




SPECIFICATION FOR TELEPHONE SYSTEM (L-S16)


JKR 20300-0103-22

CKE.LS.03.16.(01).2021


CAWANGAN KEJURUTERAAN ELEKTRIK

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1.0 GENERAL

1.1 SCOPE

- 1.1.1 This section of the Specification describes and specifies requirements for the supply, delivery, installation, testing, commissioning, and handing over in approved working order and maintenance during the Defects Liability Period (DLP) of the whole Telephone System in accordance with Condition of Contract, Bill of Quantities, Drawings and other related documents.

1.2 STANDARDS AND NORMATIVE REFERENCES

- 1.2.1 The material, equipment and installation shall conform to the principles of the latest standards and its addendums laid down by the Malaysian Standards (MS), International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineers (IEEE), American National Standard Institute/ Telecommunications Industry Association (ANSI/TIA), International Organisation for Standardisation and the International Electrotechnical Commission (ISO/IEC), International Telecommunications Union Standard (ITU), British Standard (BS), International Electrotechnical Commission, American Society For Testing and Material (ASTM) and Malaysia Communications and Multimedia Commission (MCMC).

1.3 TECHNICAL PARTICULARS


- 1.3.1 The Tenderers shall submit at the time of tendering all catalogues, detailed technical particulars, name of manufacturers, brand, model numbers and guarantees in respect of the equipment offered, which shall be binding. No departure from these technical particulars and guarantees will be permitted except with the written approval of the Superintendent Officer (S.O / S.O's) Representative.

1.4 GUARANTEES

- 1.4.1 Tenderers shall guarantee all equipment and material to be supplied under this contract against faulty design, materials and workmanship at the manufacturer's works within the DLP.

1.5 ELECTRICAL SYSTEM REQUIREMENT

- 1.5.1 All equipment shall be rated for operation on a 230/400V (within the tolerance as defined in MS IEC 60038; 230/400V, +10%, -6%), 3-phase, 4 wire, 50Hz system with solidly earthed neutral.

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2.0 INSTALLATION, CONFIGURATION AND WORKMANSHIP

2.1 DESCRIPTION


- 2.1.1 All works shall comply to the specifications and best engineering practices. It shall be carried out and supervised by qualified, competent and skilled contractor personnel.
- 2.1.2 The Contractor shall responsible for all related works including earthwork, hacking and making good or any civil work required for the installation. All labour, material and necessary tools etc. during the works shall be carried out on Contractor's cost. The Contractor shall ensure the site is in good condition after the installation completed.

2.2 CERTIFIED INSTALLER

- 2.2.1 The work of installation, termination, testing and commissioning of the cabling system and external infrastructure shall be conducted and carried out by a Certified Installer. The Certified Installer shall be a competent person certified by related cable manufacturer or any related local utility provider. The Contractor shall submit the list of on-site Certified Installer complete with valid certificates to the S.O / S.O's Representative at least two weeks prior to the installation.

2.3 CERTIFIED PRODUCT ENGINEER

- 2.3.1 The work of configuration, testing and commissioning of the equipment installed shall be conducted and carried out by a Certified Product Engineer. The Certified Product Engineer is a competent person certified by related telephone equipment manufacturer or principle. The Contractor shall submit the list of on-site Certified Product Engineer complete with valid certificates to the S.O / S.O's Representative at least two weeks prior to the installation.

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3.0 TELEPHONE SYSTEM AND EQUIPMENT

3.1 DESCRIPTION

3.1.1 Generally, the telephone system and equipment are as follows:

- 3.1.1.1 Public Branch Exchange (PBX) System
- 3.1.1.2 Voice Security
- 3.1.1.3 Analogue Voice over Internet Protocol (VoIP) Gateway
- 3.1.1.4 Integrated Service Data Network (ISDN) Media Gateway
- 3.1.1.5 Telephone Set
- 3.1.1.6 Operator System

3.1.2 All telephone systems and equipment shall be configured according to VLANs, security policies, IP Addresses of the telephone network which suit the requirement. Information of numbers of VLANs, port assignments, permissions, security policies etc. (where applicable) shall be submitted to S.O / S.O's Representative for approval.

3.1.3 The size of telephone system shall be categorised based on the following criteria:-


Small business	: Up to 150 users
Medium business	: 151 to 1200 users
Large business	: Above 1200 users

3.2 TYPES OF PBX SYSTEM

3.2.1 IP PBX System

3.2.1.1 An IP PBX is a fully IP Public Branch Exchange which switches calls between VoIP users on local lines while allowing all users to share a certain number of external telephone lines. The typical IP PBX shall also switch calls between a VoIP user and analogue / digital telephone user, or between two analogue / digital telephone users as operated by Public Automated Branch Exchange (PABX).

3.2.1.2 It is also known as Unified Communications server, which uses packet-switched network or Local Area Network (LAN) to transmit the signal of voice calls. The LAN shall be either the same network for data signal or dedicated network for voice signal.

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3.2.1.3 The system shall operate on 48Vd.c (nominal) with positive earthing, and shall function satisfactorily within a voltage range of 42Vd.c to 54Vd.c for not less than 80% of the calls and shall function satisfactorily within a voltage range of 44Vd.c to 52Vd.c for 100% of the calls.

3.2.1.4 The input/output of IP PBX, shall comply with VoIP requirements as follows:-


Signalling Protocol	:	Open Session Initiation Protocol (SIP) RFC 3261 with an option ITU-T H.323.
Transport Protocol	:	User Datagram Protocol (UDP) with an option Transmission Control Protocol (TCP) or Secure Real-Time Protocol (SRTP).
Codec	:	ITU-T G.711 (a-law and μ -law) with an option ITU-T G.722, ITU-T G.726 or ITU-T G.729A.
DTMF	:	In Band, RFC 2833.
Fax protocol	:	ITU-T G.711 and/or ITU-T T.38.
IP assignment	:	Dynamic Host Configuration Protocol (DHCP) and/or Static IP.
Addressing	:	Support for Internet Protocol version 6 (IPv6)

3.2.1.5 The **IP PBX for small business** shall be of a rack mounted type and comply with the following minimum technical specifications:-

Scalability	:	Up to 150 users
Ports	:	2 x Ethernet port (RJ45),
Channel	:	Up to 24 channels
Incoming line	:	SIP Trunk, Analogue, LTE
Power supply	:	Single power supply unit
Features	:	Call billing, operator system, auto attendance, directory, soft phones, voice mail

3.2.1.6 The **IP PBX for medium business** shall be of a rack mounted type and comply with the following minimum technical specifications:-

Scalability	:	151 to 1200 users
Ports	:	2 x GbE port (RJ45)
Channel	:	Up to 128 channels
Incoming line	:	SIP Trunk
Power supply	:	Single power supply unit

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Features : Call billing, operator system, auto attendance, directory, voice mail, messaging, presence, call centre, soft phones and mobile clients, voice mail.

3.2.1.7 The **IP PBX for large business** shall be of a rack mounted type and comply with the following minimum technical specifications:-

Scalability : Above 1200 users
Ports : 4 x GbE port (RJ45)
Channel : Above 128 channels
Incoming line : SIP Trunk
High-Availability : Active-active configuration, change over between Two (2) redundance system seamlessly.
Power supply : Dual power supply
Features : Call billing, operator system, auto attendance, directory, voice mail, messaging, presence, call centre, soft phones and mobile clients, voice mail.


3.2.2 Hybrid Public Automated Branch Exchange (PABX) System

3.2.2.1 Hybrid PABX system uses analogue / digital telephone networks. It shall be expanded by plugging in an additional IP card to communicate using the SIP IP-protocol to allow it to connect to IP phones or to a remote IP PBX system.

3.2.2.2 The **Hybrid PABX for small business** shall be of a rack mounted type and comply with the following technical specifications:-

Scalability : Up to 150 users
Extension Type : Analogue, digital, SIP
Ports : 2 x Ethernet port (RJ45)
Channel : Up to 24 channels
Incoming line : SIP Trunk, Analogue, LTE
Power supply : Single power supply unit
Features : Call billing, operator system, auto attendance, directory, soft phones, voice mail

3.2.2.3 The **Hybrid PABX for medium business** shall be of a rack mounted type and comply with the following minimum technical specifications:-

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Scalability	:	151 to 1200 users
Extension Type	:	Analogue, digital, SIP
Ports	:	2 x GbE port (RJ45)
Channel	:	Up to 128 channels
Incoming line	:	SIP Trunk
Power supply	:	Single power supply unit
Features	:	Call billing, operator system, auto attendance, directory, voice mail, messaging, presence, call centre, soft phones and mobile clients

3.2.2.4 The **Hybrid PABX for large business** shall be of a rack mounted type and comply with the following minimum technical specifications:-

Scalability	:	Above 1200 users
Extension Type	:	Analogue, digital, SIP
Ports	:	4 x GbE port (RJ45)
Channel	:	Above 128 channels
Incoming line	:	SIP Trunk
High-Availability	:	Active-active configuration, change over between two redundancy system seamlessly.
Power supply	:	Dual power supply
Features	:	Call billing, operator system, auto attendance, directory, voice mail, messaging, presence, call centre, soft phones and mobile clients


3.3 VOICE SECURITY

3.3.1 Session Initiation Protocol (SIP) Gateway

3.3.1.1 The SIP Gateway used to transmit voice data from an analogue device to a digital device or vice versa. The SIP gateways used with analogue / digital telephone systems to enable IP-PRI telecommunication interface standard.

3.3.1.2 The SIP Gateway shall be of a rack mounted type and comply with the following minimum technical specifications:-

Channel	:	4 to 128 Channels
Power supply	:	Single power supply unit
Security	:	Topologies hiding and Firewall
Interoperability	:	Network Addressing Translation (NAT)


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3.3.2 Session Border Controller (SBC)

3.3.2.1 The SBC used to control and manage real-time multimedia traffic flow between IP network borders, handling signaling, data, voice and video traffic.

3.3.2.2 The SBC shall be of a rack mounted type and comply with the following minimum technical specifications:-

Channel	:	Above 128 Channels
Power supply	:	single power supply unit
Security	:	<ul style="list-style-type: none"> i. Granular access control ii. IP address and SIP signaling concealment iii. Topologies hiding and signaling overload controls iv. IP telephony spam protection v. Stateful deep packet inspection vi. Signaling media encryption vii. Telephony fraud protection
Interoperability	:	<ul style="list-style-type: none"> i. Dual Tone Multi-Frequency (DTMF) ii. Header manipulation rules (HMR), iii. Number and uniform resource identifier (URI) manipulation. iv. SIP / H.323 signaling interworking v. Protocol interworking: Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Stream Control Transmission Protocol (SCTP) vi. Encryption interworking: Transport Layer Security (TLS), Mutual TLS, Secure Real-time Transport Protocol (SRTP) vii. Network Address Translation (NAT) and firewall traversal. viii. IP address translation: private / public - Internet Protocol version 4 (IPv4) / Internet Protocol version 6 (IPv6) ix. Transcoding

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3.4 ANALOGUE VOICE OVER INTERNET PROTOCOL (VoIP) GATEWAY


- 3.4.1 An Analogue VoIP Gateway is a device which convert analogue signal into data packet for transmission over IP network.
- 3.4.2 This device is used to connect analogue / digital telephones, fax machines, and similar customer-premises devices to a digital phone type or a voice over IP telephony network.
- 3.4.3 The digital interface of the Analogue VoIP Gateway consists of an Ethernet port to connect to an IP network.
- 3.4.4. The Analogue VoIP Gateway shall be of a rack mounted type and comply with the following minimum technical specifications:-

Digital interface	:	Ethernet Port
No. of extension	:	24 numbers
Type of port	:	RJ45 or RJ11
Ethernet LAN	:	100/1000 Mbps
Power supply	:	Single power supply unit
Protocol	:	H.323 or SIP, encodes and decodes the voice signal using a voice codec such as G.711, G.729, SIP RFC3261 and/or others.
Features	:	Primary / Backup SIP Server, dial tone, Ringing Generator, DC power, caller ID data and other standard telephone line signaling
Firmware	:	Upgrade via Web-Based
Compatibility	:	Interoperable with a wide range of IP PBX and softswitches

3.5 INTEGRATED SERVICES DIGITAL NETWORK (ISDN) MEDIA GATEWAY

- 3.5.1 The ISDN Media Gateway is a device which convert IP signal to PRI telecommunication standard for incoming signal from the service provider.
- 3.5.2 The ISDN Media Gateway shall be of a rack mounted type and comply with the following minimum technical specifications:-

Digital interface	:	Ethernet Port
No. of channel	:	30 channels
Type of port	:	RJ45 or RJ11

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Ethernet LAN	:	100/1000 Mbps
Power supply	:	Single power supply unit
Protocol	:	H.323 or SIP and encodes and decodes the voice signal using a voice codec such as G.711, G.729, SIP RFC3261 or others.
Features	:	Primary / Backup SIP Server
Firmware	:	Upgrade via Web-Based
Compatibility	:	Interoperable with a wide range of IP PBX and softswitches

3.6 TYPES OF TELEPHONE SET

3.6.1 Description

3.6.1.1 There are seven (7) types of telephone set:-


- 3.6.1.1.1 SIP Phone
- 3.6.1.1.2 IP Phone
- 3.6.1.1.3 Soft Phone
- 3.6.1.1.4 Wireless (WiFi) Phone
- 3.6.1.1.5 SIP/IP Digital Enhanced Cordless Telecommunications (DECT) Phone
- 3.6.1.1.6 Digital Phone
- 3.6.1.1.7 Single Line Telephone (SLT)

3.6.2 SIP Phone

3.6.2.1 The SIP Phone is known as the telephone set supported by the Ethernet specification.

3.6.2.2 The **basic SIP Phone** shall comply with the following minimum technical specifications:-

Port	:	2 nos RJ45 ports, 10/100/1000 BASE-T Ethernet connection, support PoE
Standard	:	IEEE 802.3af PoE (Class 1), ITU G.711, ITU G.729ab, IEEE 802.1p/q, RFC 3261, or latest


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- Features :
- i. Full-duplex speakerphone allows for flexibility in placing and receiving calls
 - ii. Message waiting indicator
 - iii. Speech volume control
 - iv. Ringer volume control
 - v. Ringer pitch control
 - vi. Line power option, local power option
 - vii. Support of fixed IP address
 - viii. Support of Dynamic Host Configuration Protocol (DHCP) for IP address assignment
 - ix. On hook dialing
 - x. Compatible with inductively coupled hearing aids
 - xi. Headset jack
 - xii. Two (2) lines LCD to display telephone numbers and names
 - xiii. Two (2) line appearances
 - xiv. Full hands free working
 - xv. Three (3) party audio conferencing

- Accessories :
- Cables to connect the phone
 - i. 2 x RJ9 jack for the handset and headset connection
 - ii. RJ45 jack for the LAN connection (labelled "10/100/1000 SW").
 - iii. RJ45 jack for a second 1000 BASE-T compliant connection (labelled "10/100/1000 PC").

