TECHNICAL STANDARD OF IN-BUILDING FIBRE CABLING FOR FIBRE-TO-THE-PREMISE

MTSFB 002: 2009

Committee Representation

The Fixed Network Infrastructure Sub Work Group operates under the wing of the main Multimedia Network Infrastructure (MNI) Work Group which is supervised by the Malaysian Technical Standards Forum Bhd (MTSFB) authorized by Malaysian Communications and Multimedia Commission (SKMM). The technical standards and infrastructure requirements for Fibre To The Premise document was developed by various members whom are representatives from the following:

GTL Networks Services Malaysia Sdn Bhd

Malaysian National Computer Confederation

Maxis Communication Sdn Bhd

Measat Broadcast Network Systems Sdn Bhd

Packet One Networks (Malaysia) Sdn Bhd

Telekom Malaysia Berhad

TIME dotCom Berhad

U Mobile Sdn.Bhd.

Zettabits Technologies (M) Sdn Bhd

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1 INTRODUCTION

1.1 General

1.1.1 The Fixed Network Infrastructure forms a part of the Technical Standards and Infrastructure Requirements (TSIR) document which serves as guidelines and standards in support of the Uniform Building By-Laws (UBBL). This document was prepared with the common understanding and agreement among the Fixed Network Providers' representatives in Malaysia. This sub-working group committee called Fixed Network Infrastructure was formed under the Multimedia Network Infrastructure (MNI) Working Group, approved by MTSFB.

1.1.2 In the context of meeting the needs of telecommunication's users, this document intends to complement the *Technical Standards and Infrastructure Requirements (TSIR) - Part 1: Fixed Network Infrastructure* in addressing the technical system and infrastructure requirements necessary for having the Fibre-To-The-Premise (FTTP) distribution system equipped in a building. This is important in view of FTTP technology which is used as one of a medium for delivery of higher speed of broadband services to the public / customers.

1.2 Objective

1.2.1 This document encompasses two primary objectives:

a. It outlines the *infrastructure requirements* (for the purpose of setting up a common and integrated fixed network distribution system) to consulting engineers, Developers, owners and other responsible parties for the *provisions* to be made available in the buildings.

b. It also provides the *minimum technical specifications* necessary for the in-building fibre cabling Fibre-To-The-Premise (FTTP) distribution system to function as required in buildings.

1.3 Scope

1.3.1 The guideline covers the following focus areas:

a. System infrastructure requirement in the buildings (condo/ apartment, low cost flats, single dwelling and office buildings).

b. Minimum installation guidelines and standards.

c. Minimum technical specifications.

2 SERVICE PROVIDER

2.1 General

2.1.1 The Service Provider (SP) is the entities that provide the fixed network services such as voice, broadband or high speed broadband. Generally, the high speed broadband is served via technology called the Fibre-To-The-Premise (FTTP).

2.1.2 Network Facility Provider (NFP) means a licensee authorised by the SKMM to build and commercially operate telecommunication/electronic communications systems.

2.1.3 The FTTP Network can either be provided by one or more Service Providers to the individual customer.

2.1.4 The Service Provider can provide the above-mentioned services via their own network infrastructure or leasing from other Network Facility Providers (NFP), as provided in the SKMM's *Guidelines on Implementation of Access to Network Elements* (SKMM/G/04/05).

2.2 Fibre-To-The-Premise (FTTP) Network

2.2.1 FTTP is a Passive Optical Network (PON) technology which brings the fibre to the premise to provide higher speed connection to the subscribers but not limited to any kind of technologies.

2.2.2 FTTP is one type of fibre optic communication delivery in which an optical fibre connection is directly run to the customers' premises. The premises can be residential, business, commercial, institutional and other applications where fibre network connections are distributed to a campus, set of structures, or high density building with a centrally located network operations centre. As the name implies, the technology uses fibre all the way to the customers' premises. The following is the example of the generic Network Facility Provider's FTTP network infrastructure.

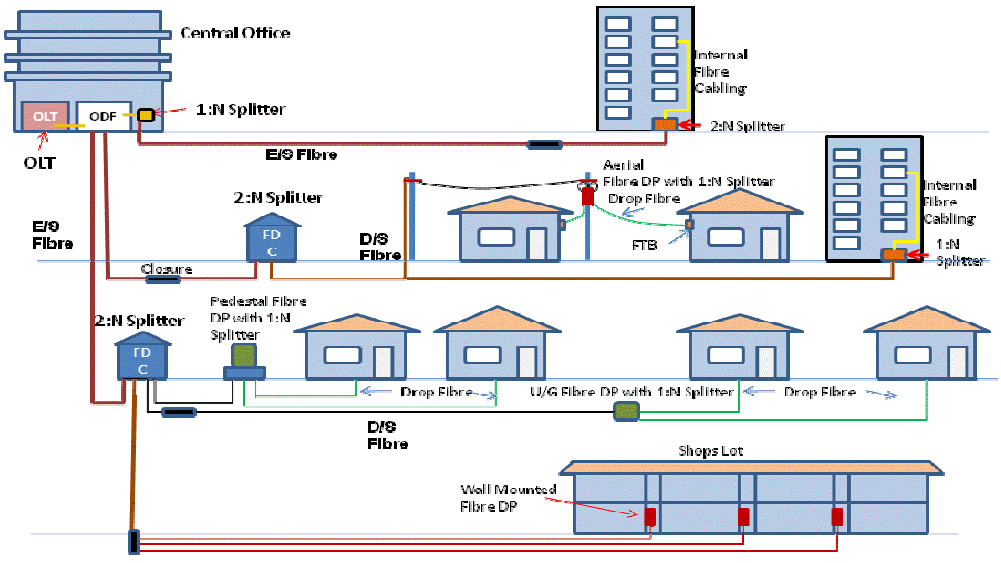


Figure 2-1: Generic Network Facility Provider's FTTP Network Infrastructure

3 BUILDING TYPE

3.1 General

3.1.1 There are two types of customer premises, defined as follows.

Table 3-1: Definition of Building type

Single Dwelling Unit (SDU)	Multi Dwelling Unit (MDU)
Condo / Apartment/Low Cost < 6 floors without Telecommunication Room	Condo / Apartment/Low Cost ≥ 6 floors with Telecommunication Room
Bungalow	
Semi-Detached	
Terrace Single Storey	
Terrace Double Storey	
Office Building/Shop House < 6 floors without Telecommunication Room	Office Building/Shop House ≥ 6 floors with Telecommunication Room
Industrial Lot	
Hotel	
Schools	
Hospital	
Club house	

3.2 Single Dwelling Unit (SDU)

3.2.1 Terrace houses – In general, the character of terrace houses is high density, each unit connected to each other in one line. The quantity of one line normally 20 or above, every two line regards as one row. The distance between each line is close, about 3 meters. But the distance between each row is comparatively far, about 5 meters. Normally Network Facility Provider's pole exists on each four houses between two lines. At the headstream of each row there has manhole resource which for underground cable from Central Office (CO) to aerial cable through closure in it.

3.2.2 Bungalows – In general, the character of bungalows is moderate density, larger area for each house than terrace house, each two houses has definite distance. Normally Network Facility Provider's pole exists on each two houses. At the headstream of each row there has manhole resource also which for underground cable from CO to aerial cable through closure in it.

3.2.3 Shop lots – The shop lots has two, three or four layers. Normally there has a manhole resource in front of each shop lot and without pole resource.

3.2.4 Others – There are few other types of customer premises and community premises such as petrol station, school and etc.

3.3 Multi Dwelling Unit (MDU)

3.3.1 Multi Dwelling Unit (MDU) – In general MDU is the premise with Telecommunication Room (TR) (or traditionally called SDF - Subscriber Distribution Frame room) located at the basement of the building.

4 EXTERNAL INFRASTRUCTURE REQUIREMENTS FOR THE IN-BUILDING FIBRE CABLING

4.1 General

4.1.1 The specification of the external building requirement follows the standard in the MTSFB's document entitled *Technical Standards and Infrastructure Requirements (TSIR) Part 1* and SKMM's document entitled *The Provision of Basic Civil Works for Communications Infrastructure in New Development Area (SKMM/G/01/09)*.

4.1.2 This section focuses on the building's underground infrastructure requirement such as manhole and duct way planning. For the case which the building is connected to Network Facility Provider infrastructure via overhead connection, the specification and rules must follow the practice of copper deployment.

4.2 Infrastructure Demarcation

4.2.1 The infrastructure boundary demarcation must follow requirements explained in the document entitled *Regulatory Framework for Telecommunications Network Boundaries REG-T007* by Jabatan Telekomunikasi Malaysia. The Private Property Line is the demarcation point between Network Facility Provider and Developer or Premise Owner

4.2.2 Private Property Line for MDU is the common access manhole connected to Telecommunication Room or direct to the building and Network Facility Provider manhole.

4.2.3 For SDU, the Private Property Line shall be at the fence and/or its boundary mark of the premise.

4.2.4 The infrastructure inside the Private Property Line is under responsibility of the property developer. The property developer is responsible to ensure all required infrastructure to support the high speed connection are available. The ownership of this infrastructure shall be handed over to the Building Management for MDU case and Premise Owner for SDU.

4.2.5 Infrastructure outside the Private Property Line shall be under responsibility of the Network Facility Provider.

4.3 Manhole

4.3.1 The manholes on the road side outside the building/compound must be prepared by the Developer so that Network Facility Provider can connect their underground manholes and ducts network. Developer shall consult Network Facility Provider on the appropriate selection of the location and size of manhole to be allocated. Recommended manhole size is explained in Appendix A.

4.3.2 For manhole reserved for connection of Drop Fibre, which is normally located with Distribution Point (DP) at the property's back lane, the manhole cover shall be made from fibre or any light material type which should be possible to be accessed by 1 person only. The recommended size is JRC7 or JB30.

4.3.3 The manhole cover must sustain the loading as defined in Appendix A.

4.3.4 The manhole must be able to sustain up to 20 years.

4.4 Underground Duct

4.4.1 The underground duct-ways are required to connect the road side manhole to the Telecommunication Room (TR) inside the building or direct to the building. The number of duct-ways depends on the size and types of the building and number of users or customers as explained in the SKMM's document entitled *The Provision of Basic Civil Works for Communications Infrastructure in New Development Area (SKMM/G/01/09)*.

4.4.2 The duct provision shall be made to accommodate the local line installation envisaged for the period of 20 years.

4.4.3 The duct routes must be as straight without sharp bends and not obstructed. The maximum allowable bending radius is 20 times of duct diameter.

4.4.4 Whenever possible, laying duct routes under expensive paving should be avoided.

4.4.5 The developer shall ensure that the constructed ducting system has a minimal risk from the nature disaster such as flood, earthquake etc. In the area where such condition cannot be avoided, the developer shall construct resolution to ensure the ducting system will always be ensured in a good quality condition.

4.4.6 The jointing chambers on the route shall be sited with particular attention to:

a. Minimize hazards to traffic and personnel;

b. Provision of adequate size for the accommodation of all equipment including repeater housings and cable joints; and

c. Having a duct sectional length (manhole centre to manhole centre distance) of 180 to 220 meters for fibre wherever practicable barring factors such as obstructions in the line of duct route which can be avoided by bending ducts major changes in the direction of the duct route and future extension or cable.

4.4.7 The developer must consult the Network Facility Provider on the appropriate selection of number and design of the duct-ways.

