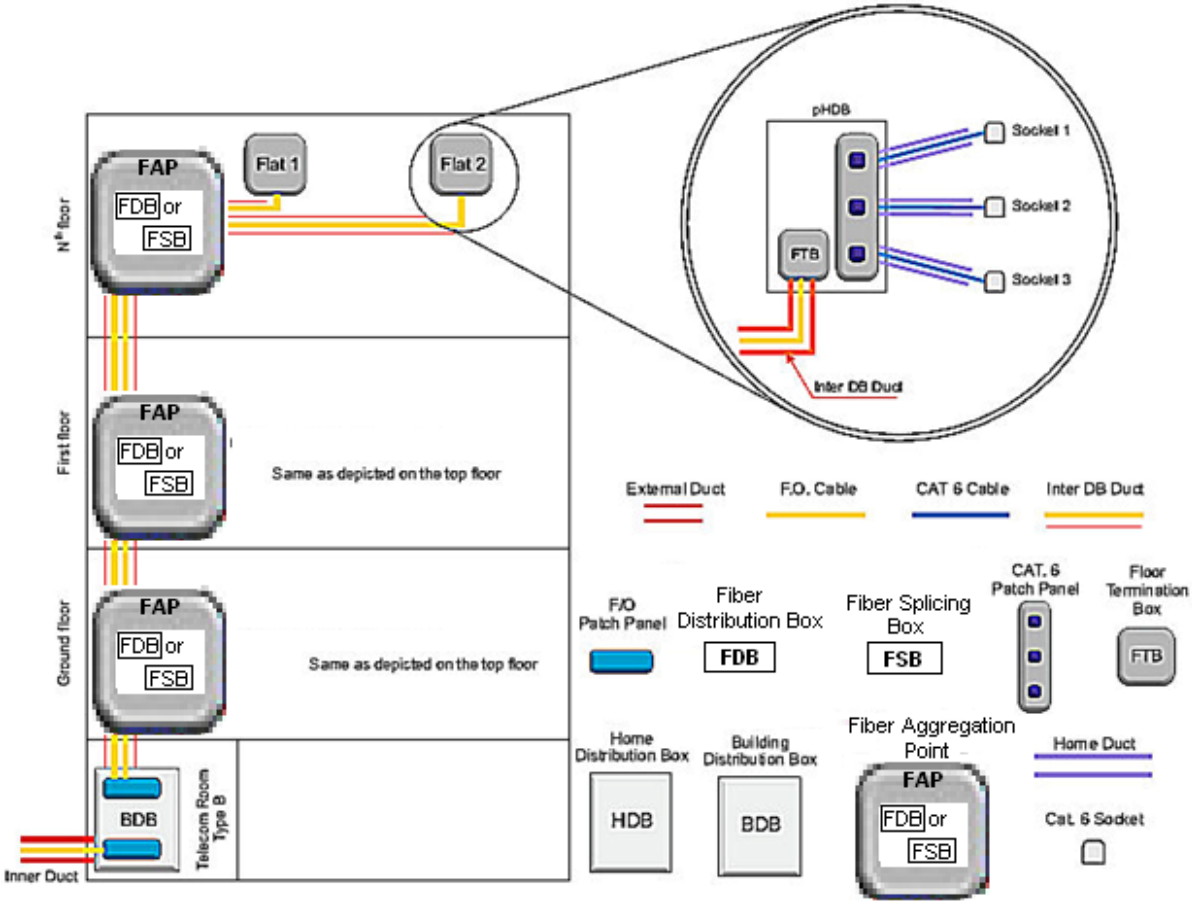
It is desirable that communications cabling and facilities are not located in air-handling spaces or plenums. If it is necessary or unavoidable to place communications cables in plenums or in air-handling spaces, the communications cable jackets, wire insulations and duct materials shall have appropriate fire resistance for the application – i.e., high resistance to fire ignition and flame spread with low smoke characteristics if burned – plenum rated cables.

# 7 Wiring Scenarios

The following wiring scenarios are provided as illustrations and guidance. It is understood that each individual building will have specific floor plans, wall layouts and distinct room locations that will necessitate customized cable pathways and node locations.

## 7.1 Multi Dwelling Units (≤ 100 connections)

Figure 3 Multi Dwelling Units (≤ 100 connections)

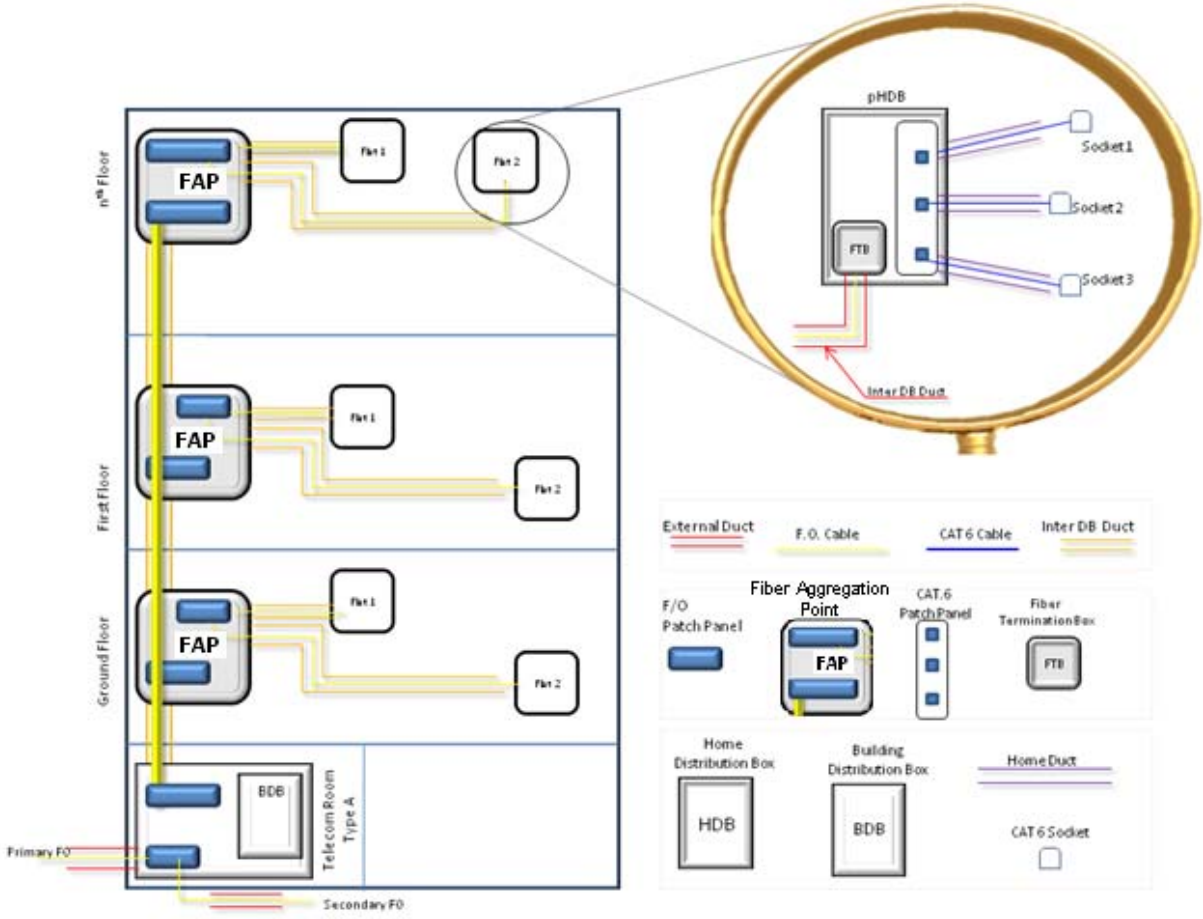



**Note 1**: If the total number of connections is more than or equal to 16, then the customer has the option to lay high capacity riser cable, terminate some of the fibers in each floor, and then lay horizontal drop cables for each flat.

**Note 2**: If the number of connections is less than 16, the customer has the option not to use Telecom Room Type B but replace it with Fiber Aggregation Point (FAP) to serve that small number of customers.

## 7.2 Multi Dwelling Units (> 100 connections)

Figure 4 Multi Dwelling Units (> 100 connections)



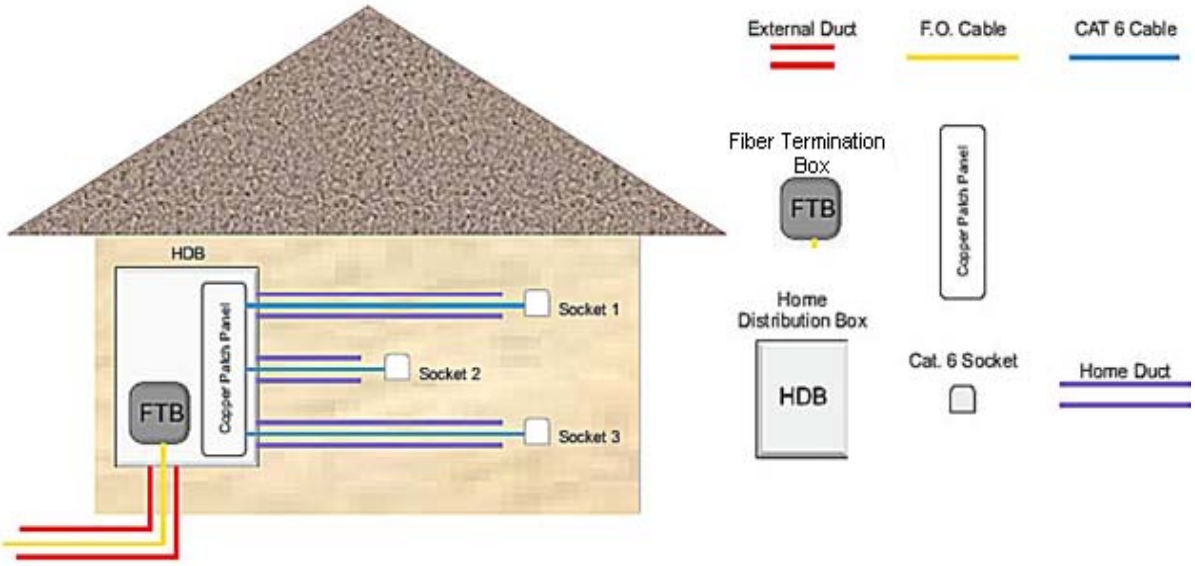

**Note 1**: For optical cable placing, there are THREE (3) different scenarios:

a) One - Fiber optical cable laid vertically from the Telecom Room (TR) through FAPs and then horizontally to each Flat directly without patching/splicing.
b) One multi-core optical cable laid vertically from TR to each FAP then patched/spliced within the FAP to connect with a 4-Fiber optical cable laid horizontally to each Flat.
c) One multi-core optical cable laid vertically from TR to service all FAPs then patched/spliced with the 4F optical cable laid horizontally up to each Flat

**Note 2**: In the scenario where patch panels are to be used, the number of patch panels in FDB inside the FAP depends on the size of riser cable and the number of horizontal cables.