3.6.2.3 The **executive SIP Phone** shall comply with the following minimum technical specifications:-

- Port :
- 2 nos RJ45 ports, 10/100/1000 BASE-T Ethernet connection, support PoE

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Standard : IEEE 802.3af PoE (Class 1), ITU G.711, ITU G.729ab, IEEE 802.1p/q, RFC 3261 or latest

Features :

- i. Full-duplex speakerphone allows for flexibility in placing and receiving calls
- ii. Message waiting indicator
- iii. Speech volume control
- iv. Ringer volume control
- v. Ringer pitch control
- vi. Line power option, local power option
- vii. Support of fixed IP address
- viii. Support of DHCP for IP address assignment
- ix. On hook dialing
- x. Compatible with inductively coupled hearing aids
- xi. Headset jack
- xii. 4.3 inch color LCD to display telephone numbers and names
- xiii. Two (2) line appearances
- xiv. 10 nos Programmable key for speed dial
- xv. Phone Directory
- xvi. Three (3) party audio conferencing
- xvii. Full hands free working


Accessories :

- Cables to connect the phone
- i. 2 x RJ9 jack for the handset and headset connection
- ii. RJ45 jack for the LAN connection (labelled "10/100/1000 SW").
- iii. RJ45 jack for 1000 BASE-T compliant connection (labelled "10/100/1000 PC").

3.6.3 IP Phone

3.6.3.1 IP Phone known as the telephone set supported by the Ethernet specification.


3.6.3.2 The **Basic IP Phone** shall comply with the following minimum technical specifications:-

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Port	:	2 nos RJ45 ports, 10/100/1000 BASE-T Ethernet connection, support PoE
Standard	:	IEEE 802.3af PoE (Class 1), ITU G.711, ITU G.729ab, IEEE 802.1p/q
Features	:	<ul style="list-style-type: none"> i. Full-duplex speakerphone allows for flexibility in placing and receiving calls ii. Message waiting indicator iii. Speech volume control iv. Ringer volume control v. Ringer pitch control vi. Line power option, local power option vii. Support of fixed IP address viii. Support of DHCP for IP address assignment ix. On hook dialing x. Compatible with inductively coupled hearing aids xi. Headset jack xii. Two (2) lines LCD to display telephone numbers and names xiii. Two (2) line appearances xiv. Full hands free working
Accessories	:	Cables to connect the phone <ul style="list-style-type: none"> i. 2 x RJ9 jack for the handset and headset connection ii. RJ45 jack for the LAN connection (labelled "10/100/1000 SW"). iii. RJ45 jack for 1000 BASE-T compliant connection (labelled "10/100/1000 PC")

3.6.3.3 The **Executive IP Phone** shall comply with the following minimum technical specifications:-

Port	:	2 nos RJ45 ports, 10/100/1000 BASE-T Ethernet connection, support PoE
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Standard : IEEE 802.3af PoE (Class 1), IEEE 802.1p/q, ITU G.711, ITU G.729ab

Features :

- i. Full-duplex speakerphone allows for flexibility in placing and receiving calls
- ii. Message waiting indicator
- iii. Speech volume control
- iv. Ringer volume control
- v. Ringer pitch control
- vi. Line power option, local power option
- vii. Support of fixed IP address
- viii. Support of DHCP for IP address assignment
- ix. On hook dialing
- x. Compatible with inductively coupled hearing aids
- xi. Headset jack
- xii. 4.3 inch color LCD to display telephone numbers and names
- xiii. Two (2) line appearances
- xiv. Full hands free working
- xv. 10 nos Programmable key for speed dial
- xvi. Phone Directory
- xvii. Speed dialing from PBX system
- xviii. Boss and Secretary function
- xix. Additional key panel
- xx. Station name display
- xxi. Room monitoring for single line
- xxii. Four (4) party audio conferencing

Accessories :

- Cables to connect the phone
 - i. 2 x RJ9 jack for the handset and headset connection
 - ii. RJ45 jack for the LAN connection (labelled "10/100/1000 SW").
 - iii. RJ45 jack for 1000 BASE-T compliant connection (labelled "10/100/1000 PC").


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3.6.4 Soft Phone

3.6.4.1 Soft Phone is a software programme for making telephone calls over the internet using general purpose computer or mobile device.

3.6.4.2 The **PC soft phone type** shall be applied at office environment or any related area specified in the design and shall comply with the following minimum technical specifications:-

Operating System	:	Windows, MacOS
License	:	Software Assurance License and/or User License
Graphical User Interface (GUI)		
Features	:	<ul style="list-style-type: none"> i. Dialpad and Phone number text box ii. 12 button speed dial iii. Call history for incoming, outgoing and missed calls. iv. Phonebook / Directory v. Microphone/Speaker volume adjustment
Protocol	:	Transport Layer Security (TLS) / Secure Real-Time Transport Protocol (SRTP), Session Traversal Utilities for Network Address Translation (STUN)/ Interactive Connectivity Establishment (ICE)
Standard	:	ITU G.711 ,ITU G.729ab, H.264, H.263, VP8 Codec
Features	:	<ul style="list-style-type: none"> i. Auto answer incoming calls ii. Caller ID Display iii. Call Hold iv. Do-Not-Disturb v. Call Waiting vi. Call Forwarding vii. Call Barring viii. Call Transfer (Blind or Attended) ix. Three (3) Party Call Conferencing x. Voice Activity Detection (VAD) xi. Support instant messaging xii. Echo Cancellation (EC) xiii. Microphone Amplification

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- xiv. Call Recording in WAV or MP3
- xv. Support PC speaker and USB headset
- xvi. Admin settings with password protection

3.6.4.3 The **mobile client soft phone type** shall be applied at office environment or elsewhere and shall comply with the following minimum technical specifications:-

- Operating System : Android and IOS
- License : Software Assurance License and/or User License
- Graphical User Interface (GUI)
- Features :
 - i. Dialpad and Phone number text box
 - ii. Call history for incoming, outgoing and missed calls
 - iii. Phonebook / Directory
- Protocol : TLS/SRTP, STUN/ICE
- Support : Google/Apple push notification for voice calls
- Standard : ITU G.711 ,ITU G.729ab, H.264, H.263, VP8 Codec
- Features :
 - i. Auto answer incoming calls
 - ii. Caller ID Display
 - iii. Call Hold
 - iv. Do-Not-Disturb
 - v. Call Waiting
 - vi. Call Forwarding
 - vii. Call Barring
 - viii. Call Transfer (Blind or Attended)
 - ix. Three (3) party Call Conferencing
 - x. Voice Activity Detection (VAD)
 - xi. Support instant messaging
 - xii. Echo Cancellation (EC)
 - xiii. Microphone Amplification
 - xiv. Call Recording in WAV or MP3
 - xv. Support speaker and bluetooth headset

3.6.5 Wireless (WiFi) Phone


3.6.5.1 WiFi Phone is a telephone using WiFi signal for making telephone calls and shall comply with the following minimum technical specifications:-

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Port	:	2 nos RJ45 ports, 10/100/1000 BASE-T Ethernet connection, support PoE
Standard	:	IEEE 802.3af PoE (Class 1), ITU G.711, ITU G.729ab, IEEE 802.1p/q, 801.11a/b/g or latest, WMM, WEP, WPS, WDS
Features	:	<ul style="list-style-type: none"> i. Full-duplex speakerphone allows for flexibility in placing and receiving calls ii. Message waiting indicator iii. Speech volume control iv. Ringer volume control v. Ringer pitch control vi. Line power option, local power option vii. Support of fixed IP address viii. Support of DHCP for IP address assignment ix. On hook dialing x. Compatible with inductively coupled hearing aids xi. Headset jack xii. Two (2) lines LCD to display telephone numbers and names xiii. Two (2) line appearances xiv. Full hands free working
Accessories	:	Cables to connect the WiFi phone <ul style="list-style-type: none"> i. 2 x RJ9 jack for the handset and headset connection ii. RJ45 jack for the LAN connection (labelled "10/100/1000 SW") iii. RJ45 jack for 1000 BASE-T compliant connection (labelled "10/100/1000 PC")


3.6.6 SIP/IP Digital Enhanced Cordless Telecommunications (DECT) Phone

3.6.6.1 The SIP/IP DECT Phone is primarily used for creating cordless telephone systems to carry voice and messaging. The system consists of SIP/IP DECT Server System, Base Station and Handset Module.

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3.6.6.2 The SIP/IP DECT Phone shall comply with the following minimum technical specifications:-

Operating System	:	SIP/IP DECT operating system
License	:	Software Assurance License and/or User License
Standard	:	DECT encryption, Generic Access Profile (GAP), SIP, TLS/SRTP
Base Station Features	:	<ul style="list-style-type: none"> i. All SIP/IP DECT channels supported for maximum use of the DECT capacity (120 duplex) ii. 12 channel base station with support for 8 simultaneous voice channels and 4 channels for switching purposes iii. Handover and Roaming support iv. DECT Standard Authentication Algorithm (DSAA) between base and handset v. Integrated SIP/IP DECT dipole antenna vi. Supports Enhanced SIP/IP DECT security
Handset Features	:	<ul style="list-style-type: none"> i. Coloured LCD handset ii. Support LCD back light iii. Polyphonic ringtone iv. Support vibrator v. Duplex hands-free vi. Support headset jack vii. Support G.711 Audio Codec viii. Support G.722 Wide Band Audio Codec ix. Support Local Phonebook (100 entries) x. Support Common Phonebook xi. Support up to 180 hours of standby time xii. Support up to 16 hours of talk time xiii. Support up to 8 narrow band concurrent calls in a Base Station xiv. Support up to 4 wide band concurrent calls in a Base Station

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3.6.7 Digital Phone

3.6.7.1 Digital Phone is a type of telephone line that carries voice and/or data by using digital sampling. By converting analogue signals to digital, these types of telephone line allow for more information to be transferred over a single connection.

3.6.7.2 The Digital Phone shall comply with the following minimum technical specifications:-


Port	:	1 port RJ11
Accessories	:	Cables to connect the Digital Phone <ul style="list-style-type: none"> i. 2 x RJ9 jack for the handset and headset connection ii. RJ11 jack for the cable connectivity
Features	:	<ul style="list-style-type: none"> i. 6 programmable keys ii. 2 lines LCD display iii. Hands-free, Half Duplex iv. Soft keys / LCD prompts v. Support additional key button vi. Message waiting indicator

3.6.8 Single Line Telephone (SLT)

3.6.8.1 SLT is a basic phone, made up of a handset and base with a keypad. Though the Time Division Multiplexing basic SLT is simple, they may allow for additional features as required to suit the user's needs.