4.4.8 Blown fibre system is an optional method that can be considered.

4.5 Underground Duct Route Design for SDU

4.5.1 For SDU served via underground access, the recommended designs for the duct route are as shown in Figure 4-1 and Figure 4-2, respectively. Figure 4-1 shows the under drain duct design. This design is applicable if the depth of the drain is less than 450mm (1.5 feet).

4.5.2 Before entering the wall section of the premise, small pit with minimum size 300mm x 300mm x 300mm shall be prepared for easy access during the maintenance work.

4.5.3 The Fibre Termination Box (FTB) at outside of the wall must be provided for easier future operation and maintenance.

4.5.4 If the depth of the drain is more than 450mm (1.5 feet), the recommended design is as shown in Figure 4-2. In this case, the duct must be protected by minimum 100mm of GI pipe to cover the duct from broken, to be made available by the Developer.

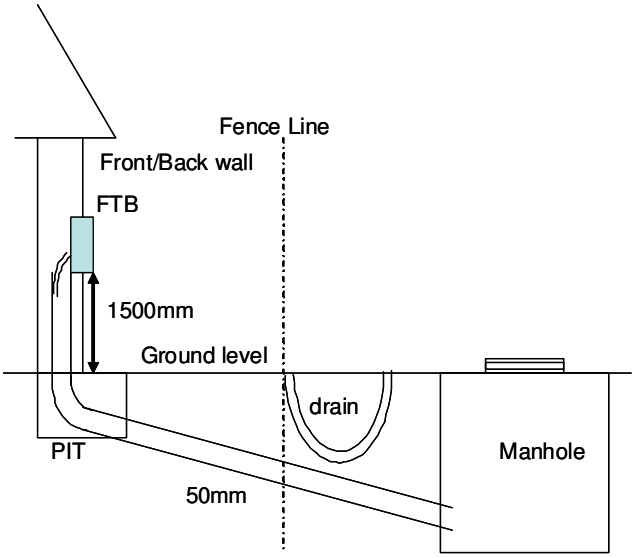


Figure 4-1 : Design of Under Drain Duct Connection

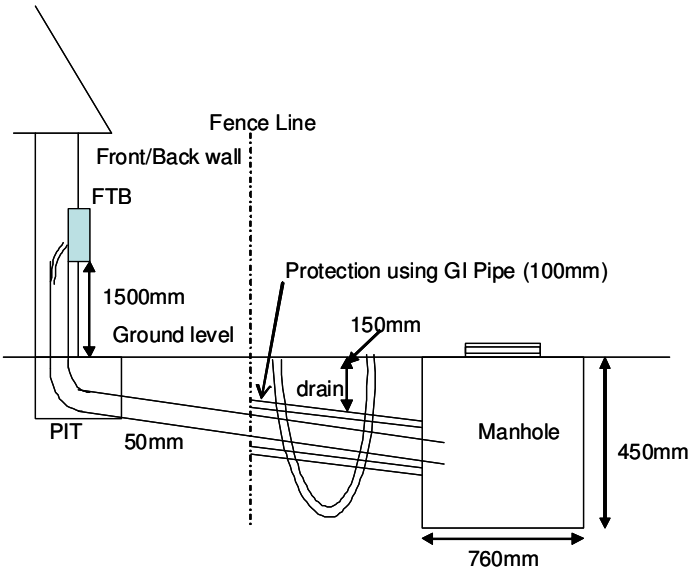


Figure 4-2 : Design of Through Drain Duct Connection

4.5.5 The duct diameter must be minimum 50mm and the maximum bending radius is 10 times of the duct diameter. Figure 4-3 shows the recommended size and allowable bending radius for the premise accessing duct. The material of the duct shall be PVC or harder and must strong enough to protect the cable inside and able to sustain up to 20 years period.

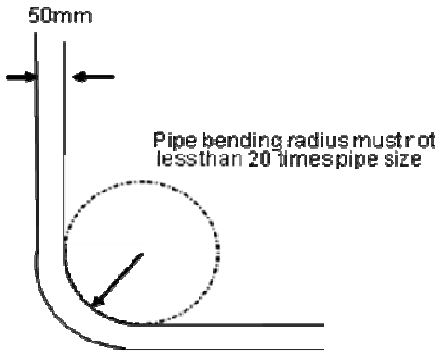


Figure 4-3 : Design of Premise's Entering Duct

4.6 Manhole and Underground Duct Route Design for MDU

4.6.1 The Developer must provide the access infrastructure manhole, with minimum specification of JC9C size with 4 duct ways for connection to the nearest Network Facility Provider (NFP)'s manhole and infrastructure. However the size of manhole and the number of duct depend on the capacity of the building. Figure 4-4 below shows the connection between the Network Facility Provider's infrastructure and the building infrastructure.

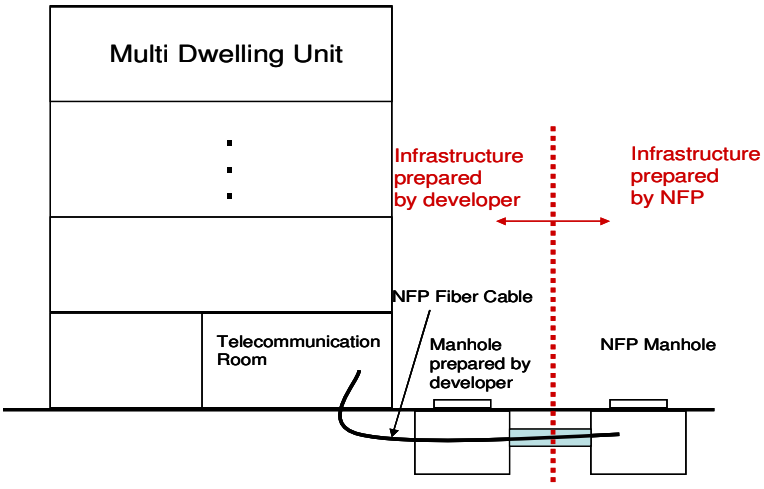


Figure 4-4 : Manhole Connection to the Building

4.6.2 Figure 4-5 and Figure 4-6 below illustrate the cable entry route from outside manhole into the building's TR. The Developer must prepare all the facilities and must be approved by Network Facility Provider during the infrastructure acceptance procedure.

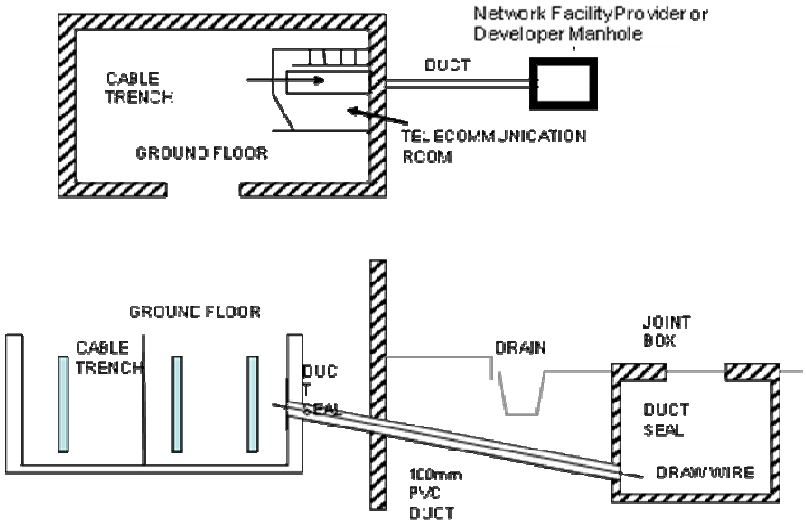


Figure 4-5 : Duct Route into Building Telecommunication Room on Ground Floor

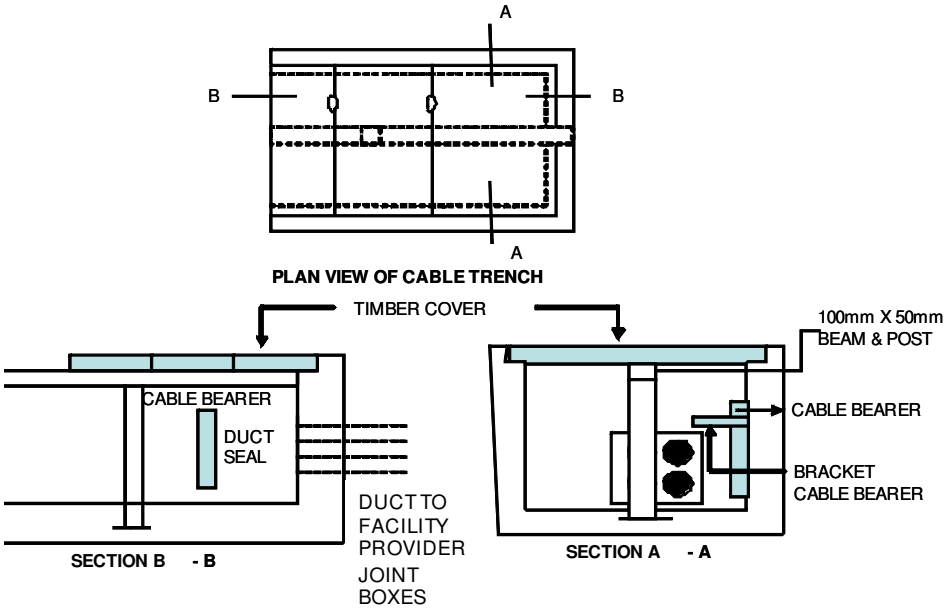


Figure 4-6: Cable Trench of Telecommunication Room

4.7 Duct and Manhole Design for Pole Feeding Properties

4.7.1 For cases where property feeds via pole, the developer must provide manhole to the nearest Network Facility Provider manhole before the Network Facility Provider can lay their cable, to serve the properties inside that new development area. Figure 4-7 below shows the connection from the nearest Network Facility Provider's manhole to properties manhole for pole type deployment.