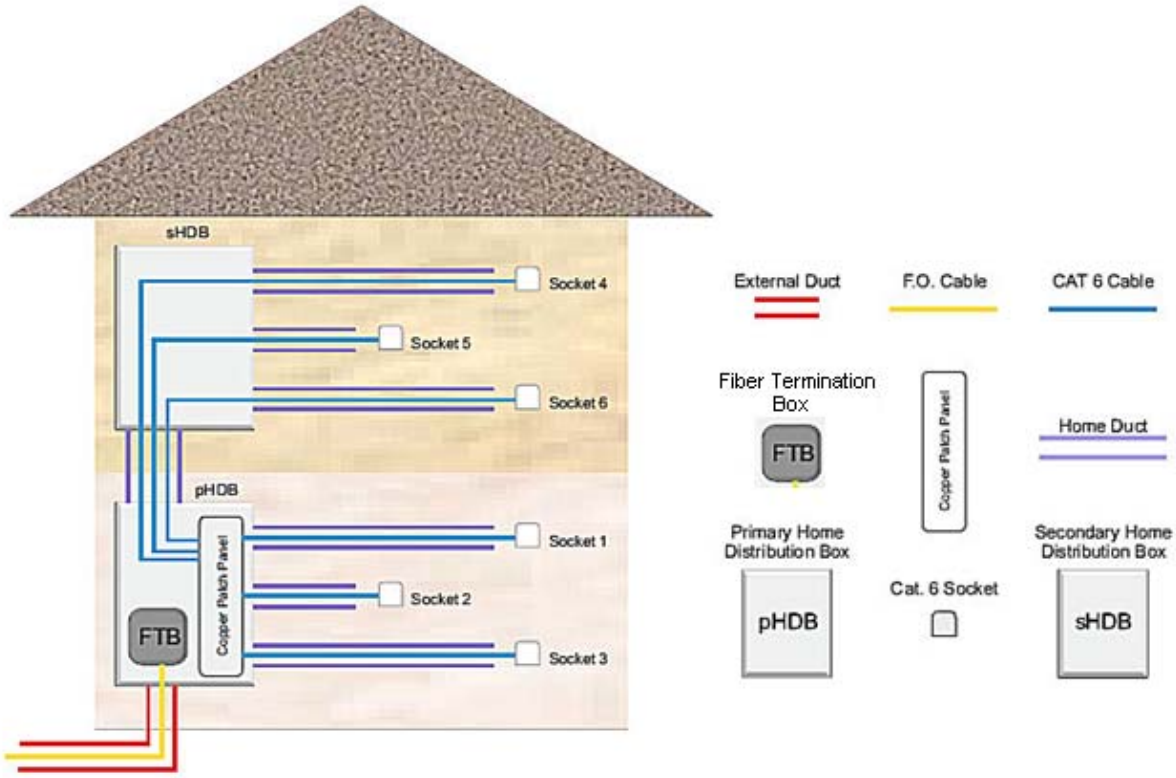
## 7.3 Single Villa with One Floor

Figure 5 Single Villa with One Floor




## 7.4 Single Villa with Multiple Floors

Figure 6 Single Villa with Multiple Floors

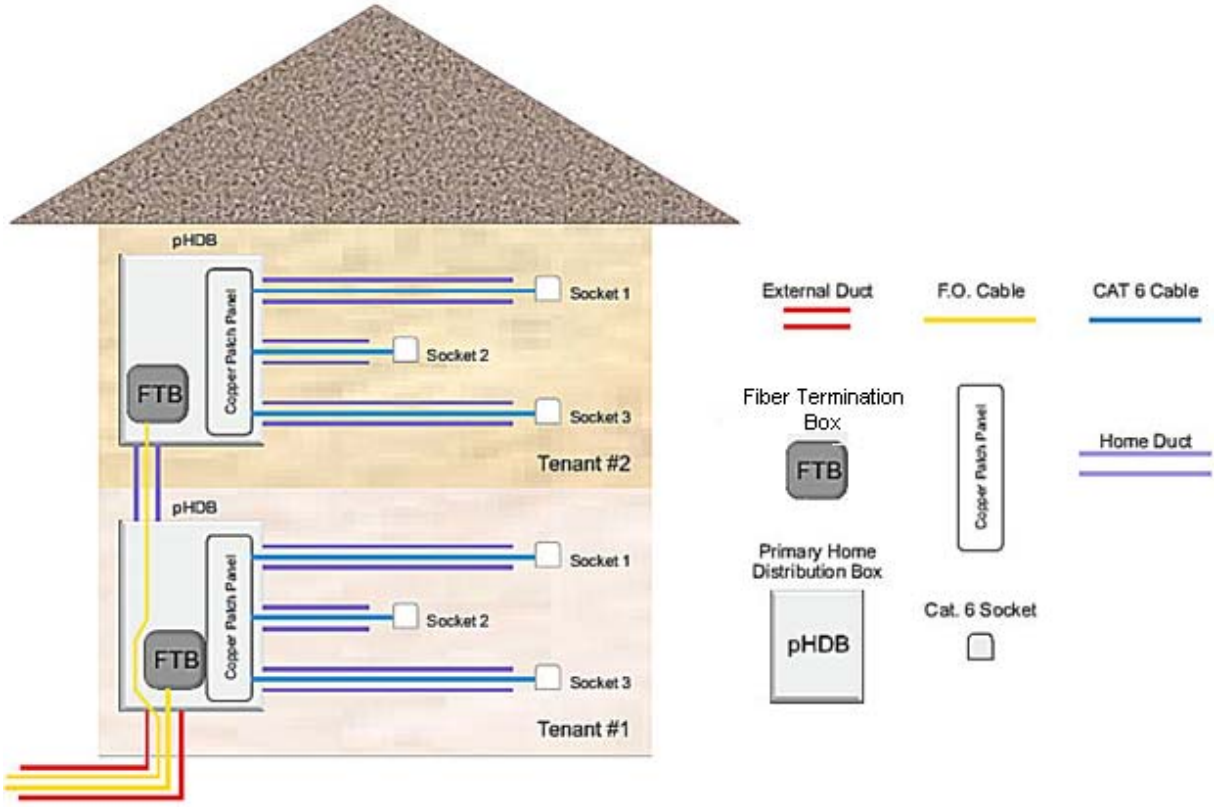


**Note 1**: If the total number of sockets on floors other than the ground floor is more than 4, the customer has the option to use active equipment (Ethernet switch) in the SHDB to minimize the number of riser cables. The Ethernet switch will not be supplied by SP or ANP.

**Note 2**: If the Category-6 cable length between sockets and copper patch panel is more than 90m, designer has to use active component (Ethernet switch) in the SHDB.

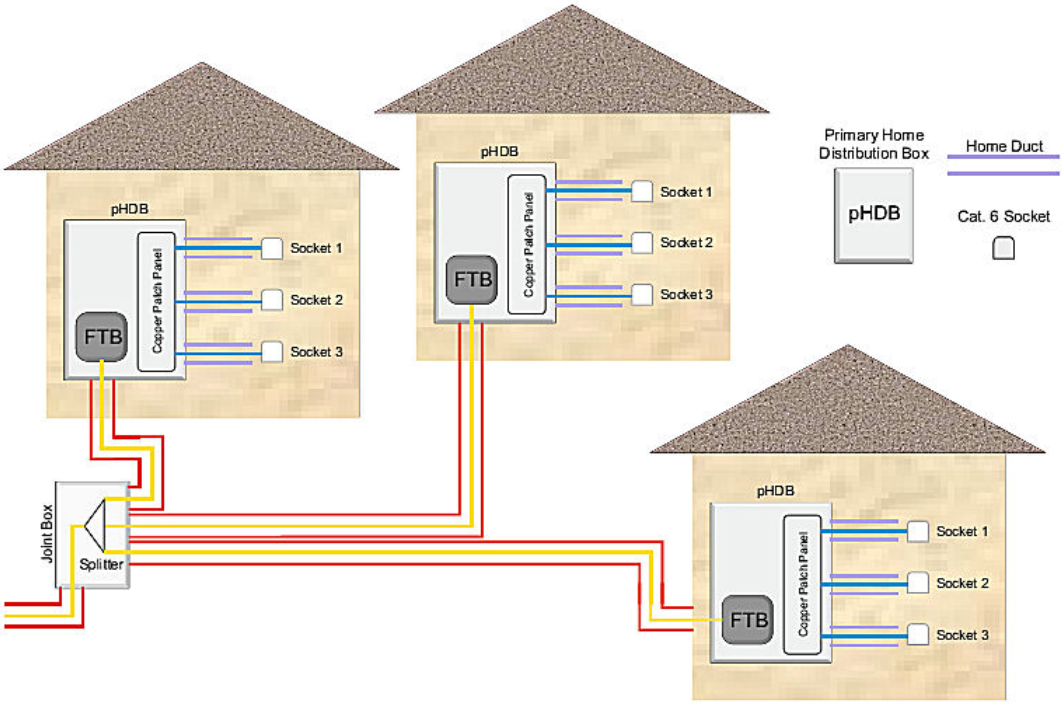
## 7.5 Single Villa with Multiple Tenants

Figure 7 Single Villa with Multiple Tenants



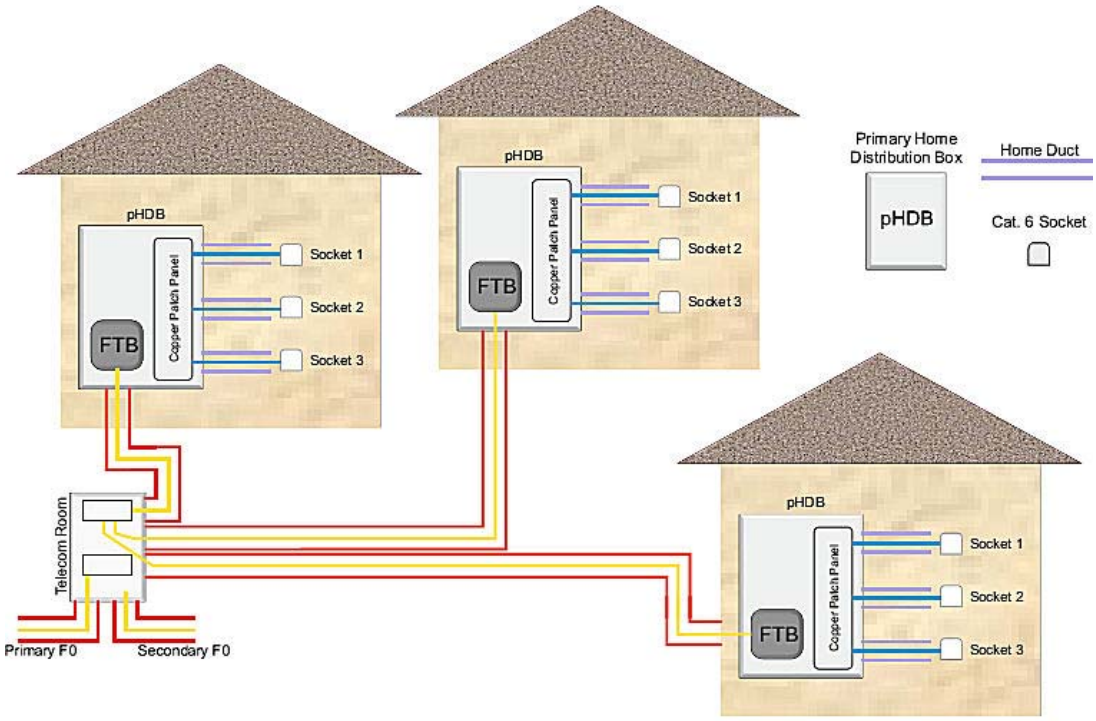
## 7.6 Compound of Villas (≤ 100 connections)

Figure 8 Compound of Villas (≤ 100 connections)



## 7.7 Compound of Villas (> 100 connections)

Figure 9 Compound of Villas (> 100 connections)




## 7.8 Existing and New Homes Internal Wiring

The home cabling illustrated in this subsection covers two scenarios:

(a) Existing homes, where cabling either already exist. In some cases existing installations may have some inherent constraints which make it impractical or prohibitively expensive to upgrade and it is assumed that in those cases no upgrades will be carried out, and

(b) New homes, where outside plant and internal wiring installations meet these requirements. This section demonstrates how one set of wiring can be used within the home, with up to three service providers, delivering different types of services to the client.

Although this section refers to home wiring, the guidelines apply to multidwelling/SOHO units by following the recommendations set out in this section above.

### 7.8.1 Existing Home Wiring:

There are two possible scenarios in which an existing home has been wired, with and without a Home Distribution Box (HDB). In the first instance the appliances within the

home can either be wired directly to the ONT device, and in the second scenario an HDB can be installed which allows the internal CAT6 cabling to be terminated within the HDB patch panel and then connected to the ONT.

It may be the case that in some installations High Speed Internet services may have been installed together with a wireless router (i.e. IEEE 802.11b/g/n standard) to minimize internal wiring requirements.

Whilst it may be unusual for a home to buy services from all three service providers, should the client wished to do so, it may be possible to adapt the existing wiring to support all three service providers. For new installations all internal wiring should be CAT-6 or better, as specified in section 5 of this document.

Where a HDB has not been provisioned (or existing ones do not meet requirements as per section 8 of this document), a new HDB should be deployed. The service providers should terminate their wiring at the back of the HDB patch-panel using CAT-6 wiring. Existing home wiring should be terminated with RJ45 connectors inside the HDB. This will allow for services to be patched within the home, according to the clients' requirements.

### 7.8.2 New Home Wiring:

It is expected that new home wiring will comply with all requirements as laid out in this document.

# 8 Technical Specifications

Section 8 contains the basic requirements for the physical elements of the internal cabling, closures and connection hardware components for SOHO and Residential network services.

It is critical that good housekeeping practices be enforced inside the telecommunications closet with cables organized neatly and general work conditions are clean and well lit. Precise and consistent labels need to be used on both ends of cables and on the cross connect frames to prevent confusion and possible service outages.

## 8.1 Telecom Room

The following applies to all telecom rooms, as appropriate given the size and space:

- The room must be easily accessible authorised personnel 24 hr./day, (all days including weekends). The room must be clean, dry and free from dust and secured from unauthorized entry
- Adequate lighting and minimum of four 20 amp and 240 volt A.C. Mains outlet from a dedicated circuit breaker should be provided
- The room must be provided with a good earth rod of not more than 5 ohms
- The door opening for the room should swing outwards
- The floor, roof and surrounding wall of the telecom room, should be free of any concealed water/drainage pipes and air-conditioning ducts passing through
- The room must be provided with an emergency light, a smoke detector and a fire alarm
- If the telecom room is proposed in the basement, an automatic sump draining system must be provided to handle water seepages

### 8.1.1 Telecom Room Type A

Refer to Annex A – Additional Requirements. Type A telecom rooms are usually large and need to be fully integrated into the general building structure and associated services to have the necessary space, lighting, environmental controls, and operational support.

### 8.1.2 Telecom Room Type B

- Size and Layout
  - Minimum floor plan size of 2m wide × 2m long.
  - The room shall have a minimum clear height of 3m.
  - The room shall have no windows.
- Shall have good lighting, proper ventilation, air circulation and room filtration capability to enable
  - Labels and warning instructions to be read from a distance of 1 m with normal or corrected-to-normal vision.
  - Dissipation of heat generated by active equipment to maintain equipment

within normal operational range – that is, between 5°C (41°F) to 45°C (113°F) and in humidity up to 85% RH.
    - Trouble free operation in desert, marine and industrial areas where dust and particulate contamination may be common in the outside environment.
- Physical Access and Security
    - Service provider (SP) operation and maintenance staff shall have 7-day, 24-hour access to the room.
    - The room shall have sufficient safe working access for personnel when shifting or relocating equipment and for the use of tools.
    - The entrance door shall have a master lock and a process to document, control and log any access to the room. It is desirable that the door include a means to remotely report an alarm to a network or building control center.
    - No water pipes for supplying hot/cold potable or chilled water shall pass through the ceiling or floor of the room.
    - No drainage or sewerage services shall pass through the ceiling or floor of the room.