3.6.8.2 The SLT shall comply with the following minimum technical specifications:

Port	:	1 port RJ11
Accessories	:	Cables to connect the SLT <ul style="list-style-type: none"> i. 2 x RJ9 jack for the handset and headset connection ii. RJ11 jack for the cable connectivity
Features	:	<ul style="list-style-type: none"> i. Electronic volume control ii. 3-steps ringer selection iii. Timed flash iv. Switchable tone or pulse setting v. Last number redial

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3.7 OPERATOR SYSTEM

3.7.1 Description

3.7.1.1 There are three (3) types of Operator System:

3.7.1.1.1 Basic Operator System

3.7.1.1.2 Call Centre System

3.7.1.1.3 Multimedia Contact Centre System

3.7.2 Basic Operator System

3.7.2.1 The Basic Operator System is primarily used by telephone operator for answering and extending inbound calls, making out-bound calls and general assistance both for the public and internal users. Generally, this system can be configured to three (3) different types of installation:


3.7.2.1.1 Operator console

3.7.2.1.2 PC based

3.7.2.1.3 Operator console and PC based

3.7.2.2 The Basic Operator System shall comply with the following minimum technical specifications:-

Incoming line	:	One (1) dedicated line
Terminal	:	Digital phone, IP phone or soft phone
Operating System	:	Soft phone is supported by Latest Windows or Linux
Software Features	:	<ul style="list-style-type: none"> i. Auto Attendant (direct call, multiple auto-attendants, record greetings, route calls, revert call, to create and edit control scripts using GUI tool) ii. Support Direct Section Selection (DSS) iii. Support a built-in VoIP functionality iv. Screen based operator's application v. Capable of being centralised and distributed across multiple locations

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		vi.	Advanced attendant call handling (keyboard and mouse)
		vii.	Multiple queues (External, Internal, Recall, Emergency etc.) – prioritisation of emergency calls
		viii.	Advanced directory search
		ix.	View users' presence
		x.	Line state and calendar activities
		xi.	Messaging
Features	:	i.	Support Operator Console features
		ii.	8 programmable keys
		iii.	2 lines LCD display
		iv.	Hands-free, Half Duplex
		v.	Soft keys / LCD prompts
		vi.	Support additional key button
		vii.	Message waiting indicator
Storage retention	:	i.	Report
		ii.	Call history
		iii.	Call recording for 7 years
License	:		Software Assurance License and/or User License

3.7.3 Call Centre System

3.7.3.1 The Call Centre System is used by supervisor and agents for answering and extending in-bound calls, making out-bound calls, general assistance both for the public and internal users and able to produce performance report.

3.7.3.2 The **Call Centre System** shall comply with the following minimum technical specifications:-

Incoming line	:	one (1) dedicated line
Terminal	:	Digital phone, IP phone or soft phone
Operating System	:	Latest Windows Server or Linux
Software Features	:	i. Call application run on embedded type server and meet the required Busy Hour Call Attempts (BHCA)

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- ii. Wall board
- iii. Support call tracking and monitoring system for all enquiries
- iv. Support agent module – Access to single view of the customer (include emails, documents, tasks and faxes)
- v. View customer's contact and enquiry history
- vi. Call recording
- vii. Call centre reporting
- viii. Support automation through an Interactive Voice Response (IVR)
- ix. Supervisor features (barging, whisper, eaves drop)

- Features :
- i. Support Operator Console features
 - ii. 8 programmable keys
 - iii. 2 lines LCD display
 - iv. Hands-free, Half Duplex
 - v. Soft keys / LCD prompts
 - vi. Support additional key button
 - vii. Message waiting indicator

- Storage retention :
- i. Report
 - ii. Call history
 - iii. Call recording for 7 years


- Storage recording : Supported file format .wav, .mp3

- License : Software Assurance License and/or User License


3.7.4 Multimedia Contact Centre System

3.7.4.1 Multimedia Contact Centre System is used by supervisor and agents to entertain in-bound / out-bound calls, general assistance both for the public and internal users, OMNI-channel platform (such as email, social-media, fax etc) and able to produce performance report.

3.7.4.2 The Multimedia Contact Centre System shall comply with the following minimum technical specifications:-

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Incoming line	:	one (1) dedicated line
Terminal	:	Digital phone, IP phone or soft phone
Operating System	:	Latest Windows Server or Linux
Software Features	:	<ul style="list-style-type: none"> i. Call application run on embedded type server and meet the required Busy Hour Call Attempts (BHCA) ii. Wall board iii. Support call tracking and monitoring system for all enquiries iv. Support agent module – Access to single view of the customer (include emails, documents, tasks and faxes) v. View customer's contact and enquiry history vi. Call recording vii. Call Centre Realtime Monitoring, Analytics and Reporting viii. Support automation through an Interactive Voice Response (IVR) ix. Supervisor features (barging, whisper, eaves drop) x. Skill-Based Routing with Automatic Call Distribution (ACD) xi. Driven instant messaging and text messaging or communication with a chatbot/callbot. xii. Integration with application such as Customer Relation Management (CRM) system xiii. Flexible Configuration (single site/ multi-site and single-server/ multi-server) xiv. Agent omni-desktop web GUI xv. Supervisor web GUI xvi. Scripting Tools xvii. Open channel Application Programming Interface (API) xviii. 3rd-party Apps and Customs Integrations xix. Auto Disaster recovery

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Features :

- i. Support Operator Console features
- ii. 8 programmable keys
- iii. 2 lines LCD display
- iv. Hands-free, Half Duplex
- v. Soft keys / LCD prompts
- vi. Support additional key button
- vii. Message waiting indicator

Storage retention :

- i. Report
- ii. Call history
- iii. Call recording for 7 years

Storage recording : Supported file format .wav, .mp3
 License : Software Assurance License and/or User License

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4.0 SYSTEM OF CABLING

4.1 DESCRIPTION

These sections describe about the system of cabling for the telecommunication installation.

4.1.1 Fibre To The Premise (FTTP)

4.1.1.1 The FTTP is a form of Fibre optic communication delivery, in which an optical fibre is run in an optical distribution network from the telecommunication service provider all the way to the premises occupied by the subscriber. The FTTP installation shall comply with ITU-T Recommendations in the G.984 series and Fixed Network Facilities - In-Building And External; MCMC MTSFB TC G024 or latest and consists of the following components:


- 4.1.1.1.1 Indoor Fibre Optic Cable
- 4.1.1.1.2 Outdoor Fibre Optic Cable
- 4.1.1.1.3 Overhead Fibre Optic Cable
- 4.1.1.1.4 Fibre Wall Socket
- 4.1.1.1.5 Optical Distribution Frame
- 4.1.1.1.6 Fibre Termination Box

4.1.1.2 The cabling system shall be able to support signal transmission for data, voice and video application. No cable jointing is allowed for the cabling system installation. The minimum bending radius shall be not less than ten (10) times of the overall fibre optic cable diameter.

4.1.2 VoIP System

4.1.2.1 The VoIP system is also known as IP telephony. It is a technology for voice communications and multimedia sessions over Internet Protocol networks. The cabling system shall comply with the Technical Code: MCMC MTSFB TC T03 or latest, JKR Specification for ICT Networking System (L-S38) and consists of the following components:

- 4.1.2.1.1 Singlemode Fibre Optic Cable - Outdoor
- 4.1.2.1.2 Singlemode Fibre Optic Cable - Indoor
- 4.1.2.1.3 Multimode Fibre Optic Cable - Outdoor
- 4.1.2.1.4 Multimode Fibre Optic Cable - Indoor
- 4.1.2.1.5 Fibre Optic Patch Panel Horizontal cabling
- 4.1.2.1.6 Unshielded Twisted Pair (UTP) Copper Cable

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- 4.1.2.1.7 Shielded Twisted Pair (STP) Copper Cable
- 4.1.2.1.8 Singlemode Pigtail, Adapter and Patch Cord
- 4.1.2.1.9 Multimode Pigtail, Adapter and Patch Cord
- 4.1.2.1.10 Fibre Optic Cable Splicing Cassette
- 4.1.2.1.11 RJ45 Modular Jack
- 4.1.2.1.12 RJ45 Patch Panel
- 4.1.2.1.13 RJ45 Patch Cord

4.1.3 Analogue / Digital Telephone System

4.1.3.1 The Analogue / Digital System is only limited to voice system and the design shall comply with the Technical Code: MTSFB TC T03:2019 or latest and consists of the following components:


- 4.1.3.1.1 Indoor Multipair Telephone Cable
- 4.1.3.1.2 Indoor Jumper Cable
- 4.1.3.1.3 Outdoor Multipair Underground Fully Filled Telephone Cable
- 4.1.3.1.4 Overhead Integrated Barrier Telephone Cable
- 4.1.3.1.5 RJ11 Modular Jack
- 4.1.3.1.6 Distribution Frame
- 4.1.3.1.7 Distribution Point Box
- 4.1.3.1.8 Connection/Disconnection Module
- 4.1.3.1.9 Surge Protective Device (SPD)

4.2 TYPES OF CABLE

4.2.1 Indoor Fibre Optic Cable

4.2.1.1 The Indoor Fibre Optic Cable shall comply with ANSI/TIA-568.3, ISO/IEC 11801-1 and the following minimum technical specifications:-

Fibre Core Count	:	2 cores
Fibre Class	:	Optical Single-mode (OS) 2 type
Core/Cladding Diameter	:	≤ 9 µm / 125 µm
Macro Bending Loss	:	Bend insensitive fibre ≤15mm bending radius
Cable Type	:	Tight Buffer
Jacket Material	:	Low Smoke Zero Halogen (LSZH)
Flame Test Method	:	IEC60332-3, IEC60754-2, IEC61034-2


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Maximum attenuation	:	0.50 dB/km at 1550 nm 0.50 dB/km at 1310 nm
10 Gbps Ethernet distance	:	10km at 1310 nm wavelength
10 GbE cable distance	:	Support up to 10km distance with less than 6.2 dB total insertion loss with maximum of 2 connections
25 GbE cable distance	:	Support up to 10km distance with less than 6.7 dB total insertion loss with maximum of 2 connections
40 GbE cable distance	:	Support up to 10km distance with less than 6.7 dB total insertion
100 GbE cable distance	:	Support up to 10km distance with less than 6.3 dB total insertion loss with maximum of 2 connections

4.2.2 Outdoor Fibre Optic Cable

4.2.2.1 The Outdoor Fibre Optic Cable shall comply with ANSI/TIA-568.3-D and ISO/IEC 11801-1 and the following minimum technical specifications:-

Fibre Core Count	:	2 cores
Fibre Class	:	Optical Single-mode (OS) 2 type
Core/Cladding Diameter	:	≤ 9 µm / 125 µm
Cable Type	:	Loose Tube
Jacket Material	:	Polyethylene (PE)
Armoured	:	Corrugated Steel-armoured
Cable Standards	:	ANSI/ICEA S-87-640
Maximum attenuation	:	0.30 dB/km at 1550 nm 0.40 dB/km at 1310 nm
10 Gbps Ethernet distance	:	10km at 1310 nm wavelength
10 GbE cable distance	:	Support up to 10km distance with less than 6.2 dB total insertion loss with maximum of 2 connections
25 GbE cable distance	:	Support up to 10km distance with less than 6.7 dB total insertion

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40 GbE cable distance	:	loss with maximum of 2 connections Support up to 10km distance with less than 6.7 dB total insertion loss with maximum of 2 connections
100 GbE cable distance	:	Support up to 10km distance with less than 6.3 dB total insertion loss with maximum of 2 connections

4.2.3 Overhead Fibre Optic Cable

4.2.3.1 The Overhead Fibre Optic Cable shall comply with ANSI/TIA-568.3, ISO/IEC 11801-1, ITU-T G.652.D and the following minimum technical specifications:-

Fibre Core Count	:	2 cores
Fibre Class	:	Optical Single-mode (OS) 2 type
Core/Cladding diameter	:	9 µm / 125 µm
Cable Type	:	Loose Tube
Jacket Material	:	Low Smoke Zero Halogen (LSZH) and UV Resistance sheath
Strength Member	:	Steel Wire
Cable Standards	:	ITU-T G.657A2
Maximum attenuation	:	0.40 dB/km at 1550 nm 0.50 dB/km at 1310 nm


4.2.4 Structured Cabling System

4.2.4.1 The cabling for VoIP System shall comply with ICT Networking System as specified in JKR Specification for ICT Networking System (L-S38).