4.7.2 The manhole specifications shall follow specification as explained in section 4.3 above.

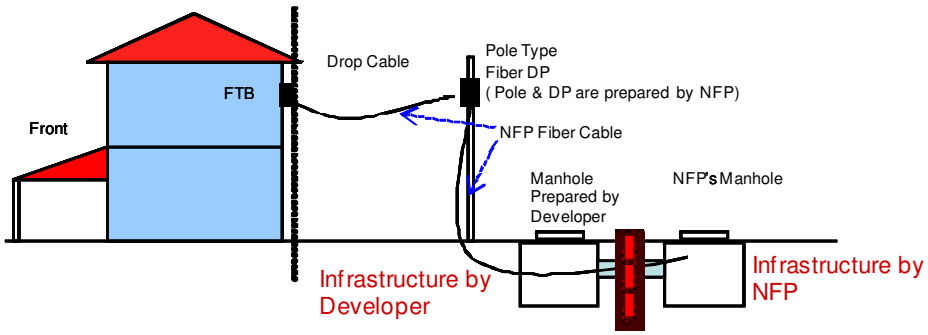


Figure 4-7: Manhole Connection for Pole Type

5 INTERNAL INFRASTRUCTURE REQUIREMENTS FOR THE IN-BUILDING FIBRE CABLING

5.1 General

5.1.1 This section covers the requirement for infrastructure inside the building such as Telecommunication Room, Floor Riser and Cable Trunking. The other general elements must follow requirement as explained in the *MTSFB's* document entitled *Technical Standards and Infrastructure Requirements Part 1 Fixed Network Infrastructure.*

5.2 Telecommunication Room (TR) Requirement

5.2.1 The minimum requirement for Telecommunication Room (TR) must follow the requirements as explained in the MTSFB's document entitled *Technical Standard and Infrastructure Requirements Part 1.*

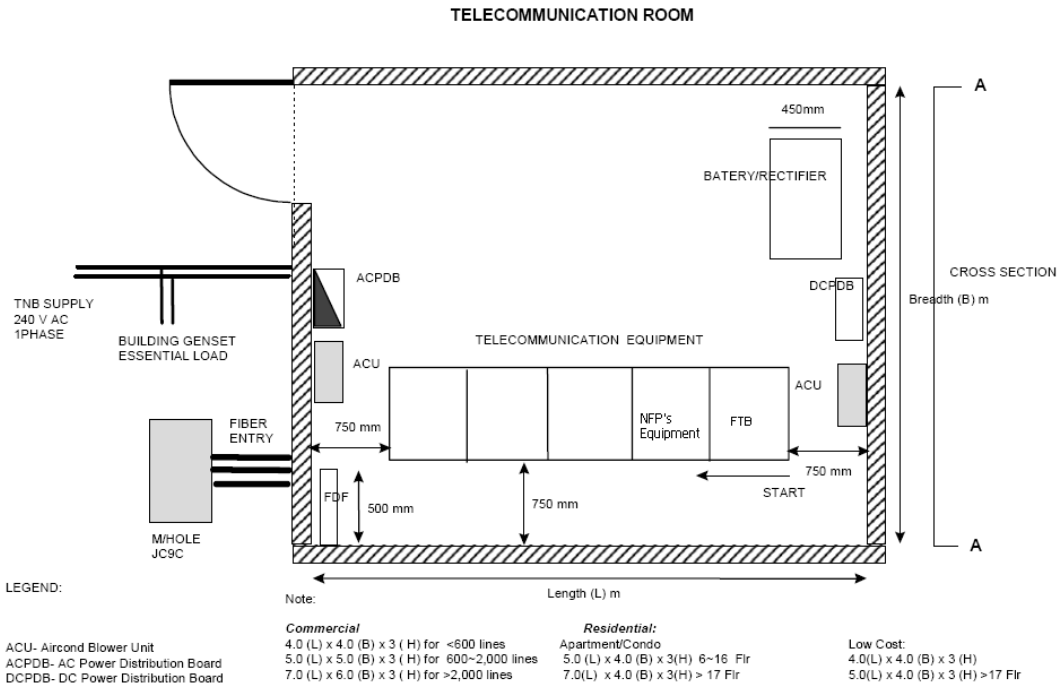


Figure 5-1 : Telecommunication Room Arrangement

5.2.2 The Fibre Termination Box (FTB) must be located at the right most position as this is the nearest point leading to the internal riser as illustrated in Figure 5-1.

5.2.3 The Network Facility Provider's network elements will be located adjacent to the FTB. The FTB shall be connected to the building internal cabling and will become a connection point with the Network Facility Provider's network element. The size of the FTB will depend on the number of premises inside of the building.

5.3 Riser

5.3.1 The riser in the MDU properties must be used as the cable route from the TR to each floor level. The minimum requirement for the riser and duct must follow requirements as explained in the MTSFB's document entitled *Technical Standards and Infrastructure Requirements Part 1.*

5.4 Trunking

5.4.1 The trunking is required for laying the cable inside the building and acts as the protection and cable guide. For the MDU, the trunking located inside the riser is referred as the Vertical Trunking while the trunking located from the Riser room at each floor to the Fibre Wall Socket (FWS) inside each individual unit of premise is referred as the Horizontal Trunking. The Vertical and Horizontal Trunking must be provided in all MDU properties. For the SDU, the trunking must be used to lay the cable between the FTB, located at the outside wall, and the FWS located inside the premise.

5.4.2 Figure 5-2 below shows the example of trunking location for the MDU and SDU.

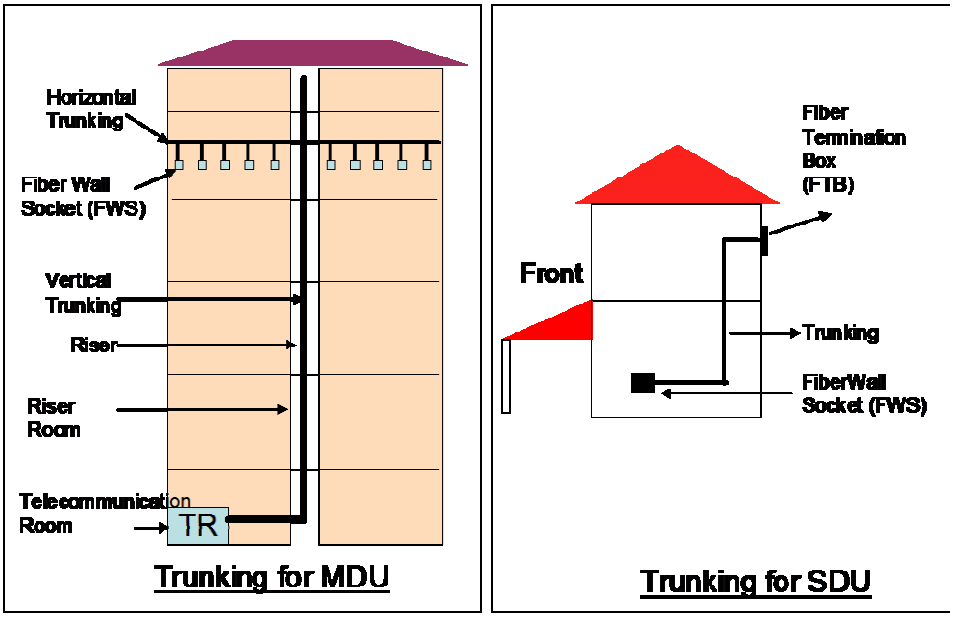


Figure 5-2: Trunking for MDU and SDU

5.4.3 The minimum requirement for trunking must follow the MTSFB's requirement as explained in the document entitled *Technical Standards Infrastructure and Requirements Part 1*. The riser, Horizontal and SDU's trunking bending radius must be greater than 10 times of the trunking size to ensure that the fibre cable meet the minimum bending radius.

5.4.4 The Horizontal and SDU's trunking must be made from PVC or harder type of conduit with minimum 19mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to reduce the aesthetics either within or outside of the premise. The detail specification of trunking is as explained in SKMM's document entitled *The Provision Of Basic Civil Works For Communications Infrastructure In New Development Area (SKMM/G/01/09).*

5.5 Fibre Termination Box

5.5.1 The FTB is referred as the fibre termination point at the Telecommunication Room (TR) and riser room for the MDU. The FTB acts as the connection point between the Network Facility Provider's fibres and the in-building fibre cable. It also acts as the distribution point for in-building cabling. Sample of FTB to be used for MDU is as shown below. Developer must provide FTB with SC-UPC adaptor to be patched with Network Facility Provider's SC-UPC connector.

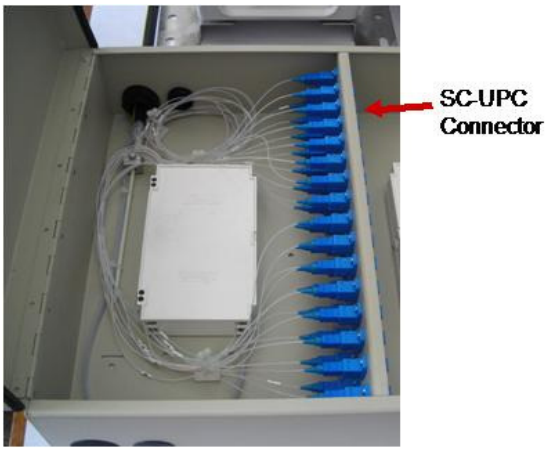


Figure 5-3: Fibre Termination Box for MDU

5.5.2 The FTB located at floor riser room acts as the connection point between the medium or low density fibre count distribution cables and individual Drop Fibre into the customer premise.

5.5.3 For the SDU, FTB is located at individual customer's premise either at a back or in front of the premise depend on the Developer's design. FTB acts as the demarcation point between the outdoor Drop Fibre and the indoor cable into the customer's premise. Example of the single core termination FTB, which is normally used for SDU, is shown in Figure 5-4 below. The Developer must provide the FTB with SC-UPC connector typed. During the service activation, the Network Facility Provider will terminate the Drop Cable at the SC-UPC adaptor inside FTB.

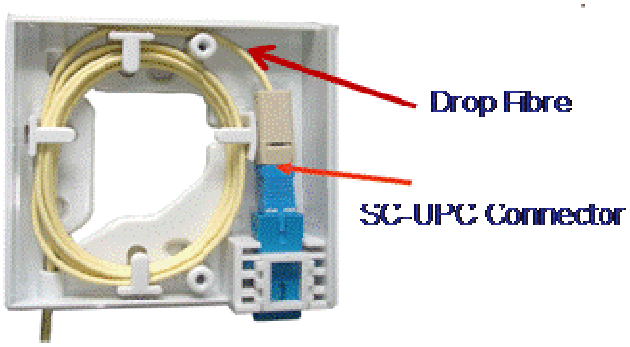


Figure 5-4 : Fibre Termination Box for SDU

5.5.4 The FTB must be provided by the Developer and shall be type approved by SIRIM. FTB must be robust and weather proof especially for outdoor installation. The detailed specification of the FTB is explained in Appendix B.

5.6 Fibre Wall Socket

5.6.1 The Fibre Wall Socket (FWS) is a termination point for the Internal Fibre cable and act as a connection point to the Customer Premise Equipment (CPE). Figure 5-5 below shows the example of the FWS. Generally the FWS is structured same as the FTB and the specification is explained in Appendix B.

5.6.2 The FWS must be provided by the developer with SC output connector for connection with CPE's patch cord. The CPE's patch cord will be provided by the Network Facility Provider during the service activation.

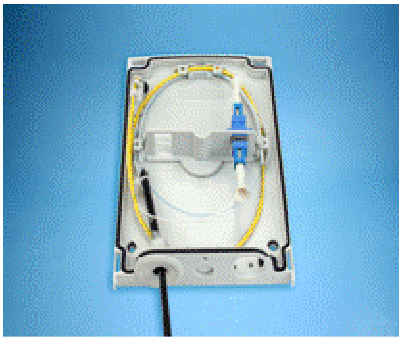


Figure 5-5 : Sample of FWS

5.6.3 Minimum one unit of FWS must be provided by the developer in all premises. However the number of FWS can be more depend on the number of potential customer in each unit of premise. The FWS must be type approved by SIRIM.

5.6.4 The FWS must be placed at 0.3m above the floor level and 0.3m from the corner of the wall or from electrical points. The FWS must be made from the non-corrosive material or treated metallic material to resist corrosion.

5.6.5 The FWS is highly recommended to be placed adjacent to the electrical power socket for FTTP CPE to function.

6 CABLING FOR SINGLE-DWELLING UNIT

6.1 General

6.1.1 Generally premise internal cabling covers the interconnections from the Fibre Termination Box (FTB) to the Fibre Wall Socket (FWS). For SDU, FTB is referred to the termination box at every individual premise and FWS is the socket located inside each individual premise for connection with CPE.