## 8.2 Floor Aggregation Point (FAP)

- Can be a dedicated small room (any size) or a space within a service room as long as it provides
    - Ready access by building owner and/or Service provider (SP) – i.e., shall be in a common area that can be easily accessible by SP operation and maintenance staff.
    - Sufficient working space around the equipment to permit maintenance, repair and relocating of equipment as well as the safe use of tools.
- Shall have good lighting, proper ventilation and air circulation characteristics as noted above for the telecom Room Type B.

## 8.3 Building Distribution Box (BDB)

- Shall be a standard 19” steel rack (wall- or floor-mounted).
- Must be of adequate size to accommodate at least the following items:
    - Optical Patch Panels for termination of optical cables from all the flats (dwelling units) in that particular building.
    - Optical Patch Panel to terminate ANP optical cable(s).
    - All Service Providers’ active and/or passive components.
    - 4-way PDU of 240V AC (BS 1363 UK standard with isolated breaker of 30A) dedicated to Telecommunications Services.
    - Vertical and horizontal cable management.
    - Space to coil ANP optical cable(s) for maintenance purpose (max of 3m).
    - Any customer equipment (switches, routers, etc…).
- Must be accessible from all sides (front, back, right and left) with lockable doors with at least 600mm of clear space.

  - It is preferred that 750 mm of clear working space is provided in front of equipment when access door is open.
- Must have cable entries from top and bottom.
- A dust-free ventilation mechanism must be available (grid doors, replaceable filters and/or ventilation fans).
- Must be installed in an easy to access area with good lighting, proper ventilation and air circulation. A BDB shall not be installed in any inaccessible, high humidity or water condensing areas.
- Earthing (grounding) facility must be provided for all metallic components with a single bonding point to connect to the building grounding system.
- Any internal wiring and Low Voltage (LV) power cables must be separated by a distance of at least 50mm.
- For active BDB units, a convenience outlet (240V AC) shall be provided for test equipment of the Service Provider maintenance and operations technical staff.

### 8.4 Floor Distribution Box (FDB)

- Shall be a wall mounted 19" steel cabinet or rack (Wall mounted at a height of 120 cm above finished floor level) and located close to risers inside telecom closets
- Must be of adequate size (not less than 30(L) X 30(H) X 15(D)) to accommodate at least the following items:
  - Optical Patch Panels for termination of optical cables
  - Optical Patch Panel to terminate ANP optical cable(s).
  - All Service Providers' active and/or passive components.
  - 4-way PDU of 240V AC (BS 1363 UK standard with isolated breaker of 30A) dedicated to Telecommunications Services.
  - Vertical and horizontal cable management.
  - Space to coil ANP optical cable(s) for maintenance purpose (max of 3m).
  - Any customer equipment (switches, routers, etc…).
- Must be accessible from all sides (front, back, right and left) with lockable doors with at least 600mm of clear space.
  - It is preferred that 750 mm of clear working space is provided in front of equipment when access door is open.
- It should be installed at a height between 40 cm and 120 cm above the finished floor level
- Must have cable entries from top and bottom.
- A single conduit of at least 25 mm (1 inch) internal dia., black and of uPVC material should be provided from each floor distribution box to the indoor equipment cabinet of each office, residence, flat and other independent areas in the same floor
  - Each floor distribution box must only be linked to living units on the floor where it is located
  - There can be multimple floor distribution boxes on a floor, depending on the building configuration and number of units
- The distribution boxes on different floors of a villa should be connected through a

PVC conduit, of a 50 mm diameter

- The distribution box should have one 50 mm (2 inch) conduit to the rooftop of the villa, from the cabinet or from the telephone entry duct location, in order to provide access to cables from the antenna
- A dust-free ventilation mechanism must be available (grid doors, replaceable filters and / or ventilation fans).
- Must be installed in an easy to access area with good lighting, proper ventilation and air circulation. A BDB shall not be installed in any inaccessible, high humidity or water condensing areas.
- Earthing (grounding) facility must be provided for all metallic components with a single bonding point to connect to the building grounding system.
- Any internal wiring and Low Voltage (LV) power cables must be separated by a distance of at least 50mm.
- For active BDB units, a convenience outlet (240V AC) shall be provided for test equipment of the Service Provider maintenance and operations technical staff.

## 8.5 Primary Home Distribution Box (PHDB)

- The PHDB must be flush mounted (inside the wall) with 4 lockable compartments. (All) doors must provide a dust-free ventilation mechanism (grid doors, replaceable filters and / or ventilation fans).
    - SP compartment shall accommodate the following :
    - Four (4)-way PDU of 240V AC (BS 1363 UK standard with isolated breaker of 13A) dedicated to Telecommunications Services.
    - Two (2) Optical Network Termination units (ONTs).
    - One (1) Fiber termination Box (FTB).
    - Simple cable management to minimize bending stresses on cables and enable clear unambiguous identification of optical fibres.
    - Space to coil fibre cable(s) for maintenance purposes (max of 1m).
    - SP compartment door must be lockable with a master lock.
- Customer compartment shall accommodate the following:
    - As a minimum, 24 Ports CAT-6 Patch Panel for villas or 8 Ports CAT-6 for flats (there is no actual limit on the total number of ports if customer demand is for more).
    - 2-way PDU of 230V AC (BS 1363 UK standard with isolated breaker of 13A).
    - Simple cable management to minimize bending stresses on cables and enable clear unambiguous identification of pairs...
    - Any customer equipment (switches, routers, etc…).
- Must have capability for cable to entry from all sides with grommets and seals for cable entry ports and openings.
- Must be installed in readily accessible area with good lighting, proper ventilation and air circulation. The PHDB shall not be installed either in inaccessible or hazardous areas such as inaccessible corners, areas of high humidity, prone to water-condensation, adjacent to boilers, chillers or other industrial motors used to service building systems.

- Must be dedicated to the unit that it is located in.
- The location of the indoor equipment cabinet should be at a common point, where all the internal conduits meet and the Structured Cabling System (SCS) on a star topology can be installed. However, the farthest socket must not exceed 90 m from the cabinet
- The cabinet distribution box location should not be adjacent to any electrical distribution or bus bars
- The cabinet distribution box should be installed at a height of 120 cm above the finished floor level
- If the PHDB is made of conductive metallic materials, an earthing (grounding) connection point shall be provided and utilized – a single point for the whole PHDB.
- Any internal wiring and LV power cables must be separated by a distance of at least 50mm.
- All internal conduits should be of a diameter not less than 25 mm (1 inch) to extend the structured cables from ONU to SCS socket locations at each room

### 8.6 Secondary Home Distribution Box (SHDB)

- The SHDB must be flush mounted (inside the wall) with one compartment having front door, which provides a dust-free ventilation mechanism (grid doors, replaceable filter and/or ventilation fans)
- The box shall be of adequate size to accommodate any of the following (decided by customer demand):
    - CAT-6 Patch Panel (there is no actual limit on the total number of ports).
    - Two (2)-way PDU of 230V AC (BS 1363 UK standard with isolated breaker of 13A).
    - Simple cable management to minimize bending stresses on cables and enable clear unambiguous identification of pairs.
    - Any customer equipment (switches, routers, etc…).
- Must have cable entry ports on all sides to permit easy connection as well as grommets and seals for these cable entry ports and openings.
- Must be installed in an easy to access area with good lighting, proper ventilation and air circulation. The SHDB shall not be installed either in inaccessible or hazardous areas such as inaccessible corners, areas of high humidity, prone to water-condensation, adjacent to boilers, chillers or other industrial motors used to service building systems.
- Must be dedicated to the unit it is located in.
- Location of SHDB should take into consideration Wi-Fi coverage wherever possible.
- If the SHDB is made of conductive metallic materials, an earthing (grounding) connection point shall be provided and utilized – a single point for the whole SHDB.
- Any internal wiring and LV power cables must be separated by a distance of at least 50mm.

## 8.7 Risers

Risers are required in multiple-storey buildings for the installation of telecom fibre optic cables from main telecom room to other floors.

- Galvanized slotted iron cable trays (minimum 200x50 mm HDRF (Heavy Duty, Return Flange) should be provided from the main telephone room, to each telephone closet and extended up to the roof telephone room
- The risers to each floor must be symmetrical and vertically in line with the main telecom room.
- Where the main telecom room, floor telephone closet and roof telecom rooms are to be located one below the other in vertical line, a continuous cable trays/ conduits must be provided with pull boxes/access panels at every turning point and at interval of 15 meters each, up to the main telecom room. Right angle or sharp bends are to be avoided
- If a building consists of more than one tower, all the above specified requirements are required in each tower The towers must be inter-connected at the main telecom room, by separate cable trays of minimum 2 nos. and size 200x50 mm or through floor raceways passing through a common area between the two buildings. The same requirements also apply to mezzanine and penthouse floors. The telecom cable trays should have adequate separation from electrical cable trays. Electrical cable trays should not cross the telecom cable trays.
- Flexibility in cable plant placement can be provided by first placing small diameter microducts (OD < 13 mm) into the building. The small diameter microducts can be more easily placed in wall cavities, riser spaces and into/through telecommunications closet spaces. The small fiber or possibly some copper building cable can be placed into the microduct using blowing or pulling technologies and thereby be protected from physical damage from contact with the building during placement.
- Another alternative would be to use cable raceways integrated into plastic mouldings that are designed to look like wood trims and mouldings used along ceiling/wall and floor/wall corners. The cabling is then readily accessible but hidden from direct sight inside the moulding products.

## 8.8 Optical Fiber Cable

- Refer to Annex B – Optical Fiber Cable Specifications for details. The optical fiber cables used within SOHO and residential buildings shall require adequate fire resistance ratings and mechanical robustness performance for the inside applications of placement in tall riser spaces, tight wall cavities, inside conduits/ducts and through walls and ceilings. These optical fiber cables also need to survive undamaged during the physical stresses involved during the handling and placement operations involved in the installation and construction phases of cabling the building.

## 8.9 Optical Fiber Termination Box (FTB)

- Shall be wall mounted.
- Must be “Indoor type” rated with applicable fire resistance and mechanical robustness.
- Have the capacity to terminate four (4) fiber cables using fusion splicing technique and accommodate spliced fibers in splicing organizers / cassettes.
- Shall have four (4) LC simplex adaptors, each equipped with 1.5m pigtail terminated with LC/APC connectors. Connector insertion loss shall not be more than 0.2dB and return loss shall be better than 55dB.
- Optical characteristics of the optical fiber terminated in the FTB shall be as per ITU-T G657.A2.
- Shall have flexibility, adequate working space and ease-of-accessibility to the fiber splicing trays and cable management elements.
- Shall have guiding rings and guiding tubes to minimize mechanical stress and facilitate fiber identification and traceability.
- Shall have hard material body (plastic or aluminium) to resist impacts and accidental contact.

## 8.10 Optical Fiber Patch Panels

- Shall be installable in a standard 19” rack with wall mounting as an option.
- Shall have 24 LC simplex adaptors, each equipped with 1.5m pigtail terminated with LC/APC connectors. Connector insertion loss shall not be more than 0.2dB and return loss shall be better than 55dB.
- Optical characteristics of the optical fiber shall be as per ITU-T G657.A2.
- The panel should have a locking system, cable clamps, be compact in size and use compression fittings.
- Shall have flexibility and provide easy access to the fiber splicing and management, with slide in/ slide out mechanism for the fiber modules or opening with hinges.
- Shall have enough splice organizing trays to splice and terminate optical cable(s) to all available connector terminated fiber.
- There shall be guiding rings, guiding tubes and fiber patch cord management.
- Shall have a steel body. Splice organizing trays shall comply with the following specifications:
    - Must be made of plastic material that will provide resistance to water, corrosive chemicals, household cleaners, paints, extreme temperature and impacts.
    - Must be able to hold minimum of 12 fusion or mechanical splices per tray with sleeve / mechanical-connector grip facility.
    - Must have enough space to hold up to 1m coil of each fiber.
    - Optical fiber must not suffer any attenuation inside the tray due to curvature radius.
    - Each splice tray shall be protected by an individual cover.
    - Cascaded trays must be easily accessible without damaging existing

fibres.

### 8.11 Fiber Splice Box/Enclosure (FSB)

- Shall be wall mounted cabinet or joint closure made of plastic or steel
- It should have a locking system, cable clamps, be compact in size and use compression fittings.
- Shall provide easy access to the fiber splicing and management, with an opening mechanism that uses screws or hinges
- Shall have sufficient splice organizing trays and optical cable(s) entries.
- Splice organizing trays shall comply with the following specifications:
    - Must be made of plastic material that will provide resistance to water, corrosive chemicals, typical cleaners, extreme temperatures and impacts.
    - Must be able to hold minimum of 12 fusion or mechanical splices per tray with sleeve / mechanical-connector grip facility.
    - Must have enough space to hold up to 1m coil of each fiber.
    - Optical fiber must not suffer any attenuation inside the tray due to curvature radius.
    - Each splice tray shall be protected by an individual cover.
    - Cascaded trays must be easily accessible without damaging existing fibers.

### 8.12 Optical Fiber Patch Cord

- Shall be factory made with LC/APC simplex connector on each end.
- Optical characteristics of the fiber shall be as per ITU-T G657.A2.
- Return loss of the patch cord with connector shall be better than 55dB.
- Insertion loss shall not be more than 0.2dB per connector.
- Shall be of appropriate and approved lengths (1m, 2m, 3m, 5m and 10m).
- The overall diameter of the patch cord shall not be more than 2mm.
- Outer jacket shall be Low-Smoke, Zero-halogen (LSZH) materials or Flame Retardant PVC (FR-PVC).