4.2.5 Indoor Multipair Telephone Cable for Analogue / Digital Telephone System

4.2.5.1 The Indoor Multipair Telephone Cable is the telephone cables **for vertical and horizontal installation**. The indoor telephone cables shall comply with latest MS 2121 and the following minimum technical specifications:-

Conductor size	:	0.63mm
Insulation	:	Solid Polyethelene

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No of pairs : One (1)
 Insulation Thickness : 0.25mm
 Insulation Resistance : 300 MΩ

4.2.6 Indoor Jumper Cable for Analogue / Digital Telephone System

4.2.6.1 The Indoor Jumper Cable for patching installation between/within distribution frame shall comply with MS 2122 and the following minimum technical specifications:-

Conductor size : 0.50mm
 Insulation : Solid Polyethelene
 No of pairs : One (1)
 Insulation Thickness : 0.20mm
 Insulation Resistance : 300 MΩ

4.2.7 Outdoor Multipair Underground Fully Filled Telephone Cable for Analogue / Digital Telephone System


4.2.7.1 The Outdoor Multipair Underground Telephone Cable used is Fully Filled Unit Twin moisture barrier polyethylene sheathed cable (FF PEUT). The cable shall comprise of solid plain annealed tinned copper conductor PVC insulated, twisted in pairs and shall be PVC sheathed coloured grey. The FF PEUT cable shall comply with MS 2124 and the following minimum technical specifications:-

Conductor size : 0.63mm
 Insulation : Solid Polyethelene
 No of pairs : One (1)
 Insulation Thickness : 0.25mm
 Insulation Resistance : 300 MΩ

4.2.8 Overhead Multipair Integrated Barrier Telephone Cable for Analogue / Digital Telephone System

4.2.8.1 The Overhead Multipair Integrated Barrier Telephone Cable used is Integral Barrier Unit Twin moisture barrier polyethylene sheathed cable (IB PEUT). The IB PEUT cable shall come with steel wire and comply with MS 2123 , MS 2125 and the following minimum technical specifications:-

Conductor size : 0.63mm
 Insulation : Solid polyethylene
 No of pairs : One (1)

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Insulation Thickness : 0.25mm
 Suspension Wire / Strand : Included

4.3 CABLING ACCESSORIES

4.3.1 The Fibre Wall Socket for FTTP shall comply with UL 94 V-0 rating and the following minimum technical specifications:-


Type : Indoor wall mounted
 Port : 1 inlet port, 2 outlet ports
 Material : High-impact type, flame retardant, thermoplastic
 Size : 85mm(H) x 85mm(W)

4.3.2 The Fibre Termination Box (FTB) for FTTP is used to protect and distribute the optical Fibre links in FTTP Networks and shall comply with the following minimum technical specifications:-

Type : Wall mount
 Core Capacity : 4
 Material : Plastic Injection Moulded or thermoplastic and made of fire retardant as specified in UL 94 standards
 Dimension - High Density : 410mm(H) x 350mm(W) x 140mm(D)
 - Premises : 240mm(H) x 220mm(W) x 85mm(D)
 Adaptor : SC/UPC, SC/APC
 Protection Rating : IP55 (Outdoor), IP44 (Indoor) as specified in IEC60529

4.3.3 The Optical Distribution Frame (ODF) for FTTP is a frame used to provide cable interconnections between communication facilities, which integrate Fibre splicing, Fibre termination, Fibre optic adapters & connectors and cable connections together in a single unit. The ODF shall comply with the following minimum technical specifications:-

Type : Wall mount and rack mount come with equipment bonding terminal
 Core Capacity : 72
 Material : Cold-rolled steel and powder coated in light grey (RAL7035)
 Dimension : 800mm(W) x 400mm(D) x 2200mm(H)

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- 4.3.4 Singlemode Pigtail shall comply with ANSI/TIA-568.3-D or latest and ITU-T G.652 or G.657 and the following minimum technical specifications:-

Fibre Class	:	OS 2 type
Core/Cladding Diameter	:	$\leq 9 \mu\text{m}$ / $125 \mu\text{m}$
Connector Type	:	SC
Jacket Material	:	Low Smoke Zero Halogen (LSZH)
Flame Test Method	:	LSZH (IEC60332-3, IEC60754-2, IEC61034-2) or CMR


- 4.3.5 The Cabling Accessories for Structured Cabling System in VoIP System shall comply with ICT Networking System as specified in JKR Specification for ICT Networking System (L-S38).

- 4.3.6 The telephone faceplate for Analogue / Digital Telephone System shall comply with the following minimum technical specifications:-

Type	:	Indoor wall mounted
Port	:	RJ11 Socket - Screw Terminals
	:	RJ45 and Telephone Faceplates – IDC
Material	:	High-impact type, flame retardant, thermoplastic (Urea or Polycarbonate)
Size	:	85mm(H) x 85mm(W)
Contacts	:	Six positions with four contacts (phosphor bronze wire with gold plating and of minimum size 0.45 mm diameter)

- 4.3.7 The distribution frame for Analogue / Digital Telephone System shall comply with the following minimum technical specifications:-

Type	:	Floor standing or wall mounted come with equipment bonding terminal
Terminal block	:	10 pairs type mounted on the back mount frame (Stainless steel type with latches and hole)
	:	Quick slip non-screw and non-solder type
	:	Equipped with plug-in break points to isolate the PABX

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4.3.8 The distribution point box for Analogue / Digital Telephone System shall comply with the following minimum technical specifications: -


Type	:	Wall mounted come with equipment bonding terminal
Material	:	Fabricated from mild steel sheet
Finishing body	:	The box shall be treated with two layers of rust proof primer and finished with another two layers of enamel green paint
	:	The doors and hinges shall be so constructed to prevent sagging and misalignment. Doors shall be able to be opened through – 180 degrees to permit unobstructed access to the inside of the box.

4.3.9 The Connection/Disconnection Module For Analogue / Digital Telephone System shall comply with the following minimum technical specifications: -

Internal diameter of connection wire	:	0.4mm-0.63mm
No. of pair	:	10 Pair
Material	:	Thermoplastic flammability class UL 94 V0

4.3.10 The Surge Protective Device (SPD) for Analogue / Digital Telephone System is a device used on telecommunication systems to protect the insulation and conductors of the system from the damaging effects of surge. The SPD shall comply with the following minimum technical specifications:

Continuous Operating Voltage	:	127V AC / 180V DC
Nominal Discharge current, In	:	5kA per lines
Nominal Current, IL	:	0.25 A
Type of connection	:	Series
Degree of protection	:	IP 10

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5.0 EXTERNAL TELECOMMUNICATION INFRASTRUCTURE

5.1 DESCRIPTION

5.1.1 The External Telecommunication Infrastructure shall meet the specifications as specified in MCMC MTSFB TC G025 or latest while consist of the following component as below:

5.1.1.1 Underground Infrastructure

5.1.1.2 Overhead Infrastructure

5.2 UNDERGROUND INFRASTRUCTURE


5.2.1 Telecommunication Manhole

5.2.1.1 Telecommunication manholes shall be of factory pre-fabricated or Precast concrete type. The typical manhole design, specification, accessories and manhole concrete cover as shown in Figure 5.1, Figure 5.2 and Figure 5.3 in appendix respectively.

5.2.1.2 In-situ manhole is the manhole that is constructed at site and mainly is due to limitation of accessibility to the location such as remote area, hilly, island etc. In-situ manholes shall be constructed with Quality A concrete (cement, sand and aggregate which is 1:2:4) Telecommunication manhole is an opening to a confined space such as a shaft, utility vault, or large vessel.

5.2.1.3 The types and sizes of manhole as shown in Table 5.1 may used for reference only and shall comply with MCMC MTSFB TC G025 and MS 1293 :-

No.	Manhole type	Recommended internal dimension L X W X H (mm)	No. of duct way 100mm diameter	Loading weight (tonne)
1.	Pit	460 X 460 X 760	2	5.0
2.	JB30	850 x 850 x 760	2	22.5
3.	JRC7	1160 x 855 x 850	2	22.5
4.	JC9	1810 x 890 x 1150	4	22.5
5.	JC9C	1960 x 1260 x 1020	4	22.5

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No.	Manhole type	Recommended internal dimension L X W X H (mm)	No. of duct way 100mm diameter	Loading weight (tonne)
6.	R1B	1980 x 1370 x 1830	6	22.5
7.	R2A	3280 x 1500 x 1830	12	22.5
8.	R2A (M)	3740 x 1640 x 2000	16	22.5

Table 5.1: Type and minimum manhole specifications

5.2.1.5 The manhole shall come together with appropriate size of heavy duty concrete cover suitable for manhole type as listed in Table 5.1 and shall comply with latest BS EN 124.

5.2.2 Underground Ducts

Underground ducts are divided into three (3) category as below;

5.2.2.1 Main duct


5.2.2.1.1 The main duct for underground installation is used in two (2) conditions which are open trench or Horizontal Directional Drilling (HDD) method. The typical duct depth specification as Figure 5.4 in Appendix. The minimum technical specifications as below:

For open trench method;

Type : GI Pipe, uPVC, PVC or HDPE
Diameter : 100 mm

For HDD method;

Type : HDPE
Diameter : 100 mm

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5.2.2.1.2 All duct shall be provided in nominal lengths of 6 meter and type of underground duct as below:

i. Galvanised Iron (GI)

The Galvanised Iron (GI) that have been dipped in a protective zinc coating to prevent corrosion and rust shall comply with BS 1387 / MS 863 and the following minimum technical specifications:

Material	:	Galvanised Iron
Wall Thickness	:	5.4 mm
Inner Diameter	:	100 mm
Class	:	B
Pipe End	:	Threaded Cut & Socketed
Application	:	Road crossing, entering the building or hard standing

ii. Unplasticised PVC (uPVC)


The uPVC which means no plasticizer has been added to the PVC compound shall comply with BS 3506 and the following minimum technical specifications:

Material	:	Unplasticised Polyvinyl Chloride (uPVC)
Inner Diameter	:	100 mm
Wall Thickness	:	2.6 ~3.0 mm
Class	:	D
Application	:	Coastal area

iii. PVC

The PVC shall be comply with MS 1034 and the following minimum technical specifications:

Material	:	Polyvinyl Chloride (PVC)
Inner Diameter	:	100mm
Wall Thickness (mm)	:	2.6mm
Application	:	Turfing area

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iv. HDPE

The HDPE ducts are particular suitable for horizontal direct drilling (HDD) applications or trenchless design. HDPE shall comply with MS 1058 and the following minimum technical specification:

Material	:	High Density Polyethylene (HDPE)
Pressure Rating	:	PN10
Inner Diameter	:	100 mm
Wall Thickness	:	8.1~9.1 mm
Application	:	HDD

5.2.2.2 Subduct


The subduct is used to lay multiple cables inside the main duct and to maximize the duct space and protection. The sample of subduct arrangement inside the duct is shown as Figure 5.5 in appendix. The subduct shall comply with the following minimum technical specification:

Material	:	High Density Polyethylene (HDPE) corrugated
Diameter	:	32 mm
Wall Thickness	:	3.0 mm

5.2.2.3 Innerduct

The Innerduct is a flexible fabric system designed specifically for increasing main duct capacity. The unique textile construction allows the innerduct to conform to the shape of cables placed within, greatly reducing wasted space and increasing cable deployment efficiency. Figure 5.6 in Appendix illustrates the innerduct installation. The innerduct shall comply with the following minimum technical specification:

Size	:	50mm x 3-Cell
Cable Diameter	:	≤ 21.6mm

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5.3 OVERHEAD INFRASTRUCTURE


5.3.1 Telecommunication Pole

5.3.1.1 The telecommunication pole is a column to support overhead cable. All poles shall meet the specifications as specified in latest MCMC MTSFB TC G024 and as Figure 5.7 in Appendix.

5.3.1.2 Telecommunication pole shall be installed not more than 50 metre apart interval.

5.3.1.3 The minimum technical specification of pole shall be as specified below:

Type	:	Round Tapered Galvanised Steel Pole or Concrete Pole
Nominal Height	:	6.7m ,7.5m, 9.0m
Top Diameter	:	10cm - 14cm
Bottom Diameter	:	16.7cm - 26cm
Maximum load/point	:	200kg
Maximum total load	:	1,600 kg
Permanent bending load	:	30 %
Minimum bending load	:	224 kg
Embedded Pole Length	:	1150 mm, 1300 mm, 1500 mm
Accessories	:	i. Concrete kicking block as Figure 5.8 in Appendix ii. Stay wire complete with necessary accessories

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6.0 TELECOMMUNICATION EARTHING SYSTEM

6.1 DESCRIPTION

The earthing system for telecommunications to meet basic safety requirements in accordance with the IEC 30129, IEC 60364 and ANSI/TIA-607-C.

6.2 TELECOMMUNICATION EARTHING COMPONENT

6.2.1 General


The generic telecommunications earthing infrastructure originates at the electrical entrance facility earth and extends throughout the building. It includes the following major components:-

- 6.3.1.1 Primary Bonding Bar (PBB)
- 6.3.1.2 Secondary Bonding Bar (SBB)
- 6.3.1.3 Telecommunications Bonding Backbone (TBB)
- 6.3.1.4 Telecommunications Bonding Conductor (TBC)
- 6.3.1.5 Backbone Bonding Conductor (BBC)

6.2.2 Primary Bonding Bar (PBB)

The PBB shall be used as a connection point for telecommunication earthing infrastructure to the electrical main earthing bar and as a central attachment point for the SBB(s). The PBB shall comply with the following minimum technical specifications:-

Dimension	:	50mm (W) x 6mm (Th)
Material	:	Tinned Copper
Others	:	<ul style="list-style-type: none"> i. Bar provided with holes for use with correctly matched cable lug and other accessories ii. Cleaned and antioxidant iii. Earthing terminals or bars mounted on porcelain insulators shall be provided iv. All connections to the PBB shall be soundly made and electrically satisfactory by means of bolts and nuts with spring washers and jam nuts

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Location : Entrance Facility i.e. (Subscriber Distribution Frame, Main TCR, Server Room)

6.2.3 Secondary Bonding Bar (SBB)

The SBB is the earthing connection point for telecommunications systems in the TCR and SDF Room. The SBB shall comply with the following minimum technical specifications:-

Dimension	:	25mm (W) x 6mm (Th)
Material	:	Tinned Copper
Others	:	<ul style="list-style-type: none"> i. Bar provided with holes for use with correctly matched cable lug and other accessories ii. Cleaned and antioxidant iii. Earthing terminals or bars mounted on porcelain insulators shall be provided iv. All connections to the SBB shall be soundly made and electrically satisfactory by means of bolts and nuts with spring washers and jam nuts

6.2.4 Telecommunication Bonding Backbone (TBB)

The TBB is a conductor that connects all SBBs to the PBB. The intended function of a TBB is to reduce or equalise potential differences. The TBB shall be used to interconnect all SBB with the PBB using minimum 25mm x 6mm copper tape.