6.1.2 This section focuses on the cabling between FTB and FWS. The architecture of it is laid by the Developer or Premise Owner depending on their preferences since cost of installation is normally borne by the customers. Figure 6-1 below shows the schematic diagram for all elements consist in internal cabling for SDU.

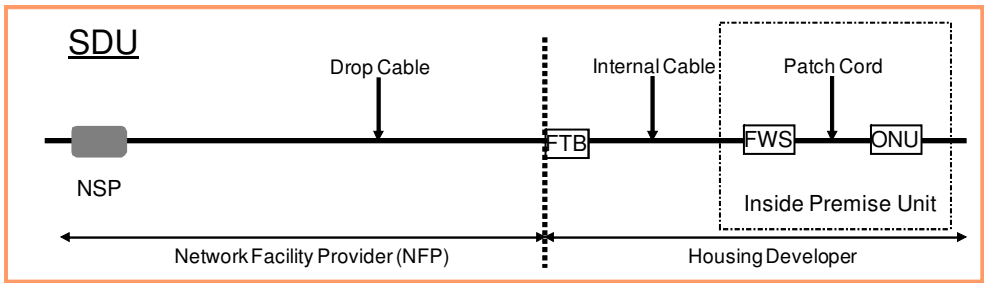


Figure 6-1 : Schematic Diagram for SDU Cabling

6.2 Cabling and Network Boundary for SDU Served via Pole

6.2.1 The Fibre Termination Box (FTB) at the customer's premise will be the point of separation between Network Facility Provider and Premise Owner responsibility as shown in Figure 6-2 below.

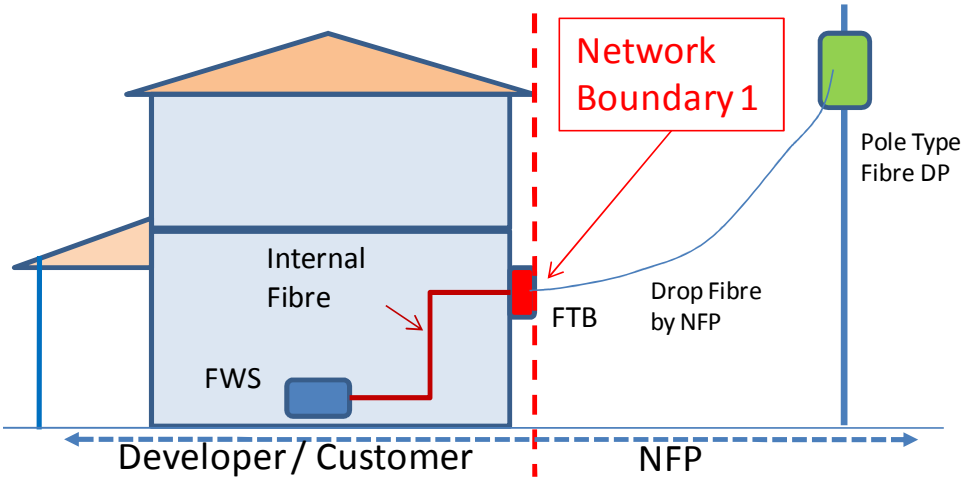


Figure 6-2 : Network Boundary for SDU (Pole Type)

6.2.2 FTB for SDU is normally terminated at the back lane of the premise. For SDU served via pole, FTB will become a network boundary between Network Facility Provider and Premise Owner cabling as shown at "Network Boundary 1" in Figure 6-2. From FTB towards the fibre DP is under Network Facility Provider's responsibility. From FTB, including FTB itself, towards inside of the building will be Premise Owner's responsibility and normally provided by the Developer.

6.2.3 Internal Fibre cable for SDU is referred to the connection cable between FTB and FWS inside the premise as shown in Figure 6-2 above.

6.2.4 For each unit of residential type of premise, only single core of Internal Fibre is required.

6.2.5 Layout of the Internal Fibre into the customer's premise depends on the customer's preference.

6.3 Cabling and Network Boundary for SDU Served via Underground

6.3.1 In case of SDU served via underground DP, the network boundary will be fibre DP itself as shown at "Network Boundary 2" in Figure 6-3. Cabling from underground fibre DP towards customer premise shall be provided by the Developer and will be Premise Owner's responsibility. Manholes (including Fibre DP located manhole) and underground ducts are also under Developer's responsibility as explained in Section 4. Fibre DP generally will be provided by NFP during provisioning of the network.

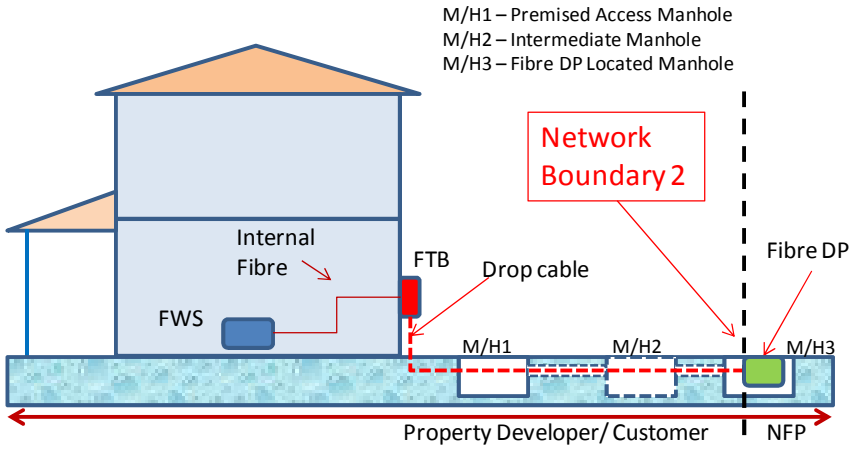


Figure 6-3 : Network Boundary for SDU (Underground Type)

6.3.2 Drop Fibre must be connected to the premise wall FTB and at the other side it must be coiled inside the manhole and must be covered with end cap or terminate the fibre core inside the cable closure. During the service activation, Network Facility Provider will do the connection between Drop Fibre and Network Facility Provider fibre. The label of premise number must be pasted inside the closure or at the fibre cap. The label must be made from polyethylene or material which is able to sustain at up to 10 years or more.

6.3.3 Distance of underground Drop Fibre generally must not exceed 50 meter to ensure the power attenuation loss is within allowable range. At every unit of premise, minimum two core of fibre must be provided.

6.3.4 Underground Drop Fibre must be laid inside underground duct. The underground duct or conduits must be from PVC or harder type of conduit with minimum size of 50mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to keep the aesthetics either within or outside the customer premise. The sample connection for Drop Fibre is shown in Figure 6-4.

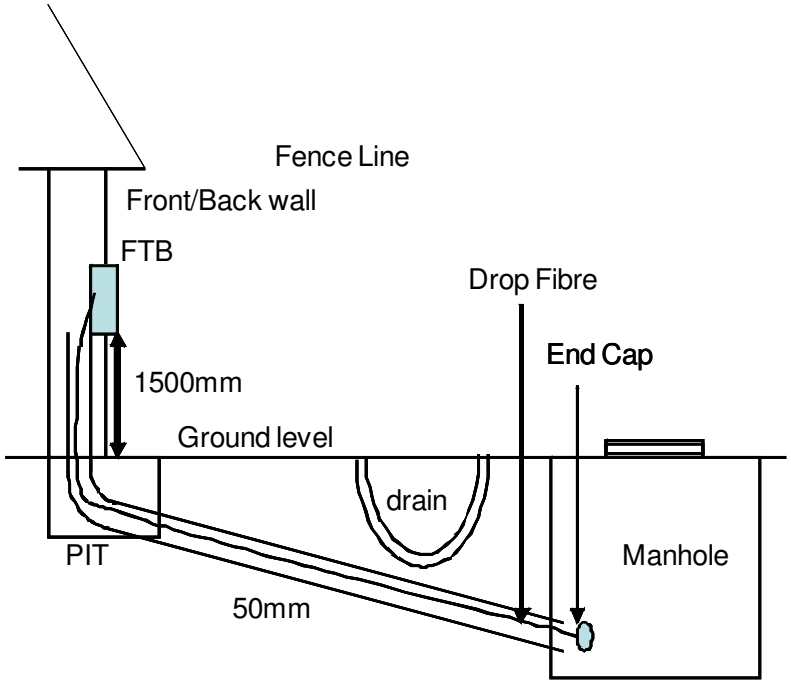


Figure 6-4 : Connection of Underground Drop Fibre

6.3.5 For underground case, the Network Facility Provider is recommended to provide the surface DP instead of underground DP. Fibre DP will be provided by Network Facility Provider. However, developer must reserve minimum 600mm x 600mm adequate space above the manhole. Developer is to provide a riser from manhole to the reserved space.

6.3.6 For each unit of residential type of premise, only single core of Internal Fibre is required.

6.3.7 Layout of the Internal Fibre into the customer premises depends on the customer's preference.

6.4 Cabling and Network Boundary for SDU – Shop Lots

6.4.1 The sample cabling for shop lot is shown in Figure 6-5. FTB that serves one area must be mounted on the wall in the staircase area. The FTB acts as network boundary between the Premise Owner and Network Facility Provider cabling as marked as "Network Boundary (3)" in Figure 6-5. FTB will act as connection point between Network Facility Provider and each shop unit.

6.4.2 Developer must prepare the FWS at each shop unit and must be connected to FTB via Internal Fibre.

6.4.3 FTB, FWS, Internal Fibre and all related infrastructure must be prepared by developer and will under the Premise Owner's responsibility. The FTB and FWS must follow the specifications as detailed out in Appendix B.

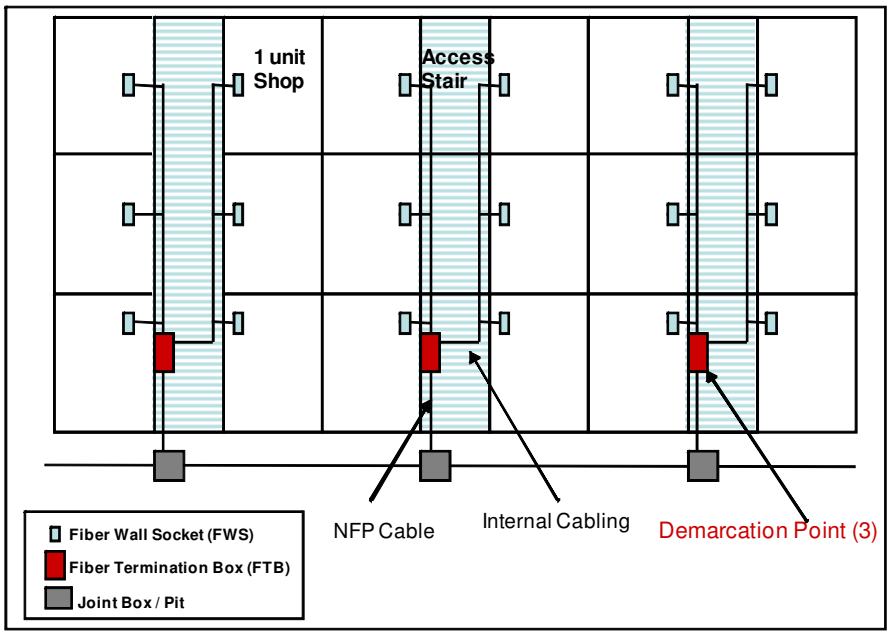


Figure 6-5 : Network Boundary for Shop Lot

6.4.4 Developer must provide a space minimum 600mm x 600mm beside FTB as shown in Figure 6-6 below. The space will be used for Network Facility Provider to locate their network element. Network Facility Provider will do jumpering with Internal Fibre at FTB during the service activation. For shop lots or business type of SDU, number of Internal Fibre core must at least 2 cores together with SC-UPC adaptor. However, it can be more than 2 cores, depend on number of potential resident in that shop unit.