### 8.13 Unshielded Twisted Pair (UTP) Cable

- All UTP cables used in internal wiring must be at least Category-6 rated balanced cables.
- Sheath materials of all UTP cables used in internal wiring must be Low-Smoke, Zero-halogen (LSZH) or Fire-Retardant PVC (FR-PVC).
- Sheath materials of all UTP cables used between individual buildings within a compound (for example) must be of external rated cable with weather-resistant jacket material – e.g., sheath shall be water (rain) resistant, sunlight resistant and able to withstand the temperature extremes and diurnal cycling between hot days and cold night conditions.

- Depending on the customer application and likelihood of electrical induction problems in a location, twisted-pair cabling with metallic shielding - STP (Shielded Twisted Pair) cable or FTP (Foil Twisted Pairs) - can be used if required.

### 8.14 UTP Termination Point (UTP Outlet or Socket)

- All UTP outlets used in internal wiring must be at least Category-6 rated.
- Terminations shall be done using IDC (Insulation Displacement Contact) design and technique with matching and appropriate tools.
- All UTP outlets must be a shuttered RJ45 socket and preferably of “Keystone Module” to help minimize contamination of the termination.
- It is highly recommended that dual UTP outlets with two separate cables be installed near TV outlets and in big rooms.
- Faceplates may be installed “horizontally” (landscape) or “vertically” (portrait), but in all cases the RJ45 socket shall be oriented in such a way that the plug latch will be on the underside. This orientation helps to ensure that the contact springs are at the top of the socket and therefore less susceptible to dust or dirt settling on them.
- UTP outlets shall not share the same face plate with any LV power sockets.
- UTP outlets shall not be installed outdoors unless housed in an appropriate enclosure with appropriate IP rating and environmental seals.

### 8.15 UTP Patch Panel

- All Patch Panels used in internal wiring must be at least Category-6 rated.
- All sockets shall be RJ45 and preferably “Keystone Module” to simplify maintenance.
- Termination shall be done using IDC (Insulation Displacement Contact) technique with matching and appropriate tools.

### 8.16 UTP Patch Cord

- All UTP patch cords used in internal wiring must be at least Category-6 rated.
- Patch Cords must be factory-terminated with RJ45 connectors on both ends.

### 8.17 External Ducting

- Refer to “15. *Annex D – External Ducting Specifications*”

### 8.18 External Ducting Entry Box (Optional)

- The entry box is a reinforced concrete structure, with a heavy duty Ductile Iron Frame and Cover of rating grade ‘A’ and size is 60x60x80 cm. The cover shall have marking as “Telephones”
- The location of the entry box, depends on the location of existing/proposed

external line plant

- The entry box should be constructed at a maximum distance of 1 meter from plot line. If it is not practical to install within the plot, then install it outside the plot. Make sure it touches the boundary wall• Due to the variables involved, it is essential to consult at the design stage, to decide the location of the entry box and entry pipe. The consultants/ contractors must not deviate from the stipulated location
- An earth rod must be provided at the entry box. The required earth resistance should not exceed more than 5 ohms
- Rach Entry Box is equipped with entry pipes.Entry pipes for the entry box are uPVC ducts. These ducts are to be extended from the entry box towards the customer premises and towards line plant location.
    - Entry pipes should be laid at a depth of 60 cm from the proposed finished paving level. The entry pipe must be protected with concrete to prevent damages
    - Entry pipe should be extended to the entry box and beyond to the nearest existing plant location, or 1 meter from plot limit.
    - The entry pipe should be of uPVC material and of black color
    - The open ends of the entry pipe must be properly sealed, to prevent entry of sub-soil materials and ingress of water
    - Location of entry pipes must be clearly marked, above ground for easy location
    - Building contractors shall be responsible to locate the installed entry pipes on site.
    - No right-angled sharp bends should be installed throughout the duct length, except one wide-angle, long radius bend (factory made) at the terminating end of the duct, inside the main telecom room. Alternatively, at the location of the wide angle bend, a cable pull box of minimum size 600(L) x 700(W) x 800(D) mm must be provided
    - Entry pipes must be provided with a draw rope made of nylon of minimum 6 mm diameter

### 8.19 Inter-Distribution Box (DB) Ducting

- Preferably to be of u-PVC (unplasticized PVC) pipes. Other solutions like GI (Galvanized Iron) ducts or cable trays are also acceptable. These are rigid or semi-rigid ducts designed for strength and mechanical stability.
- The percentage fill of any inter-DB ducting used to distribute cabling must not be more than 50% by volume at the design stage.
- Sharp or acute (less than 90°) bends must be avoided, if possible. Whenever bends are required, use smooth gradual bends that maintain the minimum bending radius of the cable. If sharp or acute (less than 90°) turning is unavoidable, use junction boxes that can be easily accessed in the future.
- Any inter-DB duct shall maintain a minimum clearance of 50mm from LV lines. If crossing is unavoidable then it shall be at an angle of 90°.
- Ducts shall not be laid under wet areas such as kitchens or bathrooms.

## 8.20 Home Ducting

- Shall be constructed in star topology. If not possible, a maximum of four (4) sockets can be connected in series (Daisy Chain). This shall not affect the UTP cables' star topology.
- Home ducts are preferably to be of U-PVC pipe materials. Other solutions such as surface floor boxes with GI ducts or skirting multi-compartment trunking are also acceptable.
- The percentage fill of any home ducting solution used to distribute cabling must not be more than 50% by volume at the design stage.
- Sharp or acute (less than 90°) bends must be avoided, if possible. Whenever bends are required, use smooth gradual bends that maintain the minimum bending radius of the cable. If sharp or acute (less than 90°) turning is unavoidable, use junction boxes that can be easily accessed in future.
- Any duct shall maintain a minimum clearance of 50mm from LV power lines. If crossing is unavoidable, it shall be at an angle of 90°.
- Home ducts shall not be laid under wet areas such as kitchens or bathrooms.

# 9 Installation of Equipment and Cabling Procedures

## 9.1 General Guidelines

The reliable performance of the fiber and internal copper cabling network is heavily dependent on the quality assurance procedures applied and followed during the installation and construction phases. Improper installation will easily degrade the performance of optical fibre, Category-6 cable and other hardware components. The necessary quality assurance procedures include

1. Quality Inspections – Evidenced by documentation on materials used, expertise and training of workers, and records of the construction. This will include construction records and detailed work Methods and Procedures (M&Ps) that were followed during work.
2. Visual inspections completed during and after the installation and construction work – Evidenced by documentation and certifications by installation contractor as well as by quality inspection reports taken as part of acceptance of the as-built network by the service provider, building owner and other interested stakeholders.

## 9.2 Checklists and Documentation

General installation guidelines and quality checklist items that can be used to help minimize plant damage and maximize performance and reliability of the inside building network include the following items.

1. Quality Check on Materials – The sources and suppliers of all cable, connector, closure box and hardware components in the network shall be documented and retained as part of the network acceptance certification. The inspection of all incoming materials and the use of correctly sized and matched tools for cable work (fiber and copper pairs) shall be part of quality assurance procedures for any construction and installation project.
2. Check Engineering Drawings - Network schematics and engineering drawings shall be available and include the list of dwelling units, rooms, layouts and end-to-end cable route with notations of any ceiling /raised floor type construction. The testing protocols and procedures used for cable inspection and final acceptance of network shall be documented.
3. Proper Tool Selection and Use - The correct tools need to be used to obtain a good metallurgical bond for electrical connections or low loss optical connections. Punch down, splicing and crimping tools are designed to match connection housings with specific cable, conductor or fiber sizes. The type and size of tools used shall match those specified by the manufacturers of the Category-6 cables, fiber cables, connectors and termination blocks. Incorrect tools or incorrect use of tools can lead to (1) poor electrical or optical connections, (2) physically loose connections, (3) contamination of connections with small pieces of conductor (conductive metal) or dust particles, and/or (4) damage to adjacent connections or terminal pins.

4. Training Records – The training and certification records for the installation and construction crews shall be available to show that the cable plant was placed with well trained and knowledgeable workers using industry best practices.
5. Cable Span Characterization - The final acceptance performance tests for the installed system shall be documented and certified to characterize the transmission profile for the network and for individual termination points. Separate profiles of optical loss (OTDR) or transmission performance (e.g., attenuation, impedance and crosstalk) of the key spans will be available and include:
   a) OSP segment = OTDR scan of the fiber span from the OLT in the CO to the building demarcation point (BDB or PHDB).
   b) Inside Building Span = From building demarcation point (BDB or PHDB) to FDB and HDB
   c) Home Span = From HDB to individual connection point (e.g., wall jack or socket).

## 9.3 Visual Inspections

Visual inspections can occur during and after installation. The visual audit or walk-through of the network can be achieved with a simple toolkit of:

- Flashlight,
- Written checklist based on the items discussed below
- Multimeter or low-cost OTDR meter.

This visual audit can and should be an on-going process throughout the installation and construction phases. Part of this audit or review can entail interviews with installers and contractors to ascertain that craftspeople understand the methods and procedures and know who and where to go for resolution of any question.

The visual inspection should cover not only patch panels, distribution boxes, termination racks and telecommunications closets, but may also need to follow cable pathways and ducts. The inspector shall look in all the accessible places for certain warning signals such as the following.

- Damaged Cables or Ducts - Abraded, split or punctured materials caused by building corners, installation hardware and tools, or poor quality methods and procedures.
- Physically Stressed Cables or ducts – Examples include cables/ducts pulled tightly around bends or structural columns, or unsupported cable falls between floors, inadequate support or over-compression in cable trays, over-tight cable ties that compress underlying cable pairs together. These physical circumstances are factors that compress and distort fiber or conductor pairs and disrupt twist lay that will increase noise and attenuation particularly at higher frequencies.
- Cable “Housekeeping” – Examine cable trays, plenum spaces, equipment connections and terminations in telecommunications closets, distribution boxes and equipment bays for the general cable layout. The cable should be neatly arranged and secured showing good practices for stowing cable and arranging fan outs at terminations and connections.

- Electrically Vulnerable Cables – Document location and identity of cables that are (or seemed to be) placed too close to power cables, radiating cables, signal switching cables, lighting fixtures, and other possible EMI/noise sources. Such a cable link should be scheduled for electrical testing when adjacent cables are energized and in regular use.
- Physical and Fire Protection – Cables need adequate physical and fire protection at wall and floor penetrations. Physical support is needed to reduce damage from abrasion, physical impact and insulation degradation from cold flow (creep) of plastic insulations and jacket materials. Approved fire stop materials are needed for cables that penetrate walls or floors to help ensure cables and wall/floor holes do not become channels for spreading fires.
- Hardware Compatibility - The individual components of the network must match with each other and with the equipment demands for the connectors, cables, terminations, patch panels, and transmission infrastructure. These hardware components need to meet the engineering design as well as local physical environment and relevant codes with appropriate fire-rated cables used in riser and plenum spaces.
- Termination and Patch Panels – Neatness counts with data and fiber cables; particularly at terminations and cross-connection points. Loose connections can rapidly degrade or even stop data transmission. Therefore, the review should include
    - Checks of untwisted lengths of Cat-6 data cables at terminations,
    - Checks for kinks or tightly curved fiber sections.
    - Looking for loose connections – Checked by applying a small pull out stress on connection and patch panel connections by gently pulling with a force of approximately 2-4 pounds force on the cable/wire,
    - Examine the neatness and systematic arrangement of the various conductors, fibers or cables. For example, (1) terminals shall be clean with no protruding bare copper wire that may create shorts and no evidence of open pairs, split pairs, or crossed pairs, and (2) fiber connections shall be placed in orderly smooth bends into ports with minimal crossing of fibers and tight bends.

## 9.4 Operational Guidelines

The installation crews shall follow industry best practices work and use documented M&Ps that include (at a minimum), instructions covering the items listed below:

- Minimize Physical Stress During Installation – Sufficient slack cable shall be provided during and after placement to allow for connectorization, termination and subsequent re-arrangement of cable pairs. Cables should be blown into ducts or pulled in ducts will less than 100N tension. Cable reels should be positioned to allow tension free feed-off from the reel or out of the cable box into the conduit, cable tray or into plenum space. Cables placed between floors shall be gravity feed – i.e., drop cables down between floors rather than pull cable up from floor to floor to minimize the tension and stress placed on the cable. Play

out cable from bottom of reel to help cable move without kinking, crushing or pinching of cable.

- Minimize Bending Stress on Cables – The cable pull lines will be straight with minimal bends or pulling around pulleys or bends. (i.e., no sheave wheels). Cables shall never to be bent tighter than the larger of manufacturer's recommended bending radius Typically, this criteria means that the data cables will not be bent at a radius less than 8 times their diameter or for small pair count cables not bent with a radius of less than 32 mm.
- Limit Cable Torsion (Twisting) – To minimize possible torsional stress (twisting) of the cable, swivels will be used during cable pulling operations.
- After installation of cable, any open or non-terminated ends shall be cleared, capped and sealed. All cables, termination points, jumper cables, patch panel connections shall be labeled in a clear, readable and consistent manner.
- Pairs of the Category 6 cable shall not show excessive untwisting at the connection point – i.e., should not show more than 10-12 mm of pair being untwisted to accommodate connection or more than 60-70 mm of cable sheath being removed. These terminations shall also be such that the cable and pair are physically supported as close to the termination as possible to avoid undue physical stress on the conductor at connection point.
- Correct Tool Use - The correct tools need to be used to obtain a good metallurgical bond that forms the required electrical connection with low loss (attenuation). Punch down tools and crimping tools are designed to match connection blocks and cable/conductor size. The type and size of tools used shall match those specified by the manufacturers of the Category-6 cables, connectors and termination blocks. Incorrect tools or incorrect use of tools can lead to (1) poor electrical connections, (2) physically loose connections, (3) contamination of connector blocks with small pieces of conductor (conductive metal), and/or (4) damage to adjacent terminal pins.
- Maintenance of Tools – Experience has shown that the repeated use of hand tools can induce craftsperson fatigue and reduce tactile feedback, as well as abrade or blunt tool edges. For an experienced craftsperson, tactile feedback can be a very accurate indication of connection quality. However, the user fatigue and deterioration of tool can easily lead to less reliable and poor quality connections. Electrically driven tools offer more uniform connection quality for the inexperienced worker but also are prone to use too high a force. The high insertion force may damage the terminal block and adjacent pairs with the worker realizing the problem. The installer shall provide documentation that the correct tools are being used for terminating the cable, the installer has completed training and that the tools are well maintained.