6.2.5 Telecommunication Bonding Conductor (TBC)


A PBB shall be bonded to the electrical system main earthing bar (MEB) using TBC. The routing of the TBC shall consider the need to minimise both conductor length and the numbers of bends.

The TBC shall be used to connect the PBB to the electrical system MEB using minimum 25mm x 6mm copper tape.

6.2.6 Backbone Bonding Conductor (BBC)

Whenever two or more TBBs are used within a multi-storey building, the TBBs shall be bound together with a Backbone Bonding Conductor (BBC) at the top floor.

The BBC size shall be of 25mm x 6mm copper tape.

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6.2.7 Rack Bonding Conductor (RBC)

The RBC shall be used to connect the Rack Bonding Terminal (RBT) to the SBB using 16mm² PVC green earth wire.

6.2.8 Distribution Point Bonding Conductor (DPBC)

The DPBC shall be used to connect the Distribution Point Box Bonding Terminal (DPBBT) to the SBB using 6mm² PVC green earth wire.

6.3 TELECOMMUNICATION EARTHING SYSTEM INFRASTRUCTURE

6.3.1 Earthing system for telecommunication are applied depending on type of cabling system as follow and shown in Figure 6.1 and Figure 6.2:-

6.3.1.1 Combination ICT and Telephone (Structured Cabling System)

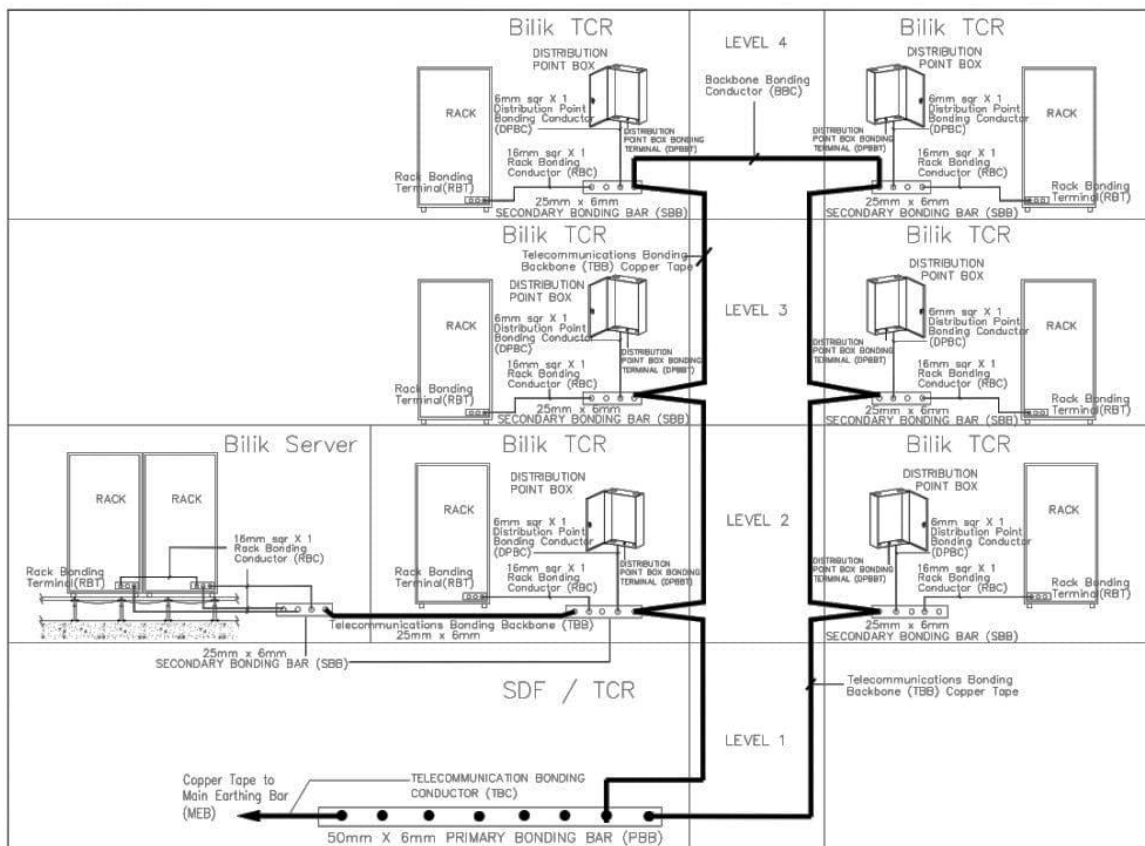



Figure 6.1: Illustrative example of Earthing System for Telecommunications (ICT and Telephone Installation)

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6.3.1.2 Analogue / Digital Telephone System (non-Structured Cabling System)

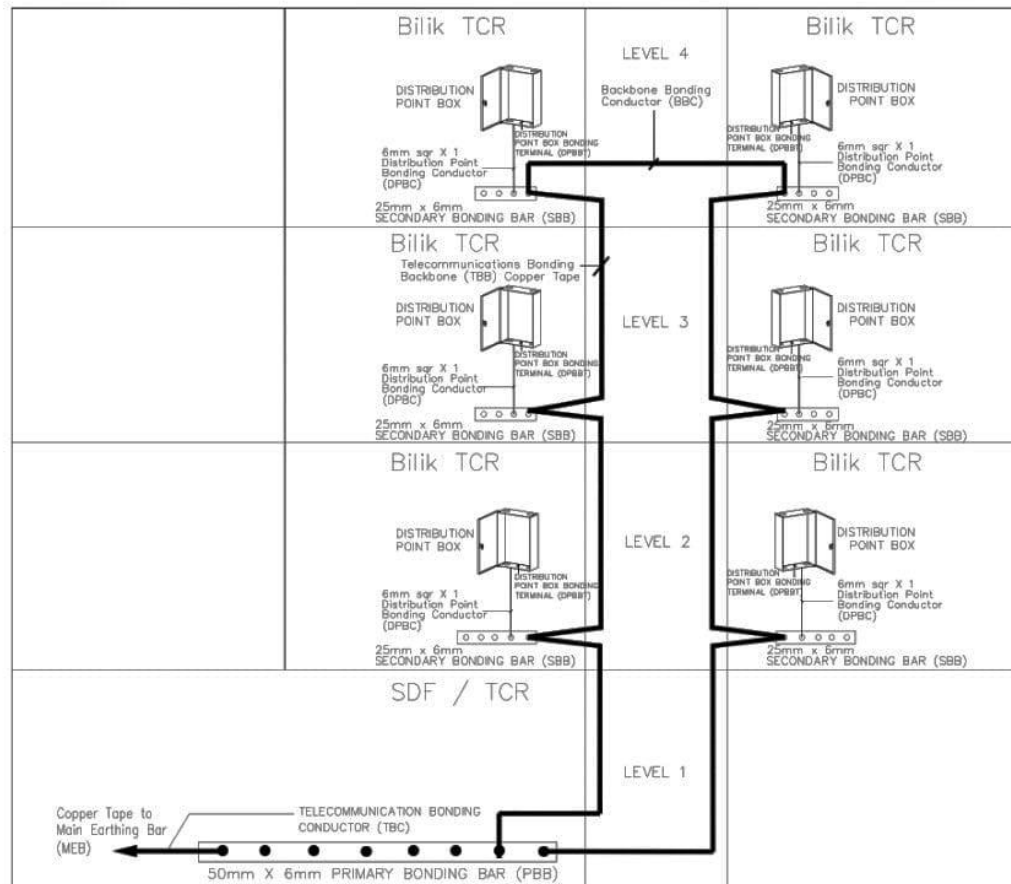



Figure 6.2: Illustrative example of Earthing System for Telecommunications (Telephone Installation only)

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7.0 LABELLING

7.1 DESCRIPTION

7.1.1 Labels shall be fitted on the outside of all optical distribution frames, Fibre termination box ,fibre wall socket, distribution frame, distribution point box etc.

7.1.2 The labels shall allow easy identification of the equipment, heavy duty types, made of durable printed stickers and shall be able to securely tie to the equipment.

7.2 FIBRE TO THE PREMISE

7.2.1 Optical Distribution Frame (ODF)

7.2.1.1 The ODF shall be labelled at top of the ports with the Building Level, FTB Number where the fibre cable originates from and shall be labelled in pairs. For example: if the fibre cable on ports 1-2 and 3-4 originates from Riser Room, Level 1, Block 'A', then the top part shall be labelled "A1.1" as shown in Figure 7.1.

7.2.1.2 The bottom part of the ports on the Fibre Optic Patch Panel (FOPP) in the same rack shall be labelled continuously, in sequence. For example: For FOPP #1 shall have alphabet 'A' and has port numbers from 1, 2 and so on (based on port capacity) then FOPP #2 shall have alphabet 'B' and has port numbers 1, 2 and so on.

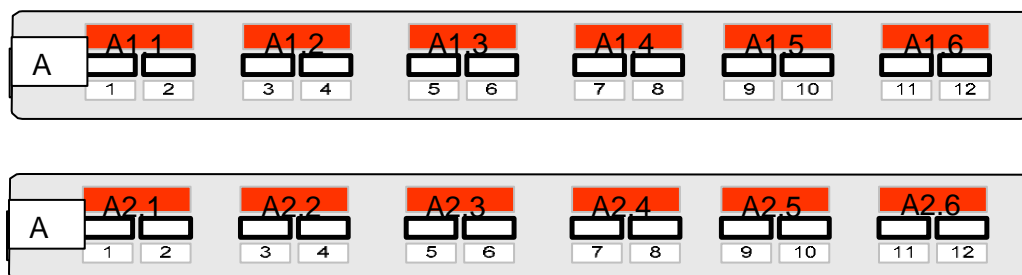



Figure 7.1: Labelling Convention Fibre Patch Panel at Server Room

Where,

- "A" represent Building Name/Code
- "A1" represent floor level fibre patch panel
- "A1.1" represent port for fibre patch cord termination

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7.2.2 Fibre Termination Box (FTB)

7.2.2.1 The FTB shall be labeled at outgoing of the ports with the Building Level, FWS Number where the fibre cable originates from and shall be labelled in pairs. For example: if the fibre cable from FTB on ports 9-10 and 11-12 originates from Block 'A', Level 2, the FWS port at the top part shall be labelled "A2.5" and "A2.6" as shown in Figure 7.2.

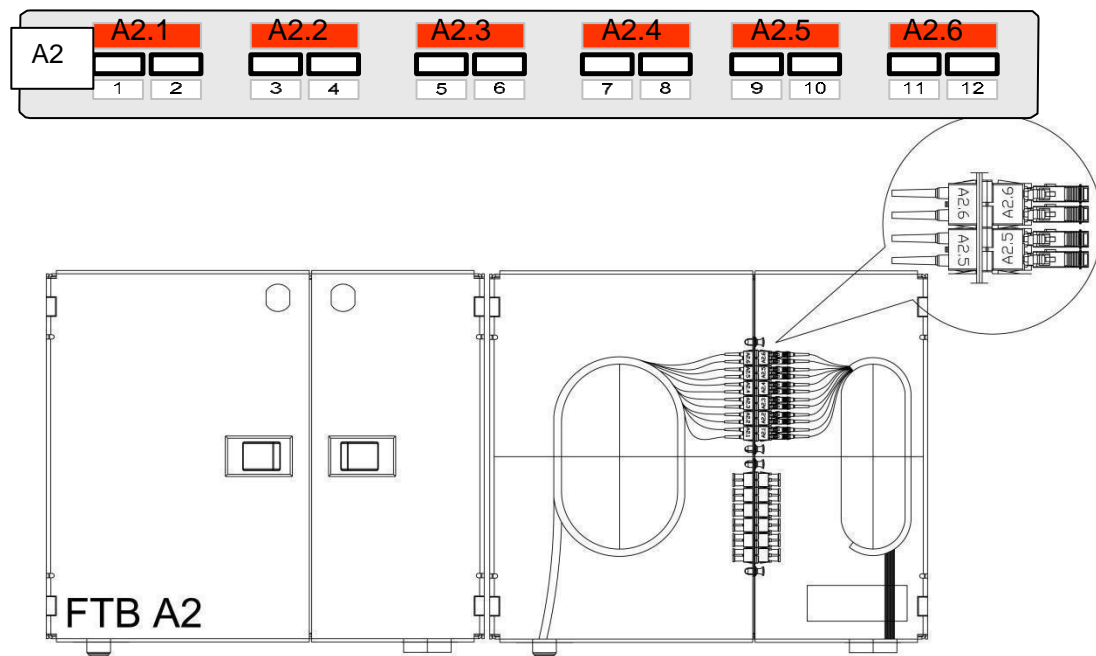



Figure 7.2: Labelling Convention Fibre Termination Box

Where,

- "A" represent Building Name/Code
- "A2" represent floor level fibre patch panel
- "A2.5" represent port for fibre patch cord termination

7.2.3 Fibre Wall Socket

7.2.3.1 The Fibre Wall Socket shall be named and labelled according to a specific labelling convention that allows easy identification of the structured cabling including type and location.