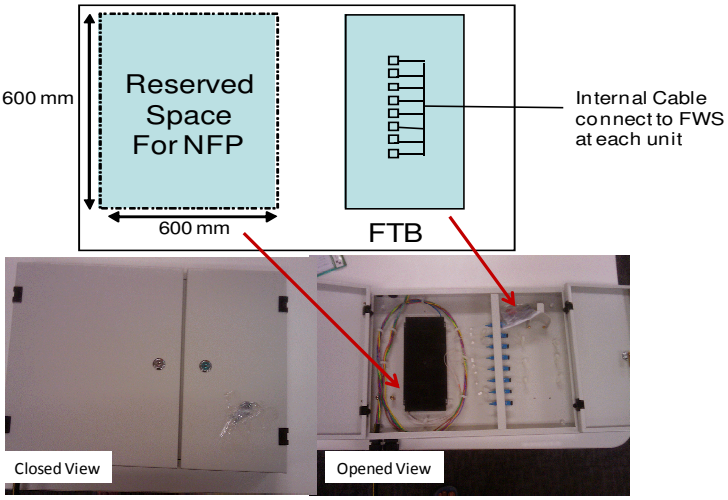


Figure 6-6 : Reserve Space near FTB

6.4.5 For each unit of residential type of premise, only single core of Internal Fibre is required.

6.4.6 Layout of the Internal Fibre into the customer premises depends on the customer's preference.

6.5 Specification for Underground Drop Fibre

6.5.1 Underground Drop Fibre is referred to the cabling between Network Facility Provider's DP, which will be inside the manhole, and customer's Fibre Termination Box (FTB). As explained in Section 6.3, Developer must prepare the underground Drop Fibre and it will be under Premise Owner responsible.

6.5.2 Figure 6-7 shows the sample structure of underground Drop Fibre. The cable that meet ITU G.657A standard is the most recommended type for underground Drop Fibre.

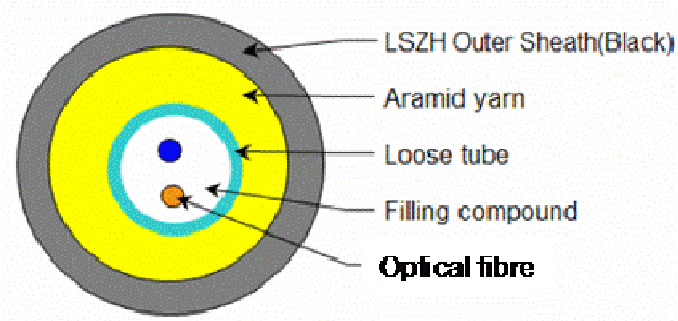


Figure 6-7 : Sample for Underground Drop Fibre Structure

6.6 Specification for Internal Fibre

6.6.1 Internal Fibre is referred to the in-building cabling from FTB to FWS. The Internal Fibre to be made available by the Developer.

6.6.2 The cable shall meet all applicable requirement stated in ANSI/ICEA S-104-696, ITU-T, IEC 60794-2 (2002-12) or JIS Standard for Optical Fibre Outside Plant Communication Cable, as well as those stated within this specification. The detailed specification is in Appendix C.

6.6.3 Cable type must be from Single-Mode and meets specification ITU-T G.657 A. General specifications for indoor fibre cables is shown in Table 6-1 below:

Table 6-1 : Specification for Internal Fibre

Item	Construction
Mode field diameter at 1310nm	8.6 +/-0.4µm
Cladding diameter	125+/-1µm
Core concentric error	0.5µm (max)
Cladding non-circularity	1% max.
Cut-off wavelength	1260nm (max)
Primary coating diameter	250+/-15µm

6.6.4 Internal Fibre cable is used for corridor and indoor cabling. Its structure is shown in Figure 6-8 below.

6.6.5 Internal Fibre cable is suitable for aerial, duct, fixing along with wall, under carpet, installation ways and its characteristics are as followings:

a) Small outer diameter, light weight, suitable for branching, indoor, limited room;

b) Reserved tearing gap of optical cable can separate the fibre easily without instruments, which is convenient to construct; and

c) Adopting small winding radius fibre with 15mm and even 10mm, suitable for indoor routing under the instance of sudden turning, for instance wall-pole corner and indoor smooth panel.

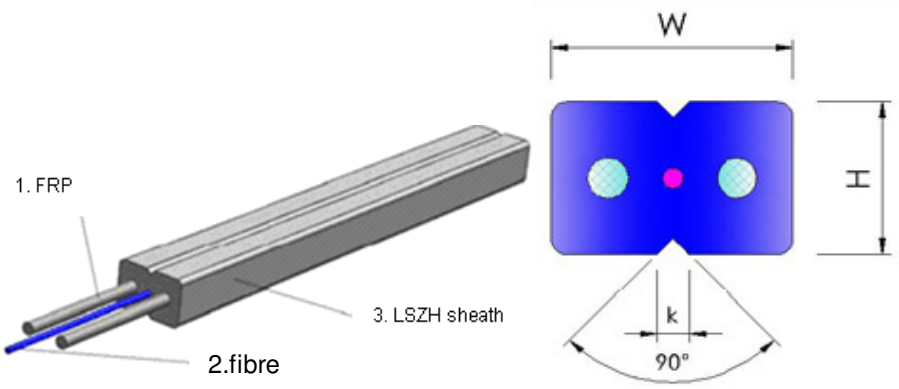


Figure 6-8 : Structure of Internal Fibre cable

6.6.6 In addition, there are two specifications for this cable (1-core, 2-core), configuring according to different scene requirements.

6.6.7 The main advantages of the indoor flexible optical cables are:

a) Easy split construction where the jacket can be peeled to open without using any tool;

b) Fibre is stripped and cleaved using conventional tools;

c) Readily available compatible interconnection components from multiple international vendors;

d) Complies to ITU-T and IEC standards; and

e) Multi-fibre core version of the same cable can be used as distribution cable (aerial or underground).

6.7 Power Attenuation Loss for SDU Cabling

6.7.1 Developer must perform the attenuation loss for each premise and provide the reading to the Network Facility Provider during the properties approval process. FTB until FWS and the loss must not exceed 1.52 dB.

6.7.2 Table 6-2 below shows sample calculation of the allowable power attenuation loss for SDU serve via pole. The cabling starts from FTB until FWS and the loss must not exceed 1.52 dB.

Table 6-2 : Cabling Power Attenuation Loss for SDU –pole type

Location	Item	Unit Loss	Unit	Total Loss	Detail
FTB	FTB : FA-SC Connector	0.7	1	0.7	FA-SC connector = 0.7 dB
Internal Fibre	Cable (1310 =0.4 dB/km) *	0.0004	50	0.02	Horizontal Cable (50m) = 0.02 dB
Inside Premise	FWS: FA-SC Connector	0.7	1	0.7	FA-SC Connector = 0.7 dB
Other	Other marginal Loss	0.1	1	0.1	Other = 0.1
Total				**1.52**	**Total = 1.52 dB**

**ITU-T G.652 reference*

6.7.3 Table 6-3 below shows the sample calculation of allowable power attenuation loss for SDU serve via underground. The cabling starts from Drop Fibre end inside the manhole until FWS inside the premise. The total loss must not exceed 2.3 dB.

Table 6-3 : Cabling Power Attenuation Loss for SDU – underground

Location	Item	Unit Loss	Unit	Total	Detail
Drop Fibre end (inside Manhole)	FA-SC Connector	0.7	1	0.7	FA-SC connector = 0.7 dB
Drop Fibre	Cable (1310 =0.4 dB/km)*	0.0004	50	0.02	Drop Fibre (50m) = 0.02 dB
FTB	FTB: FA-SC Connector	0.7	1	0.7	FA-SC connector = 0.7 dB
Internal Fibre	Cable (1310 =0.4 dB/km)*	0.0004	50	0.02	Internal Fibre (50m) = 0.02 dB
Inside Premise	FWS: FA-SC Connector	0.7	1	0.7	FA-SC Connector = 0.7 dB
Other	Other marginal Loss	0.16	1	0.16	Other = 0.16 dB
Total				**2.3**	**Total = 2.3 dB**

**ITU-T G.652 reference*

6.8 Customer Premise Equipment (CPE)

6.8.1 CPE will be connected to FWS inside each individual premise via fibre patch cord. CPE will be supplied by the Network Facility Provider to individual customer together with standard length of fibre patch cord.

6.8.2 CPE generally have a multiple type of output port such as RJ11 and RJ45. RJ11 port is for connection with normal telephone for Voice Services and RJ45 port is for internet or other interactive service connection. However, the CPE specification will be various depend on the Network Facility Provider. Figure 6- below shows the sample of CPE interface.

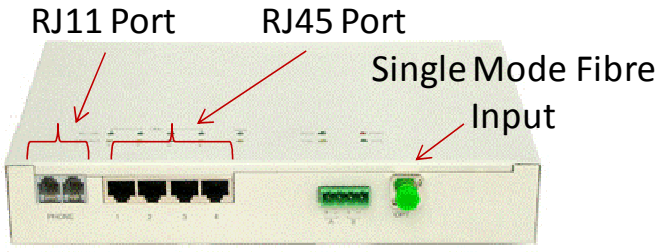
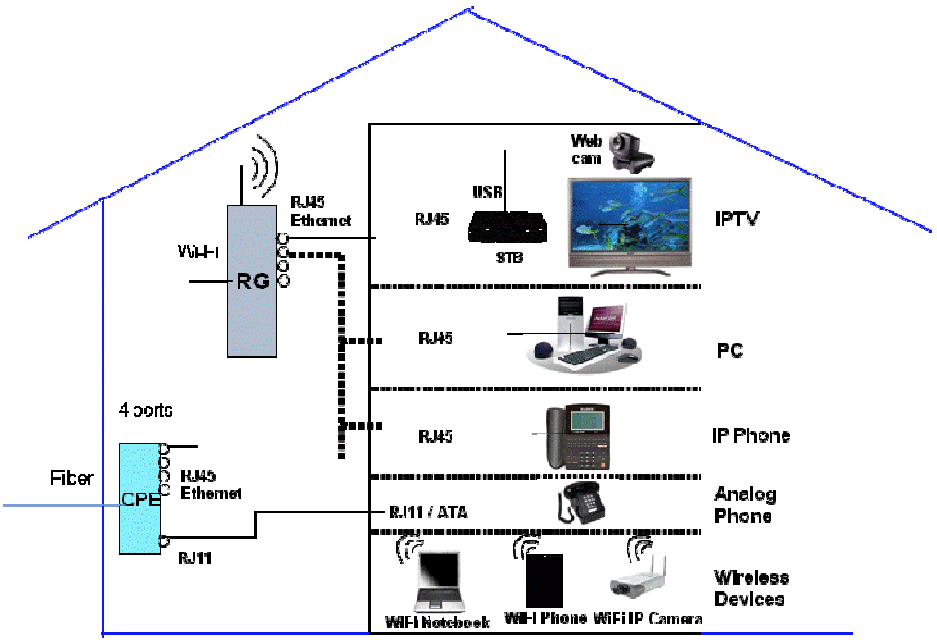


Figure 6-9 : Sample of Optical Network Unit

6.9 Telecommunication Outlet Cabling

6.9.1 Telecommunication Outlet Cabling is referring to the cabling between CPE and other in premise Telecommunication Outlet (TO). The numbers of cable required depend on the number of Telecommunication Outlet in the premises.