# 10 Test Procedures

Continuity testing shall be completed by the installation company for each optical fiber or copper cable span installed.

## 10.1 Equipment Testing

All test equipment used shall be independently calibrated or verified before use. Equipment calibration checks or verifications shall be completed at least every 12 months. Typical UTP cable test equipment for these tests will typically include one or more from the following list.

| Test Set | Test Function, Use and Capability |
|---|---|
| General Purpose Meter (Multimeter) | • Resistance, voltage and currents for the internal copper cables<br>• Checking for opens, shorts, continuity and so forth |
| Time Domain Reflectometer (TDR) | • Portable hand-held units that inject signal into optical cables and provide a graphical representation of the transmission path based on the reflected signal<br>• Checks length and attenuation coefficient of cable<br>• Capability to electronically save or print TDR trace/results<br>• Excellent for locating troubles and problems in optical cable spans |
| Wire Map Testers | • These portable products consist of two test units (trans-receivers) one a signal injector and one the receiver<br>• Checks wire path looking for opens, shorts and crosspairs<br>• Talk-set capability to facilitate testing<br>• Capability to electronically save or print mapping results |
| Automatic Cable Tester or LAN Tester | • Measures resistance, power, voltage, data rates, noise levels<br>• Checks continuity, loop length and compares to an internal reference standard<br>• Shall contain software to measure and automatically cable transmission performance against variety of standards including Category-6 as per EIA/TIA 568-C or equivalent standard.<br>• It is desirable that the test sets can record crosstalk and attenuation measurements and have the capability to electronically save acceptance test results |

These test sets should all be “Data-Safe”, which means that on initial attachment to a cable pair or optical fiber the test set checks if the cable is an active data line before any other action. If the data line is active, then the test set asks user if he/she is sure they wish to further test line since this will likely disrupt data service. Data-safe sets are not necessary during construction and final acceptance testing phases for qualification

testing. However the data-safe feature is required for any test sets used for daily maintenance and repair operations.

Qualification testing shall be completed for all new plant after it has been built or for older plant immediately after it has been modified. The qualification test record is used not only to certify the network as meeting contractual agreements, but also it will become the reference point for any future examination and troubleshooting of the network. This testing should include frequency sweeps to characterize the network fully.

## 10.2 Fiber Cabling Testing

Testing for optical fiber spans shall be based on visual inspection and certified OTDR (attenuation and optical loss) measurements of the "as received" cables, after span installation and acceptance testing. Optical testing shall be completed at 1310, 1550 and 1625 nm unless other testing protocols are approved.

- "As received" cables – This is a quality assurance check performed on random selection of incoming cables to verify that the documented cable specifications (fibercounts, colors, markings, length, and optical loss) supplied with cable reel match the delivered product.
- After Installation – This is a quality assurance check performed on every span as installed to check for continuity and help ensure no fiber breaks or cable deformations is present that causes high losses or non-usable fibers.
- Acceptance testing - This is the formal certification that the optical network has been tested and found to meet the design specifications in terms of optical loss, and attenuation characteristics. These test results are documented and stored for future reference and testing.

## 10.3 Category-6 and Connector Cabling Testing

Testing for UTP copper cable spans shall be based on certified measurements of DC resistance, attenuation, impedance and crosstalk across the full frequency range required for the service. The transmission characteristics of the category-6 cables shall be tested at frequencies up to 250 MHz following the transmission requirements of ANSI/TIA-568-C.2 as applicable for solid conductors.

- "As received" cables – This is a quality assurance check performed on random selection of incoming cables to verify that the documented cable specifications (pair counts/sizes, markings, twist length, and electrical characteristics) supplied with cable reel match the delivered product. For "as received" cable reel transmission tests, the test sample length shall be 100 meters, unless otherwise specified. The 100-meter length derives from the 90-meter maximum length of the permanent cable link, plus 5 meters at each end for a patch cord or flexible connection link.
- After Span Installation – This is a quality assurance check performed on every span as installed to check for continuity and help ensure no

conductor breaks, or cable bends have occurred that may cause high resistance, transmission and noise problems.

- Acceptance testing - This is the formal certification that the category-6 copper network which includes cable and connections/terminations has been tested and found to meet the design specifications in terms of
    - DC Resistance and Balance
    - Capacitance
    - Attenuation
    - Insulation Resistance and DV Voltage withstand
    - Characteristic Impedance and Structural Return Loss
    - Return Loss
    - Crosstalk and Attenuation to Crosstalk Ratio
    - Propagation Delay (PD) and Skew
    - Jacket Leakage

  These test results are documented and stored for future reference and testing.

# 11 Glossary and Definitions

| | |
|---|---|
| AC | Alternating Current |
| ACRF | Attenuation to Crosstalk Ratio - Far End |
| ADSL | Asymmetric Digital Subscriber Line |
| ANP | Access Network Provider |
| ASTM | American Society for Testing and Materials |
| AWG | American Wire Gauge |
| BDB | Building Distribution Box |
| CAT | Transmission category as per TIA 568 |
| | Cat-6 Category-6 |
| CLNE | Customer-Located Network Equipment |
| CPE | Customer Premises Equipment |
| DC | Direct Current |
| ELTCTL | Equal-Level Transverse Conversion Transfer Loss |
| EMI | Electromagnetic Induction or Electromagnetic Interference |
| FAP | Floor Aggregation Point |
| FDB | Floor Distribution Box |
| FEXT | Far-End Cross Talk |
| FTB | Fiber Termination Box |
| FTP or F/UTP | Foil-Screen Twisted Pair or Foil Unshielded Twisted Pair |
| FTTB | Fiber To The Building |
| FTTH | Fiber To The Home |
| FSB | Floor Splicing Box |
| GI | Galvanized Iron |
| HDB | Home Distribution Box |
| IDC | Insulation Displacement Contact |
| ITL | Independent Testing Laboratory |
| LCL | Longitudinal Conversion Loss |
| LV | Low Voltage |
| MDU | Multi Dwelling Unit |
| NEXT | Near-End Cross Talk |
| OD | Outer Diameter |
| ONT | Optical Network Termination |
| PD | Propagation Delay |
| PDU | Power Distribution Unit |
| PD SKEW | Propagation Delay Skew |
| PHDB | Primary Home Distribution Box |
| POTS | Plain Ordinary Telephone Services |
| PS ACRF | Power-Sum Attenuation to Crosstalk Ratio - Far End |
| PS NEXT | Power-Sum Near-End Crosstalk |
| PVC | Poly Vinyl Chloride |
| RFI | Radio Frequency Interference |
| QMS | Quality Management System |
| SHDB | Secondary Home Distribution Box |
| SOHO | Small-Office, Home-Office |

| | |
|---|---|
| SP | Service Provider |
| SRL | Structural Return Loss |
| STI | Surface Transfer impedance |
| STP | Shielded Twisted Pair |
| TCL | Transverse Conversion Loss |
| TCTL | Transverse Conversion Transfer Loss |
| TIA | Telecommunications Industry Association |
| UL | Underwriters Laboratories Inc. |
| UPS | Uninterruptable Power Supply |
| UTP | Unshielded Twisted Pair |
| VDSL | Very-high-bit rate Digital Subscriber Line |
| VRMS | Voltage - Root Mean Square |
| Z | Characteristic Impedance |
| Zo | Terminating Impedance |

**Access Network Provider (ANP)**: The Party to whose network an access line is directly connected and over which services are supplied. Note that an ANP may also be an Access Service Wholesaler and / or a Retail Service Provider.

**Balanced Cable**: A cable consisting of one or more metallic symmetrical cable elements (twisted pairs or quads) also known and above, as referenced in the ISO / IEC 11801.

**Cross-connection**: Any arrangement which enables a socket to be associated with a specific service.

**Customer Premises Equipment (CPE**): Any telecommunications terminal equipment connected to the customer's wiring, other than CLNE.

**Customer-Located Network Equipment (CLNE)**: Any access network provider / service provider network terminating equipment required to provide a specific service and located within the customer's premises on the customer's side of the network demarcation point.

**Daisy-Chain (or loop) wiring**: A common form of wiring where a cable to one socket is connected to another cable to the next socket etc

**Ducting System**: Any system that provides a passageway for cables. It could be pipes, trays, concrete trenches, or any other form of a channel to convey cables.

**Insulation Displacement Contact (IDC)**: A technique used to terminate copper wires without stripping-off the insulation using a special insertion tool.

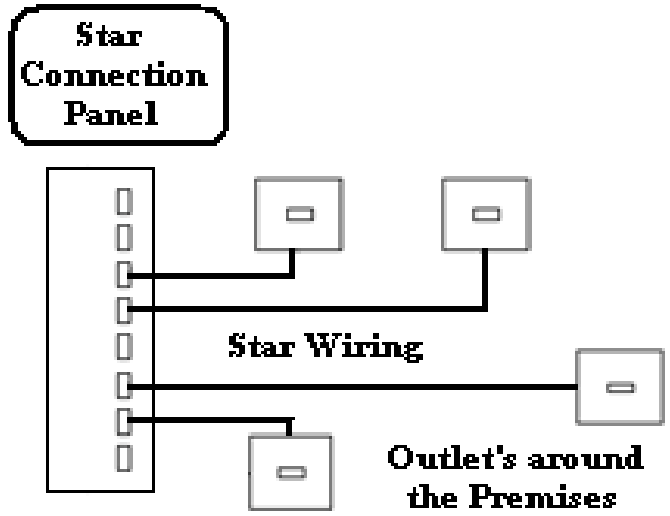
**Low Voltage (LV)**: Any voltage in the range 50–1000Vrms AC or 120–1500V DC.

**Pair**: Any set of two wires used to provide a circuit.

**Service Provider (SP):** Any company providing a Telecommunication and / or Broadcast Service to a Customer and who has the Billing Relationship with the Customer for that service.

**Star Topology**: An arrangement where each socket is separately cabled to a central point, where cross-connect facilities may be provided.

Figure 10 Star Wiring Topology



# 12 Annex A – Additional Requirements

## 12.1 Telecommunications Room

It is the responsibility of the building, dwelling or unit owner to provide the Telecom room where it is required as defined by the requirements within this documentation. The standards for Telecom room are defined elsewhere in the 'Telecommunications Equipment Room Requirements in Qatar' document.

In general, the electronic and optical equipment used in the SOHO and residential telecommunications room locations should be designed to operate reliably in ambient temperatures between 5°C (41°F) and 45°C (113°F) and in humidity up to 85%RH. The equipment should also be able to operate for short periods (e.g., up to 3-4 days) up to 55°F and as low as 0°C as well as under 90% RH.

## 12.2 Air Conditioning Requirements

It is the responsibility of the building, dwelling or unit owner to provide the Telecom room with adequate air conditioning to support the equipment as per the most current European Telecommunications Standards Institute (ETSI) document reference EN 300019-1-3, pertaining to Classification of Environmental Conditions; Stationary Use at Weather Protected Locations. At the time of publication of this document, the current version is ETSI EN 300 019-1-3 v2.3.2 (2009-11) and can be downloaded from the ETSI website (www.ETSI.org).

## 12.3 Fire System Requirements

It is the responsibility of the building, dwelling or unit owner to provide the Telecom room with a fire fighting system that conforms to telecommunications use as defined elsewhere in the 'Telecommunications Equipment Room Requirements in Qatar' document.

## 12.4 Telecommunication Closets and Distribution Boxes

The telecommunication closets and various closure boxes shall be:

- Large enough for terminal blocks and interconnections to be mounted securely and be readily accessible. The mounting support needs to be secure so that push-down tools and other connection tools can be used with solid backing to facilitate a good quality connection (IDC).
- Readily-accessible in terms of physical entrance space and internal working space for workers and for entering/exiting cables. The cable that enters from a duct or through holes in wall need to be arranged to provide adequate space to bend cable without undue stress and make stress-free connections to the terminal block.

- Adequate working space to arrange cables neatly and so provide sufficient space for re-arrangement and future cabling activities within the telecommunications closet. Empty conduits/ducts should be sealed and provided with pull tapes for future work. Good housekeeping practices at the connection points in telecommunications closets and at wall jacks are critical to achieving and maintaining a high speed data service that may be up-graded in the future.