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7.2.3.2 The **Fibre Wall Socket** Convention is shown as Figure 7.3:-

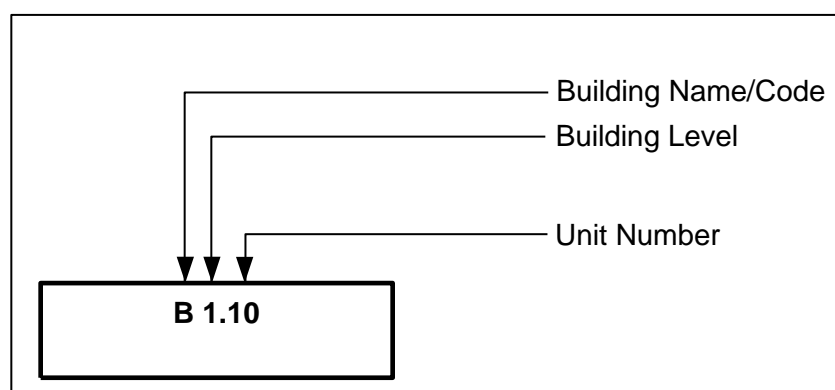


Figure 7.3: Labelling Convention for Fibre Wall Socket

Where,

- “B” represent Building Name/Code
- “1” represent Building Level
- “10” represent Unit Number

7.3 ANALOGUE / DIGITAL TELEPHONE SYSTEM

7.3.1 Distribution Frame and Distribution Point Box

7.3.1.1 All distribution frame and distribution point box shall be named and labelled according to a specific labelling convention that allows easy identification of the equipment including type and location.

7.3.1.2 The distribution frame and distribution point box labelling convention as shown in Figure 7.4 and Figure 7.5:-

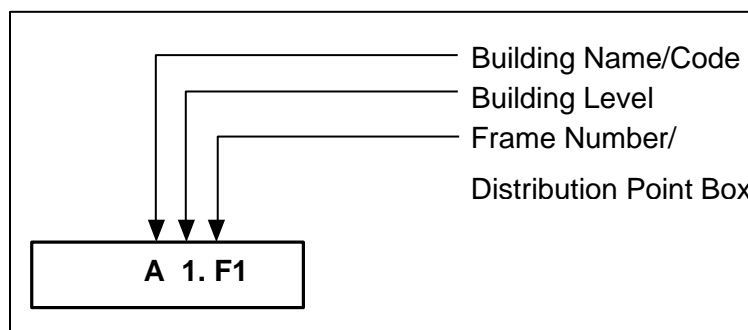



Figure 7.4: Labelling Convention for distribution frame and distribution point box

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Where,

- “A” represent Building Name/Code
- “1” represent Building Level
- “F1” represent Frame number 1

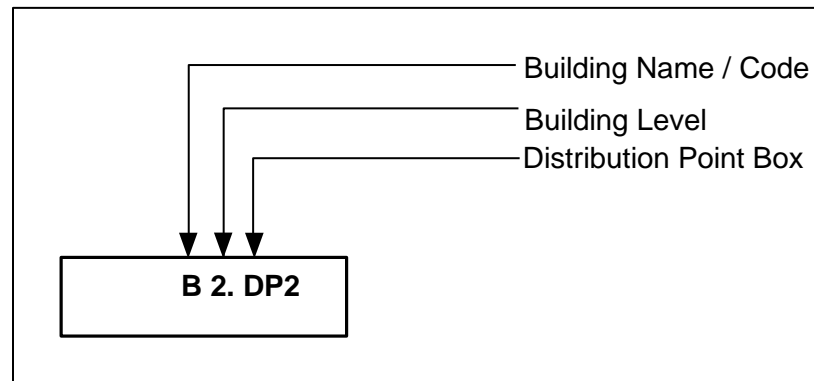


Figure 7.5: Labelling Convention for distribution frame and distribution point box

Where,

- “B” represent Building Name/Code
- “2” represent Building Level
- “DP2” represent Distribution Point Box number 2

7.4 IP PBX AND OTHER EQUIPMENT LABELLING

7.4.1 The IP PBX and other equipment as listed in Table 7.1 shall be named and labelled according to the specific labelling convention that allows easy identification of the equipment including type and location.

7.4.2 The IP PBX and other equipment labelling convention as shown in Figure 7.6 and Figure 7.7:

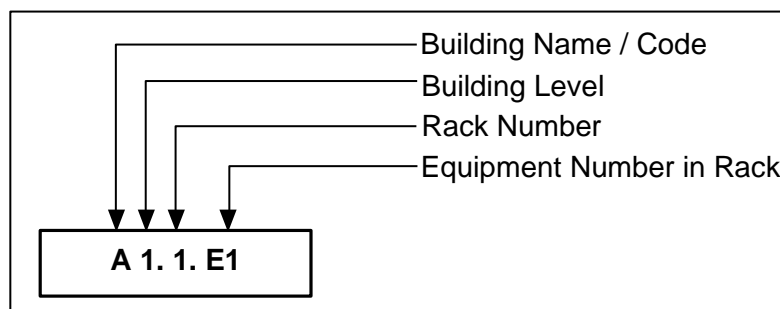



Figure 7.6: Labelling Convention for IP PBX and other equipment

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Where,

- “A” represent Building Name/Code
- “1” represent Building Level
- “1” represent Rack Number 1
- “E1” represents Equipment Name Number 1 in rack as in Table 7.1.

EXAMPLE:

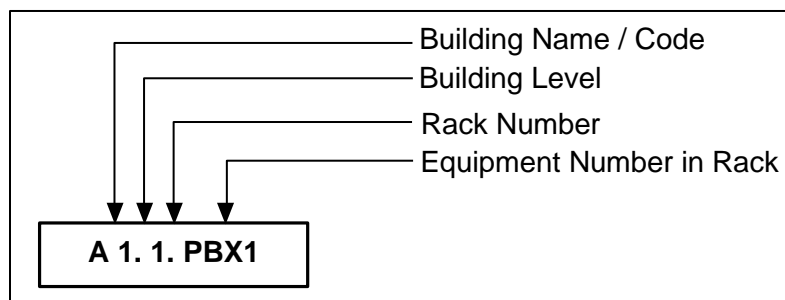



Figure 7.7: Labelling Convention for IP PBX and other equipment

Where,

- “A” represent Building Name/Code
- “1” represent Building Level
- “1” represent Rack Number 1
- “PBX1” represent Equipment Name Number 1 in rack as in Table 7.1.

Bil.	Equipment Name	Equipment Labelling
1.	IP PBX	PBX
2.	Hybrid PABX	PABX
3.	Session Border Controller	SBC
4.	SIP Gateway	SIP_G
5.	Analogue VoIP Gateway	A_VoIP_G
6.	ISDN Media Gateway	ISDN_G

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Bil.	Equipment Name	Equipment Labelling
7.	SIP Phone	SIP_P
8.	SIP/w Phone	SIPw_P
9.	IP Phone	IP_P
10.	DECT Phone	DECT_P
11.	Digital Phone	DGT_P
12.	Single Line Phone	SL_P
13.	Call Centre	Call_Ctr
14.	Operator Console	Op_C
15.	Contact Centre	Con_Ctr

Table 7.1: Equipment Labelling

7.5 VOICE FACEPLATES LABELLING

7.5.1 The Voice faceplates shall be named and labelled according to a specific labelling convention that allows easy identification of the structured cabling including type and location.

7.5.2 The Voice Faceplates Labelling Convention as shown in Figure 7.8:

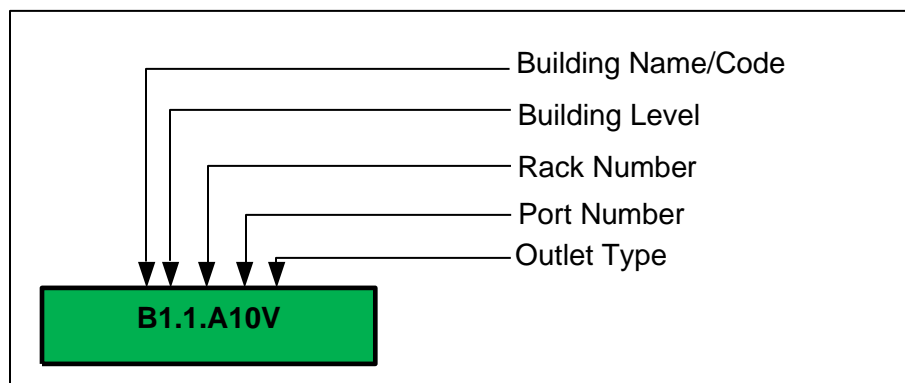




Figure 7.8: Labelling Convention for Voice Faceplate

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Where,

- “B” represent Building Name/Code
- “1” represent Building Level
- “1” represent Rack Number 1
- “A10” represent Port Number 10 on patch panel A
- “V” represent Outlet Type for Voice Outlet
- “Green Colour” represent colour for voice

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8.0 TESTING AND COMMISSIONING

8.1 DESCRIPTION

- 8.1.1 After the installation has been completed and before the Certification of Practical Completion is issued, the whole Telephone system shall be tested for compliance, performance and manufacturer's and/or local authority testing and commissioning guidelines.
- 8.1.2 The S.O and/or S.O's Representatives reserves the right to be present at all tests and The Contractor shall give at least one (1) week notice in writing to the S.O and/or S.O's Representative for this purpose. In any case, no test shall be carried out without prior approval of the S.O and/or S.O's Representative.
- 8.1.3 The contractor responsible for the work shall arrange with S.O and/or S.O's Representatives and TELCO for a final inspection and testing. If the installation is not satisfied, the contractor shall rectify all the defects and arrange for another final inspection and testing. The contractor shall forward the Certificate of Acceptance (CoA) to the S.O and/or S.O's Representative for record.

8.2 TELEPHONE SYSTEM TEST

- 8.2.1 The Contractor shall arrange with the Certified Engineer registered with the equipment's manufacturer to conduct and carry out the work of testing and commissioning of the Telephone System.
- 8.2.2 The tests to be carried out where applicable, shall consist of the following procedure or method and shall according to the equipment manufacturer's warranty and as per stated in Inspection Test Plan (ITP) provided by The Contractor and agreed by S.O and/or S.O's Representative.
- 8.2.2.1 **Visual inspection** to ensure the telephone equipment shall be properly mounted/installed according to the manual, free from dust, physically in good condition without any scratch or crack.
- 8.2.2.2 **Configuration test** to check;
- The basic calls for audio standard quality
 - Caller ID (CLID) and Calling Name (CNAM) Presentation
 - Call Forward, Dual Tone Multi-Frequency (DTMF) Tests

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- iv. Voicemail
- v. Network redundancy (if applicable)
- vi. Auto attendant
- vii. Audio conferencing
- viii. Call hold
- ix. Call transfer
- x. Session refresh
- xi. Fax

8.2.2.3 **Functionality and stress test** to ensure the equipment/system meets the functional requirement and the performances specified;

- i. Maximum call at one time during busy hour
- ii. Extension to extension test
- iii. Outgoing call from extension
- iv. Incoming call from Public Branch Exchange (PBX)
- v. Basic features system facilities
- vi. Power failure/ battery back-up test
- vii. System integration (Eg. Call billing, auto attendant)

8.2.2.4 **Security Test** to ensure the equipment and/or system meets the security requirement.


- i. PBX secure login system
- ii. Voice security test

8.2.2.5 **User Acceptance Test** with the present of S.O and/or S.O's Representative and Client's Representative.

8.3 EXTERNAL MANHOLE AND DUCTING TEST

8.3.1 The contractor shall ensure all duct lines cleaned and tested. The tests to be carried out are:-

- 8.3.1.1 Mandrel test
- 8.3.1.2 Alignment test
- 8.3.1.3 Blowing test for HDD installation

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9.0 WARRANTY AND SUPPORT

9.1 DESCRIPTION

- 9.1.1 During the Defects Liability Period (DLP), the Contractor shall be responsible for the warranty and support for the complete installation. All works shall be carried out by a competent person. All labour, materials, tools and parts necessary to rectify the defect due to manufacturing or installation faults shall be supplied and executed at the Contractor's cost.

9.2 WARRANTY

- 9.2.1 The contractor shall guarantee the installations; equipment, application system and software are free from defective or faulty design, manufacture fabrication and installation work after DLP as specified in the Contract.
- 9.2.2 All information technology-based systems and all interfacing, integration and connection systems shall be free from software error.