6.9.2 The cable type for telecommunication outlet cabling depends on the CPE output interface type. However, it is strongly recommended that developer to provide UTP cable (CAT 5, CAT 5e or CAT 6) for the telecommunication outlet cabling. Figure 6-0 below shows the sample of in-premise telecommunication outlet cabling.



Note: Customer Premise Equipment (CPE), Residential Gateway (RG) & Setop Box (STB), Phone supplied by NFP

Figure 6-10 : Sample of Telecommunication Outlet Cabling

7 CABLING FOR MULTI-DWELLING UNIT (MDU)

7.1 General

7.1.1 Generally premise's internal cabling for MDU covers the elements from the FTB inside Telecommunications Room (TR) to the individual premise's Fibre Wall Socket (FWS).

7.1.2 This section focuses on the elements between FTB and FWS and the architecture of it is laid by the Developer or Premise Owner depending on personal preferences since cost of installation is usually put up by the customers.

7.2 Cabling and Network Boundary for MDU

7.2.1 Cabling for MDU consists of four elements as below:

a. Campus backbone cabling;

b. Building backbone vertical cable;

c. Building horizontal cable; and

d. Telecommunication outlet cabling.

7.2.2 The sample of MDU cabling is shown as in Figure 7-1 below:

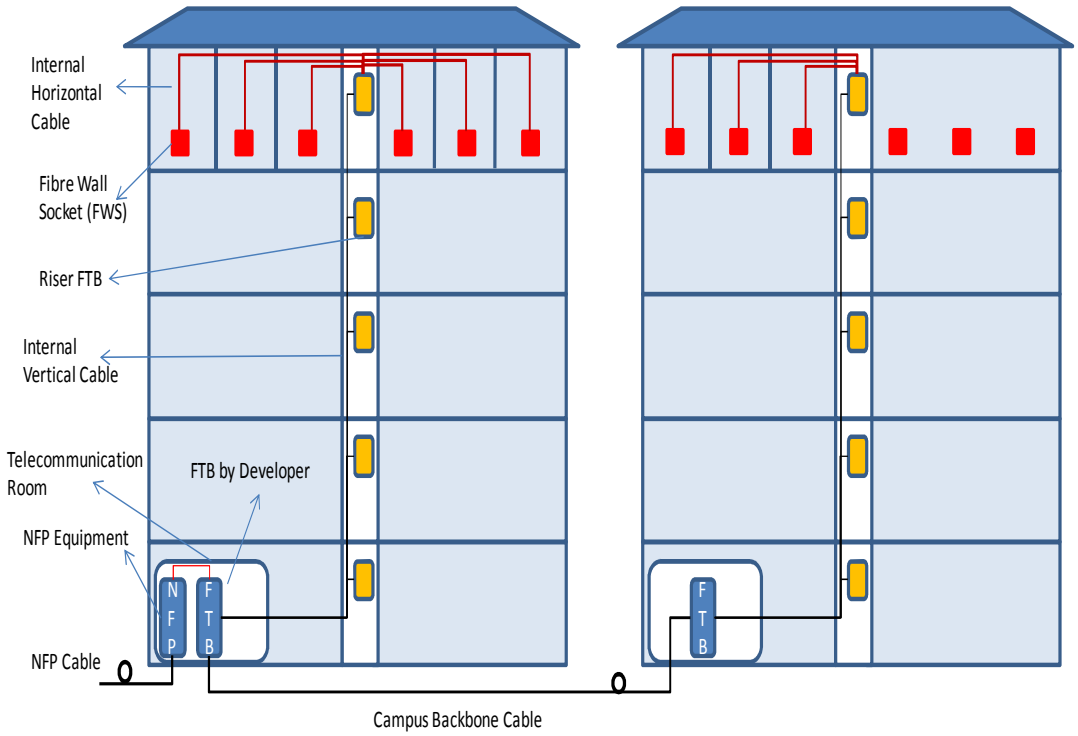


Figure 7-1 : Indoor Fibre Cabling for MDU

7.2.3 For each unit of residential type of MDU, at least two core of Internal Fibre must be terminated inside each unit. However it can be multiple cores depending on Developer's design.

7.2.4 Network boundary for MDU is as shown in Figure 7-2 below. Except Network Facility Provider and individual Premise Owner, there is a third entity involved which is the building management. It is recommended the following:

a) Network Boundary between the Network Facility Provider's and the building management – "Network Boundary (1)" to be the FTB inside the telecommunication room; and

b) Network Boundary between the building management and the individual customers – "Network Boundary (2)" to be the Fibre Wall Socket (FWS) at the individual premise unit.

7.2.5 All infrastructures inside the building and connection with Network Facility Provider's infrastructure shall be made available by the Developer and to be maintained by the building management.

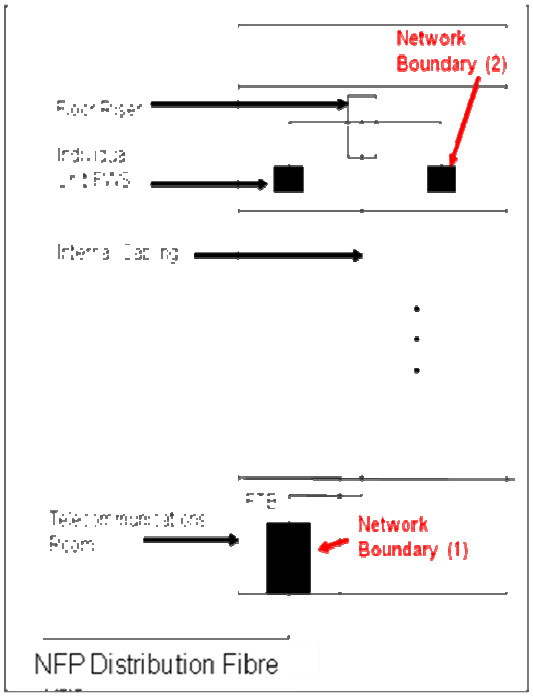


Figure 7-2 : Network Boundary for MDU

7.3 Campus Backbone Cable

7.3.1 The campus backbone cabling is referred to the cabling from the main Telecommunication Room (TR) in one building, which has connection with Network Facility Provider network, to the TR in another building. It shall include the campus backbone cable, mechanical termination at both ends and cross-connects at each TR.

7.3.2 Number of cable core for every campus backbone is depend on the developer design but must be same or more than number of Internal Vertical Cable core.

7.4 Internal Vertical Cable

7.4.1 The Internal Vertical Fibre Cable is referred to the cable between Telecommunication Room (TR) and FTB at each floor riser in the same building. Internal Vertical Cable must be provided by the Developer and must be approved by Network Facility Provider during acceptance procedure.

7.4.2 After construction by Developer, the ownership of Internal Vertical Cable must be transferred to the building management. Building management must maintain and takes the responsibility for the cable.

7.4.3 The internal vertical fibre cable must be protected with surface mounted duct and laid inside the cable riser.

7.4.4 Internal vertical fibre cable can be laid using a normal fibre. However, blown fibre system is an optional method that can be used. Detailed specification for blown fibre system is explained in Appendix D. Internal Fibre cable to be made available by the Developer.

7.4.5 For business type of MDU, the number of effective vertical fibre cable core must at least 2 cores for each individual premise unit. However it should depend on the numbers of potential resident in each premise unit. For residential, the number of effective vertical fibre cable core must at least 1 core for each individual premise unit in the building.

7.4.6 For the maintenance and future used purpose, it is highly recommended to have minimum 30% spare cores for business and 10% of spare core for residential building.

7.5 Internal Horizontal Cable

7.5.1 Internal Horizontal Cable is referred to the cabling between Floor Riser FTB to FWS inside each individual unit premise. Blown fibre system is an optional method that can be considered.

7.5.2 The responsibility for deployment and maintenance must follow same as Internal Vertical Cable which is under developer and building management. The Internal Horizontal Cable must be covered either

a. through ducting;

b. concealed inside the wall;

c. concealed underground floor; or

d. using conduit through the ceiling

depending on the design of the building. As an option, PVC ducting with wall mounted is also allowed as long as the cable is covered.

7.5.3 The minimum requirement for the riser, duct and conduit must follow requirements as explained in the MTSFB's document entitled *Technical Standards and Infrastructure Requirements Part 1*.

7.5.4 Internal Horizontal Cable can be laid separately with Internal Vertical Cable and can be spliced and connected using adaptor in*side the Floor Riser's FTB as shows in* Figure 7-3 below. In this case, the core arrangement of Internal Horizontal Cable must follow the same sequence of premise numbering system. For example, premise with unit number 1 must be connected with core number 1.

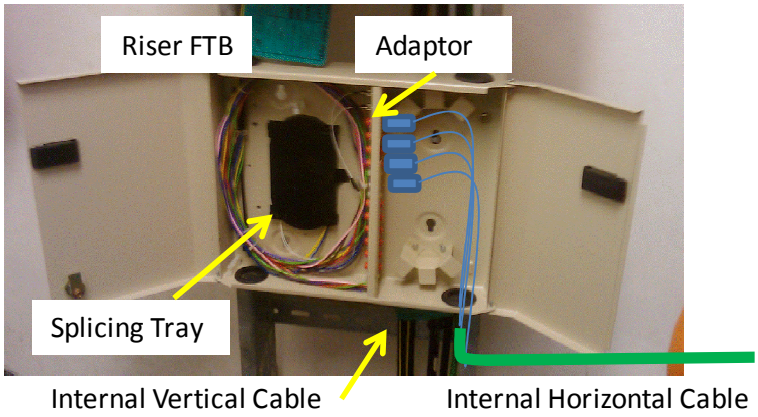


Figure 7-3 : Connection with Internal Vertical Cable

7.5.5 Internal Horizontal Cable also can be laid directly from TR until FWS in each individual premise and it will be a part of Internal Vertical Cable. The developer can use any design of laying the Internal Fibre, however it is strongly recommend to be consulted by Network Facility Provider.

7.5.6 Number of effective core for each premise is two cores for business building and one core for residential building. For the maintenance and future used, it is highly recommended to have minimum 20% of spare cores for business and 10% of spare cores for residential type in each of Internal Horizontal Cable.

7.6 Specification for MDU's Internal Fibre

7.6.1 Specification for MDU Internal Fibre is show as in Table 7-1 below

Table 7-1 : Specification of MDU's Internal Fibre

Cable	Cabling Portion	Specification
Campus Backbone	Main TR to other building TR	Single Mode ITU-T G.652 D
Internal Vertical Cable	FTB at TR to each Floor Riser	Single Mode ITU-T G.652 D or ITU-T G.657 A
Internal Horizontal Cable	Floor Riser to Individual Unit Premise FWS	Single Mode ITU-T G.657 A
Telecommunication Outlet Cable	CPE to other Telecommunications Outlet	UTP Cable- Cat5, Cat5e or Cat6

7.6.2 Cable specification for campus backbone cable and Internal Vertical Cable are normally same. Cable type must be loose tube or ribbon single mode fibres with features comply with G.652D or G.657A specification. Sample of campus backbone and Internal Vertical Cable is shown in Figure 7-4 and Figure 7-5 below.