# 13 Annex B – Optical Fiber Cable Specifications

## 13.1 Optical Fibre Characteristics

The geometrical, optical, transmission and mechanical characteristics of the fiber shall conform to ITU-T G.657.A2 for 4, 12, 24, 48, 96 and 144F cable for characteristics of a single- mode optical fiber cable.

| # | Attribute | Details | Value | | |
|---|---|---|---|---|---|
| 1 | Mode field diameter | Wavelength | 1310 nm | | |
| | | Range of nominal values | 8.6-9.5 µm | | |
| | | Tolerance | ± 0.4 µm | | |
| 2 | Cladding Diameter | Nominal | 125.0 µm | | |
| | | Tolerance | ± 0.7 µm | | |
| 3 | Core concentricity error | Max | 0.5 µm | | |
| 4 | Cladding non-circularity | Max | 1.0% | | |
| 5 | Cable cut-off wavelength | Max ($\lambda_{CC}$) | 1260nm | | |
| 6 | Uncabled fibre macro bending loss | Radius (mm)[i] | 15 | 10 | 7.5 |
| | | No. of turns | 10 | 1 | 1 |
| | | Max. at 1550nm (dB) | 0.03 | 0.1 | 0.5 |
| | | Max. at 1625nm (dB) | 0.1 | 0.2 | 1.0 |
| 7 | Proof stress | Minimum | 0.69 GPa | | |
| 8 | Chromatic dispersion coefficient | $\lambda 0$min | 1300 nm | | |
| | | $\lambda 0$[ii] | 1310 nm | | |
| | | $\lambda 0$max | 1324 nm | | |
| | | S0max | 0.092 ps/nm$^2$.km | | |
| 9 | Attenuation Coefficient | Max. from 1310nm to 1625nm | 0.4dB/km | | |
| | | Max. at 1310nm | 0.35dB/km | | |
| | | Max. at 1550nm | 0.21dB/km | | |
| | | Max. allowed point discontinuities at 1310nm and 1550nm | 0.05dB | | |
| | | Max. allowed variation[iii] | 0.1dB | | |
| | | Temperature rang | -5° to +70°C | | |
| | | Max. aging effect (25 years) | 0.05dB/km | | |
| 10 | PMD Coefficient | M | 20 Cables | | |
| | | Q | 0.01% | | |
| | | Max. PMDQ | 0.20 ps/√ km | | |

[i] The macro bending loss can be evaluated using a mandrel winding method (method A of [IEC 60793-1-47]), substituting the bending radius and the number of turns specified in this table

[ii] The fiber shall also be suitable for use in the 1550nm region, where this fiber is not optimized for use.

[iii] Variation between the value of attenuation co-efficient for any one km length of cable is compared with that of another one km length of the cable

## 13.2 Cable Construction

### 13.2.1 Strength Elements

#### 13.2.1.1 Central Strength Element

The central strength element shall be of a suitable non metallic substance such as FRP (Fiber Reinforced Polymer) rod coated with polyethylene and shall be designed to meet all mechanical strength requirements of the cable.

Requirements of typical values for the central strength member are shown in the table below.

| Sl. No. | Item | Unit | Typical values |
|---|---|---|---|
| 1 | Nominal diameter | mm | 2 for 12 and 24 fibre cable<br>2.5 for 48, 96 and 144 fibre cable |
| 2 | Specific gravity | - | 2.1 |
| 3 | Tensile Strength | MPa | 1100 (minimum) |
| 4 | Tensile Modules | GPa | 50 (minimum) |
| 5 | Flexural Strength | MPa | 1200 (minimum) |
| 6 | Flexural Modulus | GPa | 40 (minimum) |
| 7 | Elongation to Break | % | 2 % (minimum) |
| 8 | Load (Kg) to Elongation of 0.2 % | N | 900 (minimum) |

#### 13.2.1.2 Peripheral Strength Element

The peripheral strength element shall be of a suitable aramid yarns or glass fibres wrapped with plastic tape and shall be designed to meet all mechanical strength requirement of the cable.

The peripheral strength element shall be placed in between the plastic tape and the swelling tape. Requirement of typical values for the peripheral strength element are shown in the table below.

| Sl. | Item | Unit | Typical Values |
|---|---|---|---|
| 1 | Number of Aramid Yarns | Number | 21 |
| 2 | Weight | kg/km | 5 |
| 3 | Specific Gravity | $gm/cm^3$ | 1.4 |
| 4 | Breaking Strength | N | 300 (minimum) |
| 5 | Elongation to Break | % | 2 (minimum) |
| 6 | Modulus of Elasticity | GPa ($kN/m^2$) | 85 (minimum) |

**Note**: Table values in Sections 15.2.1.1 and 15.2.1.2 are given as a general values, however, any other values can be used subject to prior approval.

### 13.2.2 Cable Make-up

#### 13.2.2.1 Optical Fibers Cable Choices:

4 Optical Fibers: The standard cable core configuration will have a total of four (4) fibers arranged in two (2) loose tubes containing two (2) fibers each, with one strength member of Aramid Yarn embedded in the cable sheath. The cable will contain no metallic elements and be dielectric. Alternate designs having all four (4) fibers on a central tube or as tight buffer cable are acceptable, with prior approval.

12 Optical Fibers: The total number of fibers in the cable shall be twelve (12) with six (6) of the fibers encapsulated within two (2) loose tubes. Tight buffer cables are also acceptable, with prior approval.

24 Optical Fibers: The total number of fibers in the cable shall be twenty four (24). Six (6) fibers shall be encapsulated within four (4) loose tubes. Tight buffer cables are also acceptable, with prior approval.

48 Optical Fibers: The total number of fibers in the cable shall be forty eight (48). Six (6) fibers shall be encapsulated within eight (8) loose tubes

96 Optical Fibers: The total number of fibers in the cable shall be ninety six (96). Twelve (12) fibers shall be encapsulated within twelve (12) loose tubes

144 Optical Fibers: The total number of fibers in the cable shall be one hundred and forty four (144) arranged with twelve (12) fibers encapsulated within each of twelve (12) loose tubes.

#### 13.2.2.2 Loose Tubes:

The loose tubes containing optical fibers together with fillers shall be suitably stranded over the central strength member in one layer.

There shall be binder to maintain core geometry, stranded around central strength element, using reverse helical wrap technique.

#### 13.2.2.3 Fillers:

The fillers shall be of a transparent color made of polyethylene, polypropylene or any other approved material at the discretion of the manufacturer. All fillers shall be compatible with the other constituent components of the cable and shall not adversely affect the performance of the cable, throughout the operative life of the cable. The number of filler tubes shall be decided in such a way to maintain cable sheath circularity. The fillers shall completely fill the voids they are designed to and shall not phase separate under all operational conditions.

#### 13.2.2.4 Tight Buffer:

Individual fiber shall be coated with yellow PVC jacket of a diameter of 2.5±0.5mm each. Each fiber shall be numbered as follows:

a) from one to four for four fibers cable,
b) from one to twelve for twelve fibers cable, and
c) from one to twenty four for twenty four fibers cable.

Fiber number must be printed on the PVC jacket on each fiber at intervals of not more than 100mm. Numbers must be printed in numerals and in writing such as: “17 SEVENTEEN”, on the complete length of each fiber’s buffer. The printing shall be permanent, durable and not abraded during normal wear and use.

### 13.2.3 Identification

#### 13.2.3.1 Inside Identification

The name of the manufacturer and the year of manufacture shall be indelibly marked at intervals of not more than 100mm, either on the belting tape or on a separate polyester marking tape of not less than 3mm wide.

If a separate marking tape is used then it shall be laid over the outer wrappings and under the sheath.

#### 13.2.3.2 Cable Size Identification

The cable size shall be punch type marked (non-erasable) at every meter on the outer surface of the sheath.

#### 13.2.3.3 Cable Length Identification

Cable length (meter) shall be marked at every meter on the outer sheath surface and the markings shall be clearly visible, permanent and durable. The cable length shall be punch type marked (non-erasable) at every meter on the outer surface of the sheath.

### 13.2.4 Sheath

- The sheath shall be free from pinholes, joints, mended places and other defects.
- The minimum sheath thickness shall not be less than 1mm for 4 and 12F, 1.5mm for 24, 48 and 96F, and 2mm for 144 F cables.
- The sheath shall be reasonably circular, and the curvature of the external surface shall not be concave at any point.
- The sheath material shall be of LSZH type (Low-Smoke Zero-Halogen) or Fire-Resistant PVC (FR-PVC) suitable for internal and external use and the sheath color shall be **YELLOW**.

#### 13.2.4.1 Ultimate Tensile Strength

Tensile strength-at-break of the sheath material shall not be less than 10N/mm2.

#### 13.2.4.2 Elongation at Break

The elongation-at-break of the sheath material at break shall be ≥ 150%.

#### 13.2.4.3 Bend Test

The sheath shall show no signs of damage or ripples after a bend test have been carried out as follows:

- No Load Test:
  - The cable shall be coiled at least one complete turnaround a mandrel of diameter not more than 10 times the specified minimum cable diameter
- Full Load Test:
  - The cable shall be coiled at least one complete turnaround a mandrel of diameter not more than 20 times the specified minimum cable diameter.

### 13.2.5 Rip Cord

a) A rip cord having a minimum breaking load of not less than 150N shall be laid under the outer sheath of 2, 4 and 12 fibre cables respectively.
b) Two rip cords having a minimum breaking load of not less than 250N shall be laid under the sheath on diagonally opposite sides of the cable for 48, 96, 144 and 192 fiber cables.

### 13.2.6 Filling Compound

a) The filling compound shall be provided inside the loose tube only. Suitable industry proven filling compound shall be provided to completely block ingress of moisture into the loose tube
b) The filling compound shall be safe to handle and shall not adversely affect the performance and color of the fibre, or the constituent components of the cable, throughout its operational life.
c) The filling compound shall be compatible with the need to prepare the cable and splice the fibers under field conditions.
d) The filling compound shall be suitable for installation and operation over the temperature range -5°C to +70°C.
e) The filling compound shall be non-toxic, free from unpleasant odor and shall cause no dermatitis hazards.
f) The compound shall be non-hydrogen generating, waterproof, and neutral in color.
g) Data sheets for filling compound shall be provided along with Tender documents.

### 13.2.7 External Diameter

The external diameter of the cable, when measured by diameter tape, shall not be more than 7mm for 4F, 14mm for 12, 48 and 96 fibre cable, 17mm for the 144 fibre cables.

### 13.2.8 Color Scheme

#### 13.2.8.1 Color Scheme for Loose Tubes/Fillers

The loose tubes shall employ the following colour code:

| Tube No. | Color |
|---|---|
| 1 | Dark Blue |
| 2 | Orange |
| 3 | Green |
| 4 | Brown |
| 5 | Grey |
| 6 | White |
| 7 | Red |
| 8 | Black |
| 9 | Yellow |
| 10 | Violet |
| 11 | Pink |
| 12 | Light Blue |
| Filler | Transparent |

#### 13.2.8.2 Color scheme for the Fibres shall be as follows:

Fibres shall employ the following color code:

| Tube No. | Colou |
|---|---|
| 1 | Dark Blue |
| 2 | Orange |
| 3 | Green |
| 4 | Brown |
| 5 | Grey |
| 6 | White |
| 7 | Red |
| 8 | Black |
| 9 | Yellow |
| 10 | Violet |
| 11 | Pink |
| 12 | Light Blue |
| Filler | Transparent |

### 13.2.9 Mechanical Performance of Cable

#### 13.2.9.1 Tensile Strength

The cable shall have sufficient strength to withstand a load of value T = 9.81×W×3 N, (where W = mass of 1km of cable in kg). The load shall not produce a total strain exceeding 0.25% in the fibres, and shall not cause permanent damage to the component parts of the cable. The load shall be sustained for 10 minutes and the strain of the fiber monitored.

#### 13.2.9.2 Flexibility

The fibers and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped four (4) complete turns for ten (10) complete cycles, around a mandrel of 12×D in diameter, where “D” is the outside diameter of the cable in mm.

#### 13.2.9.3 Compressive Stress

The fibers and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 1000N applied between two flat plates of dimensions 50mm by 50mm. The load shall be applied for 60 seconds.

#### 13.2.9.4 Transportation and Storage

The cable shall be protectively packed in drums to withstand transportation. The cable design and packing techniques shall permit the storage of all cable, in its original packing (reel or drum).

#### 13.2.9.5 Vibrations and Shock

The supplier shall state the limits of vibration and mechanical shock that the cables can withstand under conditions of transport, storage and installation.

## REFERENCES

1. BS 6234 - Specification for Polyethylene Sheath
2. ITU-T G657.A2 – Characteristics of Bending-Loss Insensitive single-mode optical fibre and cable for the access network
3. IEC 794-IF5-Water Permanent Test
4. TIA TIA-568-C.0; Generic Telecommunications Cabling for Customer Premises

# 14 Annex C – Category-6 Cable Specifications

## 14.1 Insulated Conductor Characteristics

Conductor - Each conductor shall be a solid wire of commercially pure annealed copper, smoothly drawn, circular in cross section, uniform in quality, and free from defects. The nominal conductor size shall be 22 or 24 AWG. The exact conductor gauge size may vary to achieve the required Category-6 electrical requirements.

Insulation - Conductors shall be insulated with a suitable dielectric insulating material of sufficient thickness and properties to meet the electrical requirements. The insulation shall be uniform and applied concentrically; consisting of 100% virgin material. The insulation materials used will be one of the following types - polyolefin, poly(vinyl chloride), or fluoropolymer - that have proven successful at meeting the functional performance requirements of premises wires

Imperfections - The insulated conductors should have no more than an average of one fault per 1,000 conductor meter when measured at 2500 VDC or 1750 VRMS (AC).

Adhesion - The adhesion of the insulation on the conductor shall be such that the force to remove the insulation from the conductor shall not be greater than 20 N when stripped at a rate of travel of 50mm per minute.

Tensile strength and Elongation - The average elongation-at-break shall not be less than 100% and the average tensile strength-at-break shall not be less than 13.6 MPa. It is desirable that the minimum elongation-at-break shall not be less than 150%.

Resistance to Aging - After aging at 100°C for 7 days, the insulated conductors shall show no signs of cracking, splits or tears when examined at a 5× magnification, after wrapping in 6 tight turns around a mandrel having a diameter no larger than the diameter of the insulated conductor.

Compression Resistance - Insulated conductors shall be tested for resistance to compression at a rate of approach not to exceed 0.5 mm per minute and the minimum compressive strength shall not be less than 1330N over a 50-mm length of the insulated conductor sample.