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10.0 SHOP DRAWINGS AND AS-BUILT DOCUMENTS

10.1 SHOP DRAWINGS

10.1.1 Two sets of prints of shop drawings for construction and/or installation shall be submitted to the S.O's Representative for approval. The Contractor shall prepare and submit shop drawings for the whole work or parts of the work at least two weeks before the work begins. If the shop drawings submitted are not acceptable by the S.O's Representative, the Contractor shall amend and re-submit the shop drawings within two weeks from the date of return of the shop drawings. No work shall be carried out without the shop drawings being approved by the S.O's Representative. The shop drawings shall include and show the following:-


- 10.1.1.1 The dimensioned general arrangements, layouts and positions of equipment, wiring accessories such as voice point faceplate, equipment racks and all others necessary for the complete installations as specified in the Drawings and/or Bill of Quantities;
- 10.1.1.2 The dimensioned layouts and positions of all holes and cutthrough in the walls and floors for the horizontal dan backbone cabling;
- 10.1.1.3 The dimensioned general arrangements, layouts, routes and positions of all horizontal dan backbone cabling;
- 10.1.1.4 Cable routes for all cables laid underground, in ducts and trenches;
- 10.1.1.5 The dimensioned general arrangements and layout of earthing system including routes for earthing conductors and positions of earth electrodes;
- 10.1.1.6 Schematic drawings, network topology, VLAN and IP-address topology;
- 10.1.1.7 Rack population drawing.

10.2 AS-BUILT DOCUMENTS

10.2.1 As-Built documents shall consist of but not limited to the As-Installed drawings, manuals, certificates, catalogues, inventories, and parts lists.


10.2.2 The As-Installed drawings or documents shall comprise of: -

- 10.2.2.1 Site plan & cable routes;


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- 10.2.2.2 System schematic diagram;
- 10.2.2.3 Layout plan (trunking/ conduit route and location of voice points);
- 10.2.2.4 Earthing system;
- 10.2.2.5 Rack population and arrangement of equipment in TCR;
- 10.2.2.6 Setting parameters and configurations on each related equipment;
- 10.2.3.7 Source code of the application systems or software developed;
- 10.2.2.8 Test result on cabling system and each related equipment;
- 10.2.2.9 Checklist or format reporting flow during Defect & Liability Period;
- 10.2.2.10 The certificate of warranty from cable manufacturer and equipment;
- 10.2.3 If the drawings or documents submitted are not according to the actual installation at site and/or not acceptable to the S.O's Representative, the Contractor shall amend and re-submit the drawings or documents within two weeks from the date of return of the drawings or documents.
- 10.2.4 The manuals shall comprise of: -
 - 10.3.1.1 Installation manual.
 - 10.3.1.2 Operation manual, Service and Maintenance manual.
 - 10.3.1.3 Parts list, product data, catalogue and product test certificates.
- 10.2.5 The certified softcopy of As-Built documents shall be compiled on web-based format. The hardcopy of As-Built document shall be labelled at the lower right-hand corner with the Contractor's name and address, date of commissioning, document number (the document number to be obtained from the S.O's Representative), title and following particulars: -

JABATAN KERJA RAYA
 CAWANGAN KEJURUTERAAN ELEKTRIK
 CONTRACT NO.:

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- 10.2.6 Each of the As-Built documents shall be bound together with hard cover and submitted in minimum four (4) sets upon issuance of Certificate of Practical Completion of the project.
- 10.2.7 In addition, one set of the As-Installed drawing shall be submitted in the form of tracing/original document, and four sets in CD ROM.
- 10.2.8 The cost of all these documents, prints, manuals, tools etc. are deemed to be included in the Contract.

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11.0 APPENDIX

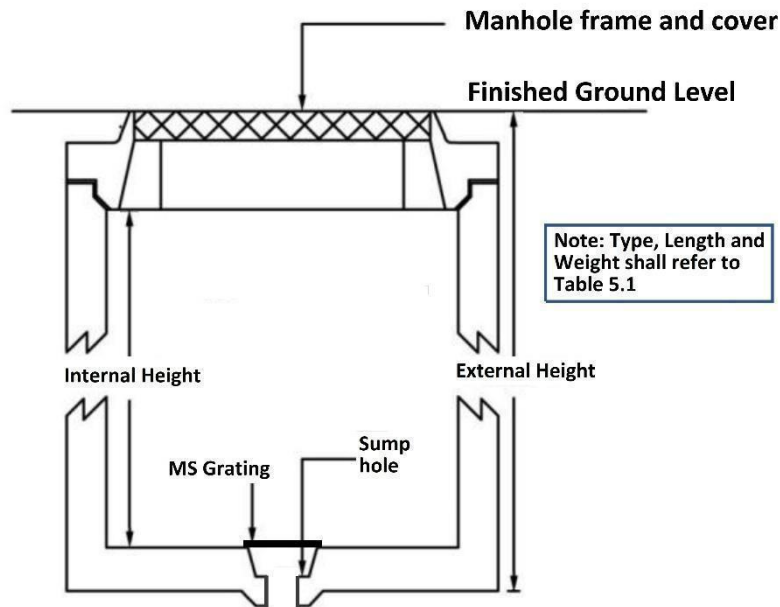



Figure 5.1: Typical Manhole design and specification

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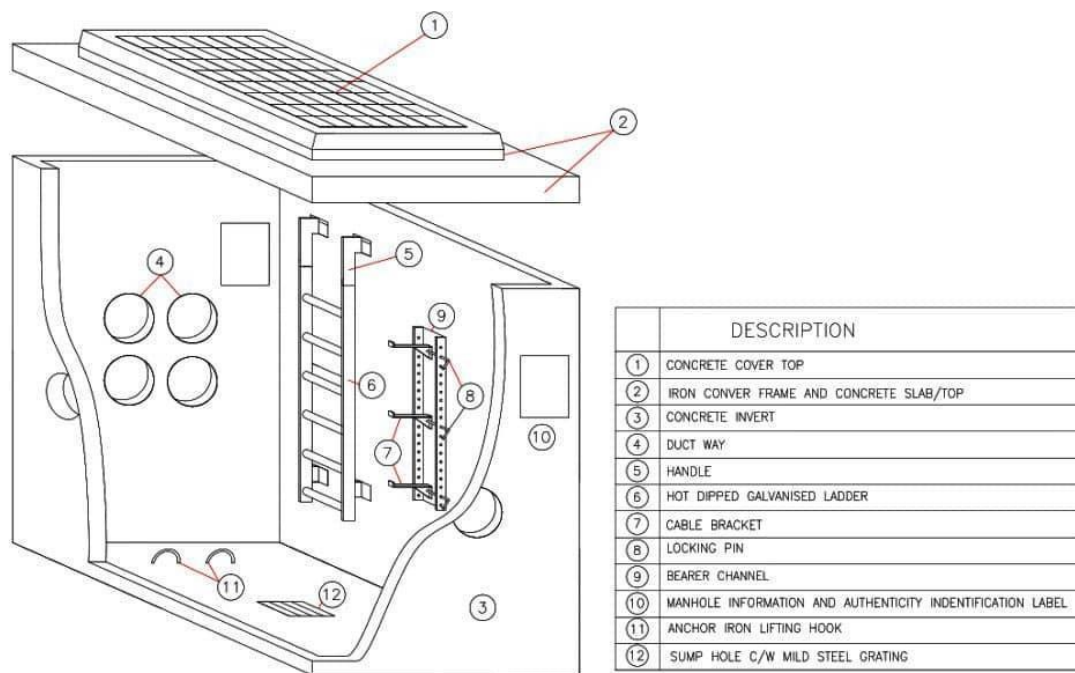


Figure 5.2: Typical manhole design and accessories for R1B, R2A and R2A(M)



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Figure 5.3 : Typical manhole cover using concrete

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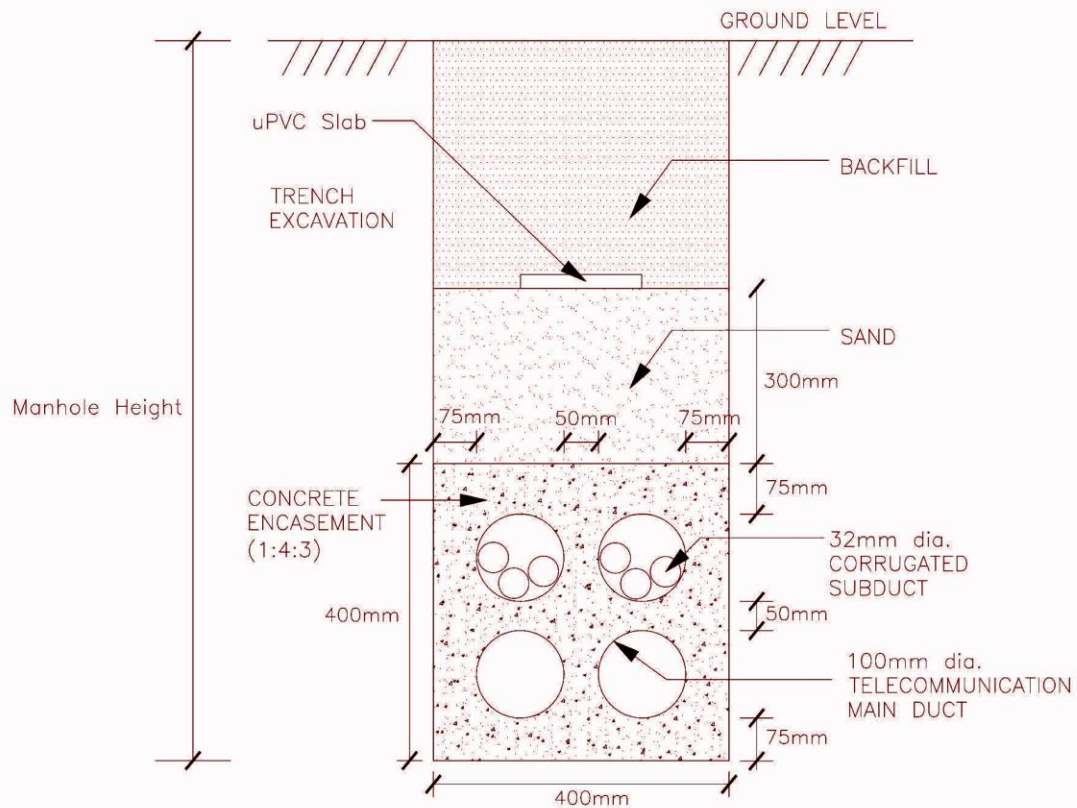



Figure 5.4 : Typical Duct Depth Specification

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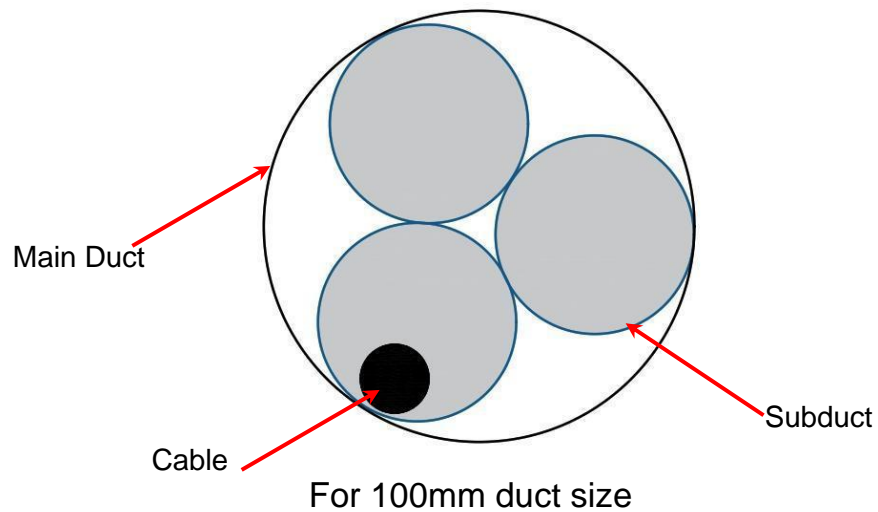



Figure 5.5: Duct category

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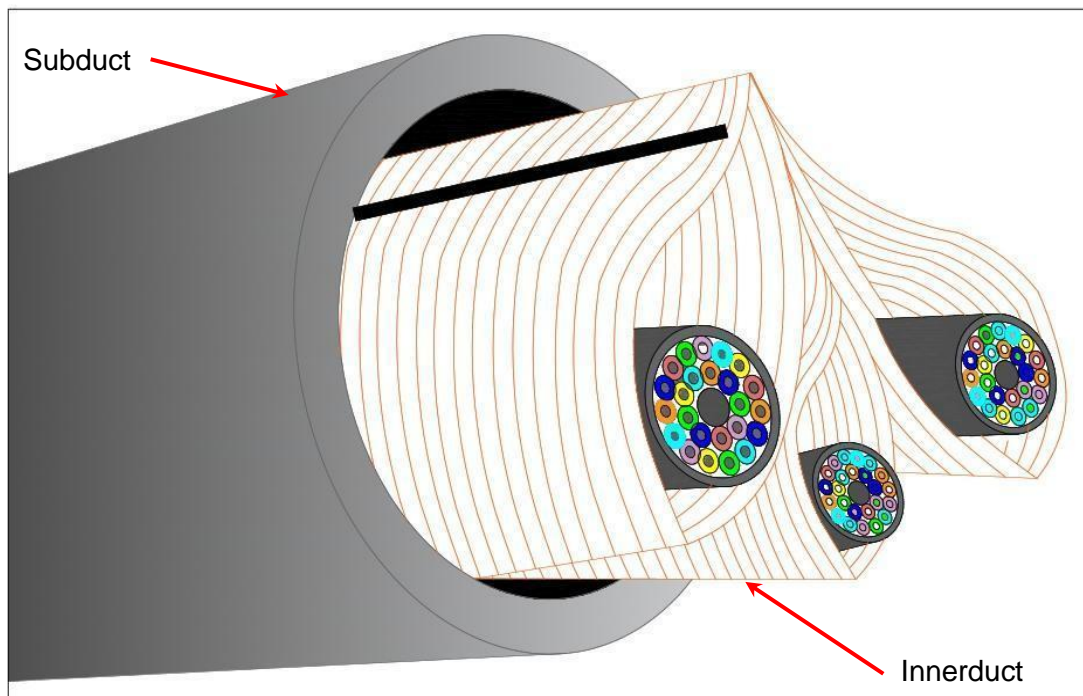