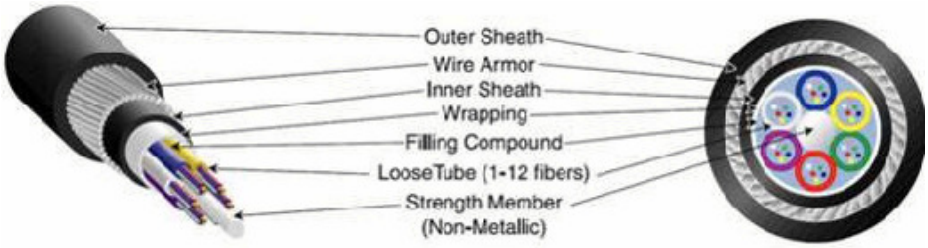


Figure 7-4 : Possible Vertical Fibre Cable design – Loose Tube

Figure 7-5 : Possible Vertical Fibre Cable design – Ribbon

7.6.3 The Internal Horizontal Cable typically follows the specifications defined for distribution fibre and the type must single-mode fibre. Internal Horizontal Cable will also become the individual in-premise Internal Fibre and it should flexible enough to be laid inside premise. The recommend type of Internal Horizontal Cable is Fibre Reinforced Plastic (FRP) or Aramid/Kevlar Reinforced type and must be Bending-Insensitive Small Bending Proof and High Reliability Single-Mode Fibre (ITU-T G.657 A). The specification is same with premise Internal Fibre for SDU as explained in Section 6.6.

7.6.4 For premises telecommunications outlet, the cable type depends on the type of CPE interface and the most recommended type is UTP cable with specification of CAT 5, CAT 5e or CAT 6 type.

7.7 Cabling Power Attenuation Loss

7.7.1 All the internal cabling must be tested and the result must be submitted to the Network Facility Provider during the cabling approval process.

7.7.2 Allowable power attenuation loss from internal cabling entering point, which is FTB inside TR, to FWS inside each individual premise must not exceed 2.2 dB. All the cable must be tested from point to point for every termination. Table 7-2 below shows the sample of cabling power attenuation loss calculation.

Table 7-2: Cabling Power Insertion Loss for Single MDU

Location	Item	Detail
Campus Backbone cable	Cable (1310 =0.4 dB/KM)*	Campus Backbone Cable (200m) = 0.08 dB
Telecommunication Room	FTB	Connector Loss = 0.5 dB
Riser	Cable (1310 =0.4 dB/KM)*	Vertical Cable (100m) = 0.04 dB
	FTB	Mechanical Splice + Adaptor = 0.7 dB
Horizontal Trunking	Cable (1310 =0.4 dB/KM)*	Vertical Cable (50m) = 0.02 dB
Inside Premise	FWS	FA-SC Connector = 0.7 dB
Other Marginal Loss	Others	Other loss = 0.16
		Total = 2.2 dB

*Note: *ITU-T G.652 reference*

7.8 Code and Tagging for MDU's Internal Fibre

7.8.1 All the internal cabling for MDU must have a code or naming convention and tagged properly for easier maintenance and connection with Network Facility Provider's cable during the service activation and during restoration process.

7.8.2 All cables need to be inventoried and one copy of inventory information must be submitted to the Network Facility Provider during the cabling approval process. All information of the cabling inventory must be placed and indicated clearly inside TR for reference. The building management must update the information whenever there are changes in the inventory.

7.8.3 The code or naming convention for the Internal Vertical Cable must follow standard as shown in Table 7-3:

a. Vertical Cable No - Numbering of Internal Vertical Cable;

b. Vertical Core No - Core number of Internal Vertical Cable;

c. Floor - The Floor number of Internal Vertical Cable terminated; and

d. Horizontal Cable No. & Core - Information of the Horizontal Cable.

Table 7-3 : Coding for Internal Vertical Cable

Item	Cable Info.			MEN Info	
	Cable No.	Core No.	Transmit/Receive	MEN Chasis No.	MEN Port No.
Code	FNxxx	xxx	TX or RX	Exxx	x
Example	FN001-FN999	000-999	RX	E010	1

7.8.4 Code or naming convention for Internal Horizontal Cable must follow as in Table 7-4:

a. Horizontal Cable No. – Numbering of Internal Horizontal Cable;

b. Horizontal Core No. – Core number of Internal Horizontal Cable;

c. Vertical Cable No. & Core No. – Information of the Internal Vertical Cable; and

d. Premise Unit No. – Premise/House unit number. The core numbering must be same as the sequence of premise unit numbering.

Table 7-4 : Coding for Intenal Horizontal Cable

Item	Horizontal Cable		Vertical Cable		Premise
	Cable No.	Core No.	Cable No.	Core No.	Premise Unit No.
Code	FHxxx	xxx	FVxxx	xxx	xxx
Example	FH001-FH999	000-999	FV001-FV999	000-999	005

7.8.5 All the Internal Fibre must be tagged properly at all respective cable and core. Sample of recommended tagging system is as shown in Figure 7-6 below. All tag must be stated clearly and sealed with transparent material for easy to read.

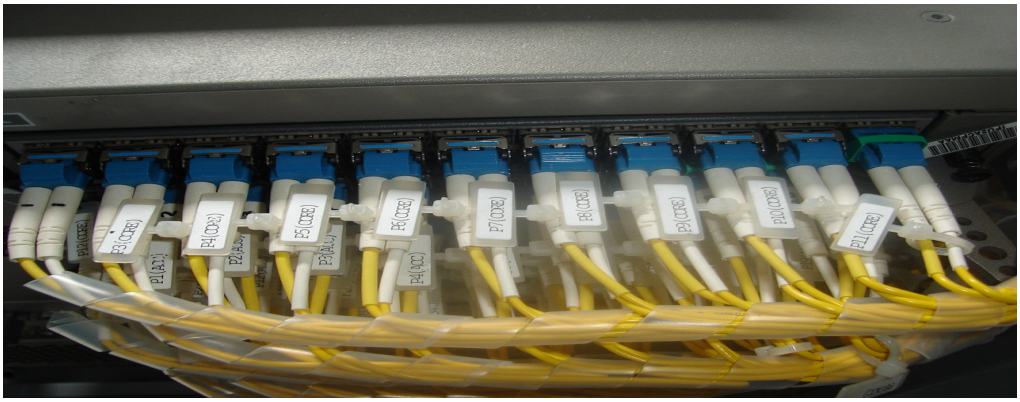


Figure 7-6: Sample of recommended Tagging System

7.8.6 Tagging must be placed at:

a. FTB inside the Telecommunication Room; or

b. FTB at Floor Rise

7.8.7 All the tagging must be placed by the housing developer initially and the record must be updated by building management upon any changes of it.

8 SAFETY PRECAUTION

8.1 Configuration of Safety Device

8.1.1 Safety facility for construction projects must strictly adhere to the Network Facility Provider guidelines issued by relevant parties in Network Facility Provider and/or any standard requirements issued by the government.

8.1.2 The use of safety equipment is strongly recommended during the installation and handling of optical fibre cable, for example gloves and safety glasses.

8.2 Other Safety elements

8.2.1 Construction environment, safety requirements and safety condition are as the following:

a) Effective fire-fighting apparatus and material must be prepared at the job location such as smoke induction and temperature induction and other alarm device and the performance must be in good condition.

b) Power supply sockets for different voltage in the machine room should have clear identification.

c) Hazardous goods such as inflammables and explosives and pigtails are forbidden in machine room.

d) Reserved holes in the building plate should configure with safe cover.

e) Add safety device to the project to ensure the safety of construction. Put an end to safety misadventure in communication construction.

9 ABBREVIATION

CAT5	Cable And Telephone Category 5
CO	Central Office
CPE	Customer Premise Equipment
DP	Distribution Point
D-Side	Distribution Side
E-Side	Central Office Side
FA-SC	Field Assembly Standard Connector
FDC	Fibre Distribution Cabinet
Fibre DP	Fibre Distribution Point
FNI	Fixed Network Infrastructure
FTB	Fibre Termination Box
FTTP	Fibre To The Premise
FWS	Fibre Wall Socket
Gbps	Gigabit per second
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
Mbps	Mega bit per Second
MDU	Multi Dwelling Unit
MTSFB	Malaysian Technical Standards Forum Bhd.
ODF	Optical Distribution Frame
OLT	Optical Line Terminal
ONU	Optical Network Unit
PON	Passive Optical Network
PVC	Polyvinyl Chloride
RJ11	Registered Jacket type 11
RJ45	Registered Jacket type 45
SC	Standard Connector
SC-UPC	Standard Connector – Ultra Polish Connector
SDF	Subscriber Distribution Frame
SDU	Single Dwelling Unit
Service Provider	Service Provider such as TM, Maxis, Time, etc
SKMM	Suruhanjaya Komunikasi dan Multimedia Malaysia
TO	Telecommunication Outlet
TR	Telecommunication Room
TSIR	Technical Standard and Infrastructure Requirements
UTP	Unshielded Twisted Pair
VOD	Video On Demand

Appendix A

Typical Manhole Specifications

1) Recommended manhole size and specifications are shown in Figure A-1 and Table A-1 below.

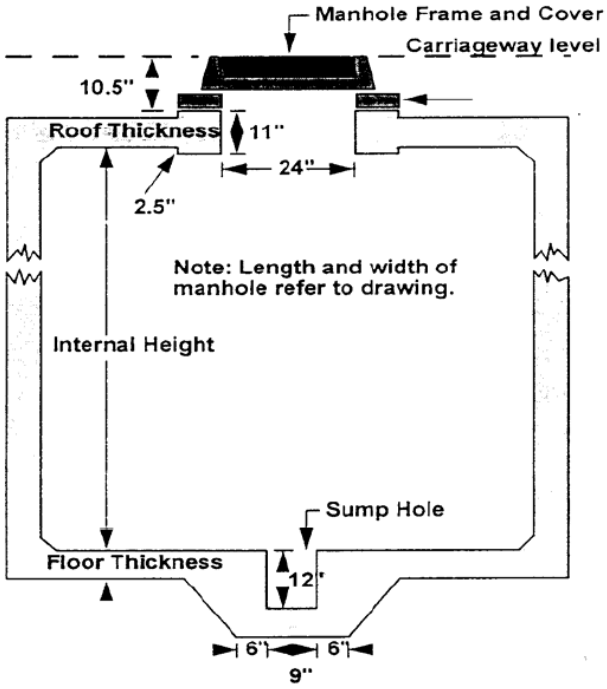


Figure A-1: Recommended Manhole Size

No	Manhole Type	Size :LxWxH (mm)	M/H strength SIRIM Std w/safety Factor x2	Tot No. Duct Way 50+50 100mm PVC & 3 HDPE	No	Qty	No	Qty	Qty	Qty			M/H Cover, Existing size	Ladder/Hook/ Step	Loading/ Unloading M/H (machinery use)
1	JB30-PIT	950x625x450	22.5 mt. Ton	2-way	0	0	0	0	0	0	0	1-hole	3E	0	Backhoe Excavator
2	JRC7	1280x975x800	22.5 mt. Ton	2-way	1	2	8	4	4	1	0	1-hole	3E	0	Backhoe Excavator
3	JC9 (M)	1570x660x1070	22.5 mt. Ton	4-way	1	2	8	4	4	2	1	1-hole	7E	existing	Backhoe Excavator
4	JC9C (M)	1820x970x1440	22.5 mt. Ton	4-way	1	4	8	8	8	1	1	2-holes	3E	existing	Backhoe Excavator
5	RIB (M)	1820x1220x1970	22.5 mt. Ton	6-way	2	4	18	8	8	2	1	2-holes	3E	existing	Backhoe Excavator
6	R2A	3050x1220x1820	22.5 mt. Ton	12-way	2	6	12	12	12	6	1	2-holes	3E	existing	Backhoe Excavator
7	R2A (M)	3660x1520x1820	22.5 mt. Ton	12-way	2	6	18	12	12	6	1	2-holes	3E	existing	Backhoe Excavator

Table A-1: Typical Manhole Specifications

Appendix B

Fibre Termination Box (FTB) Specifications

1) The termination box shall be suitable for attachment to inside or outside wall of a building.