Cold Bend - Insulated conductors shall be wrapped around a test mandrel with a diameter equal to 3 times the outer diameter (OD) at -20 ± 2°C. There shall be no cracks in the tested specimens after bending the insulated conductors 5 times around the mandrel within 20 to 30 seconds.

Shrinkback - A 150mm length of insulated conductor shall be placed in a circulating air oven for 4 hours at 115 ± 1°C. After cooling to room temperature, the difference in length between the insulation and the conductor shall not exceed 8 mm.

Twist Lengths - Appropriately colored insulated conductors shall be uniformly twisted into pairs in a way that ensures that meet the Category-6 transmission electrical requirements. The average twist length of any pair in the finished wire shall not exceed 150 mm.

Insulation Color – Color coding is required so that conductors and individual pairs can be properly and easily identified. Color coding shall be accomplished by use of colored insulation in combination with either single marks of a colored ink, or an extruded colored stripe.

### 14.2 Other Cable Components

Foil Screens - Internal cables may include a foil screen surrounding the insulated wires or the core bundle to help protect the transmitted signal from the inductive (EMI) and interference (RFI) effects from external electromagnetic influences. These foils vary in their shielding effectiveness depending on the metal thickness of the screen, its conductivity, and the physical coverage provided by the foil for the underlying conductors. The required thickness and foil material type will depend on the electromagnetic protection level desired for the application. The foil screen is normally used in conjunction with a tinned copper drain wire, which provides electrical continuity for the foil screen. As a guideline, typical foil screens usually are 0.025 to 0.05 mm thick aluminium.

Jacket Ripcords - Jacket ripcords shall be continuous in any length of wire and shall be capable of consistently slitting the wire jacket for the continuous length of 0.75 m at 23 ±3°C without entanglement or damage to the conductor insulation when examined under 5 × magnifications.

### 14.3 Cable Jacket Characteristics

Jacket Material - Jacket materials that have proven successful at meeting the functional performance requirements of telecommunications premises cables include fire-retardant polyolefins, poly(vinyl chloride), and fluoropolymers. Other materials may be used provided that they meet all the applicable performance requirements of this document.

Jacket Surface - The jacket shall be smooth, free from holes, splits, blisters, and other defects, and shall not adhere to the conductor insulation or to the core wrap if used.

Jacket Thickness - Jacket thickness is dependent on the material selected, desired fire resistance, and other functional performance requirements. Jacket thickness shall be sufficient to meet the mechanical and electrical requirements.

Material Tensile Strength and Elongation - The jacket materials shall have a minimum ultimate strength (tensile strength-at-break) of 13.6 MPa and a minimum elongation-at-break of 100%. It is desirable that the minimum elongation-at-break be at least 150%.

Resistance to Aging - After aging at 100°C for 7 days, the average tensile strength-at-break of the jacket sample shall not be less than 75% of the initial value before aging, and the average elongation-at-break shall not be less than 50% of the initial value before aging.

## 14.4 Electrical Requirements

Caterory-6 Transmission Performance- Cables shall meet the Category-6 transmission characteristics tested at frequencies up to 250 MHz. In general, electrical test criteria and procedures noted below follow the methods and procedures of the *Transmission Requirements* section of ANSI/TIA-568-C.2 as applicable for solid conductors. For all transmission tests, the test sample length shall be 100 meters unless otherwise specified.

DC Conductor Resistance - For nominal 24 AWG conductors, the resistance of any individual conductor in any reel or length of wire shall not exceed 9.38 ohms per 100m measured at 20°C. For nominal 22 AWG conductors, the resistance of any individual conductor in any reel or length of wire shall not exceed 5.9 ohms per 100 m when measured at 20°C.

Conductor Resistance Unbalance - The resistance unbalance between the two conductors of any pair in completed wire shall not exceed 5.0%.

Capacitance Unbalance — Pair-to-Ground - The unbalance to ground at 1 kHz shall not exceed 330 pF per 100 m

Insertion Loss (Attenuation) - Insertion loss (also called attenuation) is a measure of the signal loss (power) resulting from the wire as the signal passes along it between a transmitter and receiver component. The insertion loss in dB at 100 meters measured at 20°C shall not exceed

$$1.808\sqrt{(f)} + 0.017(f) + 0.2/\sqrt{(f)}$$

where *f* = frequency from 1 to 250 MHz.

The insertion loss shall be measured at 40°C (104°F) and 60°C (140°F) and the maximum permitted wire insertion loss shall be computed at these elevated temperatures by using the following factors as appropriate:

- A factor of 0.4% per °C increases from 20°C to 40°C for UTP (unshielded twisted pairs) products
- A factor of 0.6% per °C increases from 40°C to 60°C for UTP (unshielded twisted pairs) products.
- A factor of 0.2% per °C increases from 20°C to 60°C for foil-screened wire products (also called FTP or F/UTP).

Insulation Resistance - Insulated conductor(s) shall have an insulation resistance not less than 1500 megaohm-100 m.

Return Loss - Return loss of cable products shall be measured across the appropriate frequency range and shall not be less than the values calculated from the equations below where *f* is the frequency in MHz.

For *f* from 1 to 10 MHz → Return Loss (dB at 100 m) > 20 + 5 log (*f*)

For *f* from 10 to 20 MHz → Return Loss (dB at 100 m) > 25

For *f* from 20 to 250 MHz → Return Loss (dB at 100 m) > 25 - 7 log (*f*/20)

Near-End Crosstalk (NEXT) - In wire products containing 4 pairs or less, the Near-End

Crosstalk (NEXT) shall be measured across the appropriate frequency range and the NEXT Loss (dB at 100 m) shall not be less than 44.3 - 15 log (*f*/100).

Power-Sum Near-End Crosstalk (PS NEXT) - For wire products containing 25 pairs and less, the Power-Sum Near-End Crosstalk (PS NEXT) measured as dB at 100 meters between each pair and all other pairs and shall not be less than 42.3 - 15 log (*f*/100).

Power-Sum Attenuation-to-Crosstalk Ratio, Far-End (PS ACRF) - The Power-Sum Attenuation-to-Crosstalk Ratio, Far-End shall be calculated across the frequency range and the PS ACRF values in dB at 100meters shall not be less than 24.8 - 20 log (*f*/100).

Propagation Delay (PD) - The Propagation Delay (PD) shall be measured across the frequency range and the PD values in nanoseconds at 100meter shall not exceed the values determined from the following equation where f is the frequency in MHz -

$$534 + 36 / \sqrt{(f)}$$

Transverse Conversion Loss (TCL) and Transverse Conversion Transfer

Loss (TCTL) - Transverse Conversion Loss (TCL) is the measured loss from a balanced signal to an unbalanced signal measured at the near end of the wire product. For wire components, the TCL value is the same as Longitudinal Conversion Loss (LCL) where the measured loss is from an unbalanced signal to a balanced signal measured at the near end of the wire. Transverse Conversion Transfer Loss (TCTL) or Equal-Level Transverse Conversion Transfer Loss (ELTCTL) are the measured losses from a balanced signal at the near end to an unbalanced signal measured at the far end of the pairs in the wire product.

Transverse Conversion Loss (TCL) - The Transverse Conversion Loss (TCL) shall be measured as per ANSI/TIA-568-C.2 across the 1 to 250 MHz frequency range and the TCL values shall not be less than the values determined from the following equation, where f is the frequency in MHz.

| TCL (dB at 100 m) |
|---|
| $30 - 10 \log (f / 100)$ |

:

Equal-Level Transverse Conversion Transfer Loss (ELTCTL) - the Equal-Level Transverse Conversion Transfer Loss (ELTCTL) shall be measured as per ANSI/TIA-568-C.2 across the 1 to 30 MHz frequency range and the ELTCTL values shall not be less than the values determined from the following equation, where f is the frequency in MHz.

| ELTCTL (dB at 100 m) |
|---|
| $35 - 20 \log (f)$ |

## 14.5 Complete Cable Requirements

Cold Wrap Test - The completed wire shall be capable of being bent without visual evidence of cracks or splits in the jacket after the wire has been bent around a mandrel 3 times in three close turns within 30 seconds. The test will be performed at -20 ± 2°C. For wires with an OD up to or equal to 20 mm, the diameter of the test mandrel shall equal 8× OD of the wire product. For wires with an OD greater than 20 mm, the diameter of the test mandrel shall equal 10× OD of the wire.

Impact Test - The completed wire product shall be capable of surviving a 3 inch-lb impact test at -10 ± 2°C without visual evidence of cracks or splits in the jacket after the wire has been impacted. The impact cylinder shall have a flat striking surface and be 1 inch in diameter. The wire shall be placed on an anvil with a ridge 1.6-mm wide and 2.4-mm high.

Fire Resistance – Riser Cables - Internal cables shall meet the applicable fire codes. For cables used in building riser locations, these riser-rated wire products shall meet the requirements of UL-444 where the flame height during the test shall be less than 3.7 m and the temperature at any of the monitoring thermocouples shall exceed 454°C.

Fire Resistance – Plenum Cables - Internal cables shall meet the applicable fire codes. For cables used in building plenum locations, these plenum-rated wire products shall meet the requirements of UL-444 Flame and Smoke Requirements Section and when tested as per NFPA 262 the plenum-rated wire products shall show:

- A flame spread of 5 feet (1.5 m) or less
- A peak optical smoke density of 0.5 or less
- An average optical smoke density of 0.15 or less.

Jacket Marking - The outer surface of the jacket shall be durably marked in black or color contrasting ink with the following information:

- Manufacturer's Name or Code
- Year of Manufacture
- Number of Pairs
- Conductor Gauge — AWG
- Fire resistance rating
- Electrical transmission classification (i.e., Category-6).

These markings shall be spaced at equal intervals to and alternating with the sequential length marking not exceeding 0.6 meters.

Packaging - Premises wires are furnished in a variety of packages to facilitate deployment in a variety of applications. Packaging can include coils, cartons, small- and medium sized reels, or other suitable configurations. The wire shall be packed in conveniently sized packages that permit tangle-free distribution of wire from an unattended dispenser. The wire shall be evenly and compactly packed into one continuous length.

## REFERENCES

1. Telecommunications Cabling Standards with the ANSI/TIA568-C.2, Copper Cabling Components,
2. ANSI/NFPA 70, National Electrical Code, (NEC) 2008.
3. ANSI/UL 444, UL Standard for Safety Communications Cables (CSA C22.2).
4. ISO 9000, Quality Management Systems
5. ASTM D 4565, Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.
6. ASTM D 4566, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.
7. UL 1581, Reference Standard for Electrical Wires, Cables and Flexible Cords.
8. UL 1685, Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
9. UL 1666, Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts.
10. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

# 15 Annex D – External Ducting Specifications

Multiple spans of external ducts with Joint Boxes in between may be needed to extend the cabling channel. In MDU scenarios, a dedicated telecommunications room is part of external ducting.

## 15.1 Ducts

15.1.1 Specification

| Material | Inner Diameter | Available Length | Colour | Qtel Designation |
|---|---|---|---|---|
| PVC | 90mm | 5.8 m | Black | D54 |
| PVC | 50mm | 3 m | Black | D56 |

15.1.2 Formation and Requirements

| Description | No. of Ducts | Remarks |
|---|---|---|
| Each Villa | 1×D56 | |
| MDUs | 2×D54 | Additional 2×D54 from different direction need to be considered for cable route diversity |
| Joint Box to Joint Box<br>or<br>Joint Box to Telecom Room | From 2×D54<br>to<br>9×D54 | The number of D54 depends on the final cabling design as it is required to maintain at least 50% duct space for maintenance and any future expansion. |

## 15.2 Joint Boxes or Handholes

Joint boxes need to be located in the footway or verge, in a safe location and be easy to access in the future. The orientation of the Joint boxes window (access holes) needs to be designed to facilitate the cable entry. Different sized Joint boxes are based on the number of ducts entering the Joint Box, the location and number of joint closure.

### Handhole Dimensions

| Code | Internal Dimensions (mm) | | | Location of Chamber | Maximum Number of Duct Ways | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Normal Depth | | Extra Depth | | |
| | L Length | W Width | D Depth | | D54 | D56 | Depth (mm) | D54 | D56 |
| JRC4 | 915 | 460 | 780 | Footway Sidewalk | - | 5 | 75 | - | 6 |
| | | | | | 1 | 4 | 100 | 1 | 5 |
| | | | | | 2 | 2 | 125 | 2 | 6 |
| JRC12 | 1170 | 680 | 740 | Footway/ Carriageway (Roadway) | 1 | 5 | 100 | 2 | 4 |
| | | | | | 2 | 3 | 125 | 4 | 2 |
| | | | | | 3 | 2 | 150 | 4 | 3 |
| | | | | | - | - | 200 | 4 | 4 |
| JRC14 | 2285 | 680 | 965 | Footway/ Carriageway (Roadway) | 1 | 8 | 125 | 4 | 2 |
| | | | | | 2 | 6 | 150 | 4 | 4 |
| | | | | | 3 | 4 | 175 | 6 | 2 |
| | | | | | 4 | 3 | 200 | 6 | 4 |
| | | | | | - | - | 250 | 6 | 6 |
| | | | | | - | - | 300 | 6 | 8 |

Note: Manholes can be used if number of D54 ducts is more than 6.

### 15.3 General Civil Considerations

- All external ducts must be laid underground.
- Ducts to be laid at 600 mm depth from final ground level with pulling rope installed.
- Only one slow bend is acceptable for Villa connection through D56 ducts.
- Only one slow bend is acceptable for MDUs connection through D54 ducts.
- All telecom rooms of Type A shall be connected from two different directions for diversity requirements.
- Maximum distance between the Joint boxes shall not exceed 250 meters
- Minimum of JRC12 shall be used to accommodate FO (Fibre Optic) Joint Closure.
- Sharp or acute (less than 90°) bends are unacceptable and not permitted.
- Type of Joint Box depends on the usage (i.e. JRC12 and JRC 14 shall be used in areas used by heavy vehicles regardless of the number of used ducts).
- Manholes with sufficient space for closures which can accommodate minimum three splitter layers and spare cable length.

# 16 Annex E – Internal Ducting Specifications

For cabling inside buildings, microducts (ducts with OD less than 25 mm) can provide placement flexibility. In MDU scenarios, individual microducts can be used to place cable between distribution boxes and the telecommunications jack (socket). A number of colored microducts can also be bundled under one outer sheath to form an internal multi-duct conduit for easier placement and identification of cable runs.

The microduct products are designed to accommodate a single fiber optical cable primarily for deployment in a residential or intrabuilding location through either cable pulling or cable blowing procedures. The microduct product shall be flexible, lightweight, durable, and easy to install. Microduct products consist of smooth or micro-ribbed ducts and are shall be:

- Compatible with existing construction designs and building configurations for both riser- and plenum-rated applications, including cable blowing apparatus.
- Able to accommodate single or multiple microfiber cables of 2.5 to 8 mm diameter; although the most common sizes anticipated shall be fiber cables of 2.9 or 3.0 mm outer diameter.
- Allow cables to be safely deployed through pull lines or strings using less than 90-120 Newtons of force, or more often using cable blowing techniques at typical deployment speeds of 30-60 meters (100-200 feet) per minute.

Microducts are typically small-diameter, flexible, or semi-flexible ducts with inside diameters usually ranging from 3 mm to 10 mm (larger sizes available). These ducts are designed to provide clean, continuous, low-friction paths for placing optical cables that have relatively low pulling tension limits.

## 16.1 Microduct - Size and Material

Size - The standard sizes include the following from which a microduct can be chosen to match cable size and application. Various material formulations including PVC, LSZH and fluoropolymers varieties are available with differing fire resistance ratings to match building application (general purpose, risers and plenums) and customer needs.

| Designation | Nominal Size (mm) | |
|---|---|---|
| | OD | ID |
| 5 mm (*) | 5.0 | 3.0 |
| 7 mm | 7.0 | 5.5 |
| 8.5 mm | 8.5 | 6.0 |
| 10 mm | 10.0 | 8.0 |
| 12 mm | 12.0 | 10.0 |

(*) Used for small 2-2.5 mm OD cables that are blown into microduct.

The microduct products shall meet the nominal ODs and IDs noted above within a tolerance of +/- 0.1 mm in their measured OD values.

Regrind - Microduct products shall have a maximum of 5% plastic regrind used in their manufacture.

Aging - No significant changes (less than 5%) in characteristic dimensions of the microducts are allowed after aging at 75°C for 30 days. The microduct shall have a maximum longitudinal shrinkage of 2% after conditioning at 75°C for 30 days. The microduct product shall show no significant change in colour, surface appearance, and mechanical robustness after conditioning at 75°C for 30 days.

## 16.2 General Design Features

The microduct product shall consist of a smooth or micro-ribbed duct designed to accommodate a single fibre optical cable primarily for deployment in a residential or intrabuilding location through either cable pulling or cable blowing procedures.

The microduct product shall be flexible, lightweight, durable, and easy to install.

The microduct shall have the ability to be cut cleanly using standard tools.

Indoor microduct products shall be able to be deployed and operational at conditions between -5°C (23°F) and 50°C (122°F) and between 10 and 85% relative humidity (RH).

The microduct product and accessories such as end-caps, couplers, and mounting hardware shall have no sharp edges or burrs that might be hazardous to a technician or installer, or otherwise damage any cabling placed in it following the manufacturer's instructions.

Microducts shall be homogeneous and free of any visible surface flaking, chips, voids, holes, or cracks.

Microducts extruded over optical cable shall not adhere to the cable sheath.

Microduct products shall be compatible with common tools, equipment, and procedures - specifically, ducts shall be

- Provided on reels compatible with existing reel handling equipment
- Capable of being placed in underground conduit using existing swivels, slings, links, grips, winches, and winch lines
- Compatible with existing rodding devices (such as compressors or vacuum equipment) used to place a standard pull line inside the duct
- Compatible with generally used telephone cable lubricants.

### 16.3 Marking

Product information shall be permanently applied on the outside surface of the duct in readable characters at least 1.6 mm high, although characters of 3 mm in height are preferred if there is sufficient space on the microduct product. The information shall include the product name and/or number and the manufacturer's identification code, and date of manufacture.

The information shall be printed or imprinted with a contrasting color ink at minimum intervals of 0.6 m throughout the length of duct.

Length markings shall be permanently applied on the outside surface of the duct in readable characters, at least 1.6 mm high. The markings shall be printed or imprinted with a contrasting colour ink at intervals of 0.6 m throughout the length of duct.

### 16.4 Functional Performance

Installation - The product shall be able to be installed following the supplier's instructions. The supplier shall provide capabilities and capacities with 50 lbs. peak pull force. A standard fibre cable shall be able to be pulled through a test configuration that includes a minimum of 100m of duct with at least 8 x 90-deg bends with radii of between 200 and 250 mm using pull forces less than 40 lbs.

Ovality -The maximum ovality of the microduct shall be 5% when tested at 50°C for 15 days at 2 kg of weight per linear foot.

Coefficient of Friction - The maximum coefficient of friction (CoF) for a cable moving through these microducts shall be 0.35 without lubricant, and 0.30 with lubricant or in pre-lubricated duct. It is desirable that the maximum sliding coefficient when using lubricants or pre-lubricated duct shall not exceed 0.15.

Tensile and Pull Strength for indoor microducts –

- The minimum pull or tensile strength for a 7 mm OD microduct product shall be 55 lbs. when pulled at 1 inch/min.
- The minimum pull or tensile strength for an 8.5 mm OD microduct product shall be 70 lbs. when pulled at 1 inch/min.
- The minimum pull or tensile strength for a 12 mm OD microduct product shall be 175 lbs. when pulled at 1 inch/min.

Elongation for Indoor microducts - The minimum elongation of the microduct shall be 2.5% when pulled to the following stress levels at a tensile strain rate of 1 inch/min:

- 40 lbs for the 7 mm microduct
- 50 lbs for the 8.5-mm OD microduct
- 100 lbs force for 12-mm OD microduct.

Impact - After an impact of 4 ft-lbs at -5°C, the microduct specimens shall show

- No damage, cracks, or splits,
- No deformation greater than 15%, or
- No more than a 15% change in ovality.

Bending Resistance – The microduct shall be capable of being bent 180° over a mandrel with a radius of 15 OD of the microduct at -5°C. After this test, the microduct shall be able to be straightened without damage. After the bending test is completed, the ovality shall be less than 5%.

Pressure Burst Strength - The minimum burst strength for duct shall be 900 kPa) at 23°C ± 5°C.

Chemical Resistance - Microducts shall not stress crack or mechanically degrade on exposure to typical cleaners and lubricant chemicals that are routinely used in telecommunications industry. Microducts shall retain 75% of their original pull strength after 30-day exposure to the chemicals specified below.

- Water displacement lubricant - WD-40
- Wasp and Insect Spray
- Generic cable lubricant - 10% Igepal in water
- Oil- and latex-Based House Paints
- Alkaline solutions - 0.2N NaOH.
- Fuel-based liquids - Low Odor Kerosene
- Acidic solutions - 3% H2SO4
- Cleaners - Ammonia-based cleaner
- 90% Alcohol (isopropyl alcohol in water).

Fire Resistance - Microducts intended for intrabuilding use shall be rated and identified as flame resistant. The products shall exceed the following ratings when measured as per Underwriters Laboratories UL 94 or an equivalent fire resistance test.

- UL94V-2 for Riser-Rated Microducts
- UL94V-0 for Plenum-Rated Microducts.

Connection Hardware - The connector, coupler, and end-cap hardware for the duct shall withstand six (6) operations of assembly and disconnection.

# 17 Annex F – Guidelines for Component Usage

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| | Single Villa | Complex of Villas | Buildings (G+5) or up to 3000 $m^2$ | Bldg floors (G+6) to (G+10) or Bldg of 100 tenants or Bldg area upto 7000 m2 | Bldg floors (G+10) and more Or over 100 tenants or Bldg area more than 7000 m2 | Shopping malls | Group of shops & sheds |
|---|---|---|---|---|---|---|---|
| **Entry Box** | Size: 60x60x80 cm. Location: Within the compound and at Max 1 m from compound wall line | Size: JRC-4 Joint Box (Qnbn standard) Location: Depends upon the layout | Size: JRC 12 Joint Box (Qnbn standard) Location: Within the property, near plot line. Additional Boxes at all turning points of lead-in | Size: JRC 12 Joint Box (Qnbn standard) Location: Within the property, near plot line. Additional Boxes at all turning points of lead-in | Size: JRC 12 Joint Box (Qnbn standard) Location: Within the property, near plot line. Additional Boxes at all turning points of lead-in | Size: JRC 12 Joint Box (Qnbn standard) Location: Depending on the layou | Size: 60x60x80 cm with Grade A cover Position: Within land plot where lead-in branching to other blocks end at turning points |
| **Entry Pipes/ Duct** | A single (2") inch pipes/duct towards the villa & single x (2") inch pipes/ducts to be extended outside the plotline towards Qnbn Network | A single (4") inch pipes/ducts to be extended one meter outside the plot line towards Qnbn Network. Internal Distribution within plot to be in accordance with Qnbn advise | 2x (4") inch pipes/ducts towards the building and four x (4") inch pipes/ducts towards the Qnbn Network | 2 x (4") inch pipes/ducts towards the building and four x (4") inch pipes/ducts towards the Qnbn Network A diversity entry route may also be provisioned | 2 x (4") inch pipes/ducts towards the building and four x (4") inch pipes/ducts towards the Qnbn Network A diversity entry route may also be provisioned | 2 x (4") inch pipes/ducts towards the building and four x (4") inch pipes/ducts towards the Qnbn Network A diversity entry route may also be provisioned | A single x (4") inch pipes/ducts to be extended one meter outside the plot line towards Qnbn Network. |
| **Apartment Indoor Distribution Cabinet std 19" Rack** | 12U (H) x 600 mm (W) X 515 mm (D) flush mounted on wall | 12U (H) x 600 mm (W) X 515 mm (D) flush mounted on wall, per villa | 42U (H) x 800 mm (W) X 800 mm (D) Stand alone type 19" equipment Cabinet | 42U (H) x 800 mm (W) X 800 mm (D) Stand alone type 19" equipment Cabinet | 42U (H) x 800 mm (W) X 800 mm (D) Stand alone type 19" equipment Cabinet | 42U (H) x 800 mm (W) X 800 mm (D) Stand alone type 19" equipment Cabinet | 12U (H) x 600 mm (W) X 515 mm (D) flush mounted on wall |

| | Single Villa | Complex of Villas | Buildings (G+5) or up to 3000 $m^2$ | Bldg floors (G+6) to (G+10) or Bldg of 100 tenants or Bldg area upto 7000 m2 | Bldg floors (G+10) and more Or over 100 tenants or Bldg area more than 7000 m2 | Shopping malls | Group of shops & sheds |
|---|---|---|---|---|---|---|---|
| **Floor Distribution Box** | Size: One 30x30 x15 cm box recessed inside the wall for each floor. Location: Convenient location with 1 meter free wall space around and at a height between 40-120 cm above finished floor level. | Per single villa. Size: One 30x30x15 cm box recessed inside the wall for each floor. Location: Convenient location with one meter free wall space around and at a height between 40-120 cm above finished floor level. | Size: One 30x30x15 cm boxes flush to wall Location: To be provided in each floor Telecom Closet | Size: One 30x30x15 cm box flush to wall Location: To be provided in each floor Telecom Closet | Size: One 30x30x15 cm box flush to wall Location: To be provided in each floor Telecom Closet | Size: One 30x30x15 cm box flush to wall Location: To be provided in each floor Telecom Closet | Size: One 30x30x15 cm box flush to wall Location: To be provided in each floor Telecom Closet |
| **Main Telecom Room** | No requirements | Size: 2x3x3 (LxWxH) meters for villas more than 10 numbers | Size: 2x3x3 (LxWxH) meters Location: In the ground floor common area. | Size: 3x3x3 (LxWxH) meters Location: In the ground floor common area | Size: 3x4x3 (LxWxH) meters Location: In the ground floor common area. | Size: 3x4x3 (LxWxH) meters Location: In the ground floor common area. | Size: 2x3x3 (LxWxH) meters Location: In the ground floor common area. |
| **Floor Telecom Closet** | No requirements | No requirements | Size: Closet (LxWxD) 100x60x60 cm Location: In common area | Size: Closet (LxWxD) 100x60x60 cm Location: In common areas | Size: Closet (LxWxD) 100x60x60 cm Location: In common areas | Size: Closet (LxWxD) 100x60x60 cm Location: In common area | Size: Closet (LxWxD) 100x60x60 cm Location: In common areas |
| **Riser Cable Trays** | No requirements | No requirements | 20x5 cm cable trays | 20x5 cm cable trays | 20x5 cm cable trays | 20x5 cm cable trays | No requirements |

## REFERENCES

1. ISO 9000, Quality Management Systems
2. UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
3. UL 2024 Optical Fiber and Communication Cable Raceway
4. ANSI/NFPA 70, National Electrical Code, (NEC) 2008.
5. ANSI/UL 444, UL Standard for Safety Communications Cables (CSA C22.2).
6. UL 1685, Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
7. UL 1666, Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts.
8. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

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