2) The material shall be able to protect the component against harsh, high heat and humidity environment. The termination box shall be designed and conforms to IP44 of IEC 60529 Ed. 2.1 standards or better for indoor application and IP55 of IEC 60529 Ed. 2.1 standards or better for outdoor application.

3) Evidence (such as certificate, letter of conformance, etc) from SIRIM or authorized body shall be provided during approval process.

4) The termination box shall be suitable for 19" rack-mount and/or wall mounted. The offered termination box shall be complete with its respective mounting kits.

5) The framework of the high density and medium density fibre termination box shall be fabricated from electro-galvanised steel or rust proof steel plating of thickness not less than 2.0mm and the design shall conforms to ISO 2081 or other recognized standards.

6) The framework of the premise fibre termination box and fibre socket shall be plastic injection moulded or thermoplastic and made of fire retardant material. All the plastic material shall have a rating of V-1 or better as determined by Underwriters Laboratories' UL94 standard.

7) The fibre termination box shall be design with built-in splitter or without splitter.

8) All edges shall be rounded.

9) Total weight of the fibre termination box including full accessories shall be suitable for wall mounting.

10) Maximum overall dimension shall be 16" (H) x 18" (W) x 6" (D) [406mm (H) x 457mm (W) x 152mm (D)] for high density termination box.

11) Maximum overall dimension shall be 8" (H) x 5" (W) x 1.5" (D) [203mm (H) x 127mm (W) x 38mm (D)] for customer premise termination box.

12) The developer shall propose separate sizes and capacity to provide cable management and connection for high, medium, low and individual premise fibre installation including fibre socket.

13) The developer shall furnish details specification and characteristic of the various sizes of the fibre termination box and fibre socket offered during the submission of proposal for evaluation.

14) The developer shall submit proposed technical drawings complete with dimensions for the product offered.

15) The fibre termination box shall consist of moulded inner fibre slack storage, sleeve holder and integral positive lock strain relief for cable and other accessories deem necessary.

16) The fibre termination box design shall have suitable splice tray and cable management area to provide for minimum bending radius and for storage ruggedized splitter pigtails.

17) Suitable number of splice organizes trays or splice trays shall be provided in the splice compartment. The splice tray shall be of cartridge or cassette types that are stackable and flappable or able to be opened sideways.

18) The number of trays and other appropriate accessories provided shall suit the maximum number of cores of the fibres intended to be installed. The splice tray shall comply with GR-771.

19) The fibre termination box shall have pre-assembled plates with SC coupling for fibre patching.

20) It shall be designed with two (2) physically separated compartments to isolate the incoming cable (capable of accommodating splitter where needed) from the Drop Fibre compartment.

21) The door opening shall be designed for suitable operation in confined space.

22) The fibre termination box shall be provided with various sizes of cable entries at both top and bottom. All cable entries shall be provided with rubber grommets to protect the cable and prevent pest and dirt entry.

23) The rubber grommets shall have suitable guides for different cable sizes to permits pass through of additional fibres.

24) The fibre termination box design shall be economical, effective, robust and compact to provide access point for Drop Fibre and Internal Fibre.

25) Each fibre termination box shall be provided with a table or label card for circuit identification purpose. The table shall be printed on durable material in such a manner as to be permanently legible, protected by an acrylic pocket and properly displayed on the inside cover of the termination box.

26) Approved laser caution signs as per IEC 60825-1 Ed 2.0 requirements shall be provided as standard for every termination box.

27) The termination offered and its associated hardware shall be commercially available (in current production) and already been commercially deployed. Any prototype and unproven System shall be disqualified. Developer to submit evidence to prove the systems are field proven and in current production.

28) An inventory list containing lists of components or parts supplied and operation and installation manual shall be provided with each termination box.

Appendix C

Specification for Indoor Fibre Cable

1) Indoor Fibre cable shall be single-mode indoor cable reinforced with Fibre Reinforced Plastic (FRP) for indoor applications.

2) Fibre Characteristic

   a) The fibre characteristic shall be in accordance with the Recommendation of ITU-T G.657A (Bend Insensitive Fibre ≤ 15mm bending radius).

   b) Fibre attributes is as stipulated in Table 6-1, section 6.6 above.

3) Macro Bending Loss

   a) The loss performance at 1550nm and 1625nm regions shall be in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

   b) In order to ensure low loss operation at 1550 and 1625nm regions, the increase in loss for 10 turns of the loosely wound fibre using a mandrel with 15mm radius should be 0.5dB.

   c) Maximum loss at 1550nm shall be 0.25dB and at 1625nm shall be 1.0dB

4) Proof stress shall not be less than 0.69Gpa.

5) Chromatic Dispersion Coefficient

   a) Zero Dispersion Slope shall be less than and equal to 0.092ps/(nm^2 km).

   b) Zero Dispersion Wavelength shall range from 1300nm to 1324nm

6) The attenuation coefficient of the Fibre shall be as follows: -

   a) Maximum 0.35 dB/km from 1310nm to 1625nm regions.

   b) Maximum 0.4 dB/km in the 1383nm ±3nm region.

   c) Maximum 0.3 dB/km in the 1550nm region.

7) PMD Coefficient – PMD link design value shall be maximum of 0.2ps/√km in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

8) Optical fibre shall be placed within fibre microducts having properties such as

   a) Low flammability;

   b) Low smoke;

   c) Low acid/fume; and

   d) Low halogen

9) The construction of the indoor fibre shall be 1Fibre or 2Fibre cores.

10) The colour coding shall be as in the following table:

Number	Fibre
1	Blue
2	Yellow

11) The cable shall contain Fibre Reinforced Plastic (FRP) material as cable strength member. Nominal diameter for FRP shall be 0.4mm.

12) The Indoor Drop Fibres nominal outer diameter shall be 3.1 x 2.0 mm.

13) The Indoor Drop Fibres shall be sheathed with polyethylene and flame retardant characteristic. Performance on oxygen index of sheath shall be ≥ 27 %.

The Sheath

a) The sheath shall be ivory colour and shall not promote the growth of fungus.

b) The sheath around the cable and bearer wire shall be free from pinholes, joints, mended places and other defects and able to provide adequate mechanical protection against impact and crushing.

c) The sheath shall be marked with the manufacturer's name, sequential meter, month and year of manufacturer, fibre count and fibre type.

d) The marking shall be in contrasting colour to the cable sheath. The preferred marking colour will be white.

e) The general cable performance test of the offered Indoor Drop Fibre shall be in accordance with ANSI/ICEA S-104-696 or equivalent to other international standards. It shall be verified through suitable test.

f) The tensile strength of the indoor cable shall be in excess of 80 N. At this load, no residual fibre elongation and the increase in attenuation shall be less than 0.05dB/km.

Bend Test

a) The cable shall be unwound and ten (10) turns shall be wrapped in a close helix around a mandrel of radius 15mm.

b) The turns shall be applied at a uniform rate of one revolution in about 5 seconds and with sufficient tension to ensure that the specimen contours the mandrel.

c) The turns shall be then unwound and the cycle repeated three (3) times. Finally measurement shall show no change to the optical characteristics of the cable.

Appendix D

Specification for Alternative Indoor Fibre Cabling System

1) Indoor Fibre cable shall be Single-mode Indoor Fibre using Blown Fibre Distribution System for indoor applications.

2) Fibre Characteristic

   a) The Fibre characteristic shall be in accordance with the Recommendation of ITU-T G.657A (Bend Insensitive Fibre ≤ 15mm bending radius).

   b) Fibre Attributes is as stipulated in Table 6-1, section 6.6 above.

3) Macro Bending Loss

   a) The loss performance at 1550nm and 1625nm regions shall be in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

   b) In order to ensure low loss operation at 1550 and 1625nm regions, the increase in loss for 10 turns of the loosely wound fibre using a mandrel with 15mm radius should be 0.5dB.

   c) Maximum loss at 1550nm shall be 0.25dB and at 1625nm shall be 1.0dB.

4) Proof stress shall not be less than 0.69Gpa.

5) Chromatic Dispersion Coefficient

   a) Zero Dispersion Slope shall be less than and equal to 0.092ps/nm^2 km.

   b) Zero Dispersion Wavelength shall range from 1300nm to 1324nm

6) The attenuation coefficient of the fibre shall be as follows: -

   a) Maximum 0.4 dB/km from 1310nm to 1625nm regions.

   b) Maximum 0.4 dB/km in the 1383nm ±3nm region.

   c) Maximum 0.3 dB/km in the 1550nm region.

7) PMD Coefficient – PMD link design value shall be maximum of 0.2ps/√km in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

8) Optical fibre shall be placed within fibre microducts having properties such as

   a) Low flammability;

   b) Low smoke;

   c) Low acid/fume; and

   d) Low halogen.

9) The construction of the indoor fibre shall be 1Fibre or 2Fibre cores.

10) The colour coding shall be as in the following table:

Number	Fibre
1	Blue
2	Yellow

Microduct

The microducts shall be numbered.

a) The microduct nominal outer diameter shall be 5mm.

b) The microduct shall be constructed with polyethylene and flame retardant characteristic. Performance on oxygen index of sheath shall be ≥ 27 %.

c) The microduct shall be ivory colour and shall not promote the growth of fungus.

d) The microduct around the cable shall be free from pinholes, joints, mended places and other defects and able to provide adequate mechanical protection against impact and crushing.

e) The microduct shall be marked with the manufacturer's name, sequential meter, month and year of manufacturer, fibre count and fibre type.

f) The marking shall be in contrasting colour to the microduct. The preferred marking colour will be white.

g) The general cable performance test of the offered Indoor Drop Fibre shall be in accordance with ANSI/ICEA S-104-696 or equivalent to other international standards. It shall be verified through suitable test.

h) The tensile strength of the microduct shall be in excess of 70 N.

Bend Test

a) The fibre shall be unwound and ten (10) turns shall be wrapped in a close helix around a mandrel of radius 15mm.

b) The turns shall be applied at a uniform rate of one revolution in about 5 seconds and with sufficient tension to ensure that the specimen contours the mandrel.

c) The turns shall be then unwound and the cycle repeated three (3) times.

d) Finally measurement shall show no change to the optical characteristics of the cable.

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