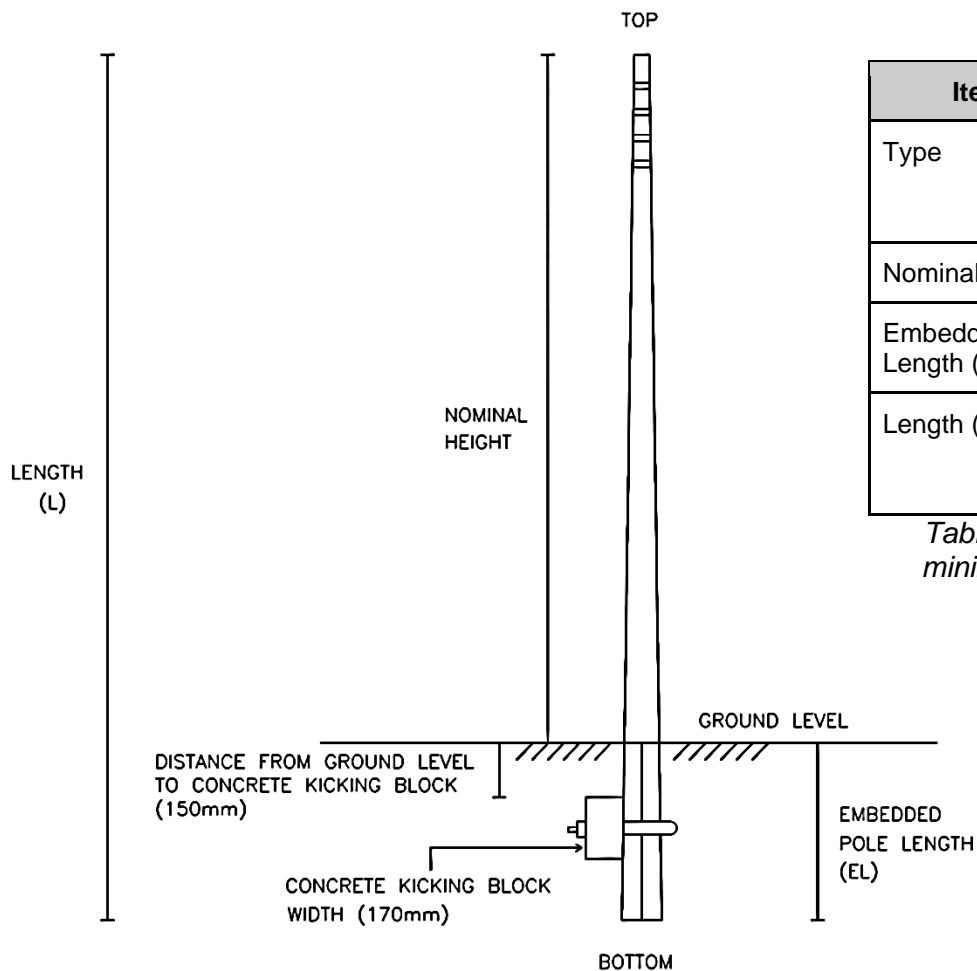


Figure 5.6: Innerduct category


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Item	Requirement
Type	Round Tapered Galvanised Steel or Concrete
Nominal Height	6.7m, 7.5m, 9.0m
Embedded Pole Length (EL)	1150mm, 1300 mm, 1500 mm
Length (L)	Nominal Height + Embedded Pole Length

Table 5.2: Requirement and minimum pole specifications

Figure 5.7: Typical telecommunication pole installation

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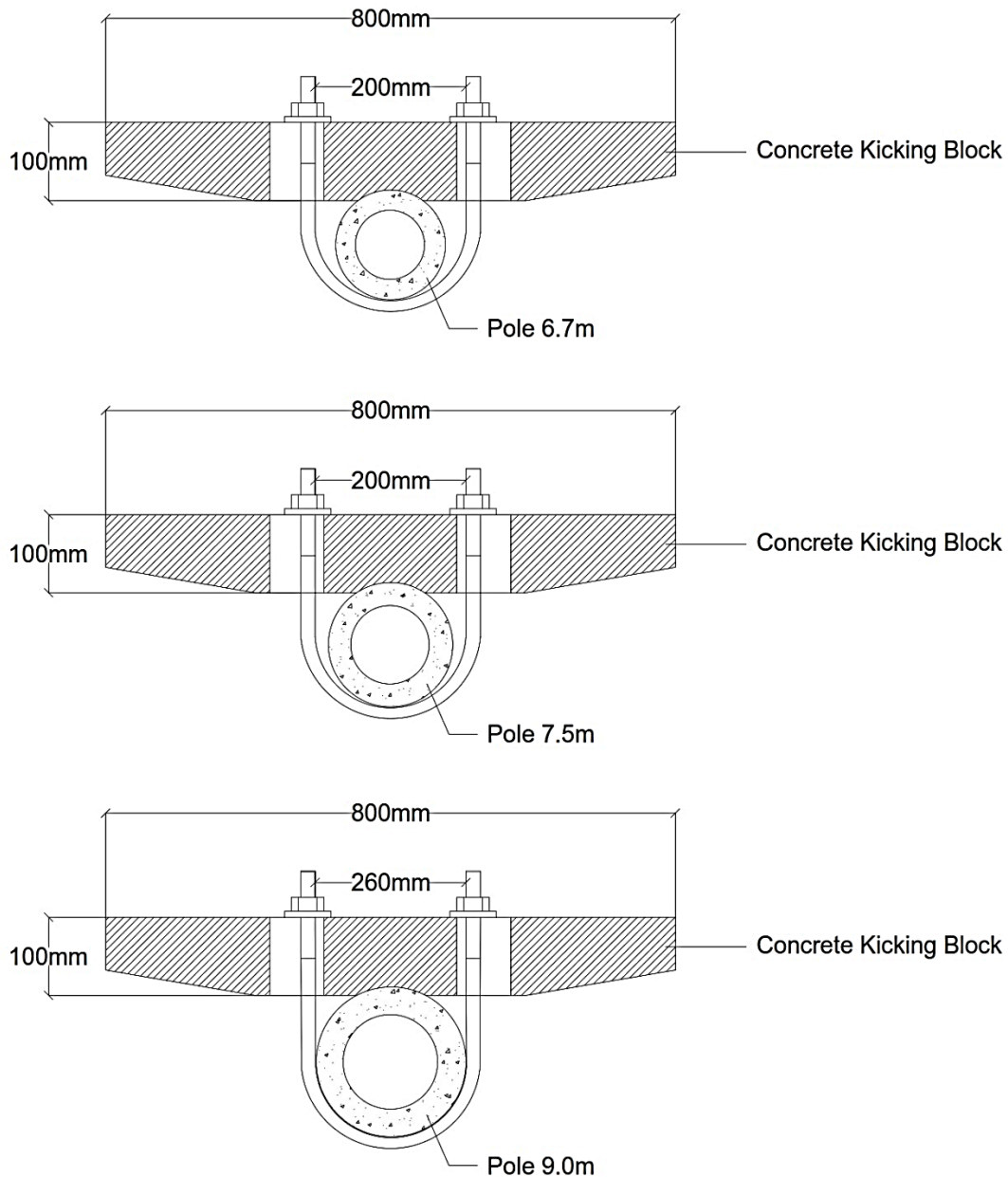




Figure 5.8: Concrete kicking block with accessories

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12.0 LIST OF STANDARDS AND NORMATIVE REFERENCES

12.1 LIST OF STANDARDS


STANDARD	DESCRIPTION
ANSI/TIA-568.0	Generic Telecommunications Cabling for Customer Premises
ANSI/TIA-568.1	Commercial Building Telecommunications Cabling Standard
ANSI/TIA-568.2	Balanced Twisted-Pair Telecommunication Cabling
ANSI/TIA-568.3	Optical Fibre Cabling and Components Standard
ANSI/TIA-607	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
ASTM F2160	Standard Specification for Solid Wall High Density (HDPE) Conduit Based on Controlled Outside Diameter
ASTM D3485	Standard Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit for Preassembled Wire and Cable
BS EN 124:2015	Gully tops and manhole tops for vehicular and pedestrian areas — Design requirements, type testing, marking, quality control
BS 1387:1985	Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads
BS 21	1985 Specification for pipe threads for tubes and fittings where pressure-tight joints
BS 8110	Structural use of concrete
BS 3506	Specification for Unplasticized PVC pipe - For industrial uses
IEC 60364	Electrical Installations for Buildings

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STANDARD	DESCRIPTION
IEC 60332-3	Tests on electric and optical fibre cables under fire conditions - part 3
IEC 60754-2	Test on gases evolved during combustion of materials from cables - part 2
IEC 61034-2	Measurement of smoke density of cables burning under defined conditions - part 2
IEEE 802.3af	Power over Ethernet
IEEE 802.1p/q	Tagging/Priority-QoS at the Data-Link/MAC Sublayer
ISO/IEC 11801-1:2017	Generic Cabling For Customer Premises
ISO/IEC 30129:2015	Information Technology - Telecommunications Bonding Networks for Buildings and Other Structures
ITU-T H.323 (12/2009)	Packet-based multimedia communications systems
ITU-T T.38 (11/2015)	Procedures for real-time Group 3 facsimile communication over IP networks
ITU-T G.652 (11/2016)	Characteristics of a single-mode optical fibre and cable.
ITU-T G.657 (11/2016)	Characteristics of a bending-loss insensitive single-mode optical fibre and cable
ITU-T G.711 (11/1988)	Pulse code modulation (PCM) of voice frequencies
ITU-T G.722 (11/1988)	7 kHz audio-coding within 64 kbit/s
ITU-T G.726 (12/1990)	40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)
ITU-T G.729ab (10/2017)	Reduced complexity 8 kbit/s CS-ACELP codec
ITU-T G.984 (03/2008)	Gigabit-capable passive optical networks (GPON): General Characteristics

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STANDARD	DESCRIPTION
MS 2121:2012	Telecommunication Cable : Plastic twin pair, triple and unit types, internal cable.
MS 2122:2012	Telecommunication Cable : Jumper Cable
MS 2123:2012	Telecommunication Cable : Self-supporting drop wire
MS 2124:2012	Telecommunication Cable : Fully filled, unit twin moisture barrier polyethylene sheathed cable (FF PEUT)
MS 2125:2012	Telecommunication Cable: Integral bearer - Moisture barrier polyethylene sheathed cable (IB PEUT)
MS IEC 60038:2006	IEC standard voltages
MS 863:1983	Welded Steel Tube
MS 1034:2013	Rigid Polyvinyl Chloride (PVC) For Underground Telecommunication Cables
MS 1058:PART 2: 2005	Polyethylene (PE) Piping System for Water Supply – Part 2: Pipes (Fourth Revision)

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12.2 NORMATIVE REFERENCES

The following normative references are indispensable for the application of this specification and technical code as below;


REFERENCE	DESCRIPTION
MCMC MTSFB TC G025:2020	Basic Civil Works – General Requirements
MCMC MTSFB TC G024:2020	Fixed Network Facilities - In Building And External
MCMC MTSFB TC T001:2013	Specification For Terminal Equipment Connecting To The Public Switched Telephone Network (PSTN)
MCMC MTSFB TC T002:2013	Specification For Analogue Calling Line Identity Presentation (A-Clip) Facility For Connection To Public Switched Telephone Network (PSTN)

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13.0 ABBREVIATIONS

For this specification, the following abbreviations and acronyms applies:

AC	Alternating Current
ANSI	American National Standard Institute
ASTM	American Society For Testing and Material
ATA	Analogue Telephone Adapter
BG	Business Gateway
BMT	Bandwidth Management Tool
BS	British Standard
BTU	Bandwidth Termination Unit
CoA	Certificate of Acceptance
CO Trunk	Central Office Trunk
CMR	Communications Multipurpose Cable Riser
DC	Direct Current
DDI	Direct Dialing Inward (Europe)
DHCP	Dynamic Host Configuration Protocol
DID	Direct Inward Dialing
DOMÉ	Direct over Metro-E
DP	Distribution Point Box
DTMF	Dual Tone Multi-Frequency
ER	Equipment Rack
FTB	Fibre Termination Box
FTTP	Fibre to the Premise
FWS	Fibre Wall Socket
FXO	Foreign Exchange Office
FXS	Foreign Exchange Subscriber
GI	Galvanised Iron
GSM	Global System for Mobile Communication
HDPE	High Density Polyethylene
HMR	Header Manipulation Rules
HSBB	High Speed Broadband
IDC	Insulation Displacement Connector
IDD	International Direct Dialing
IDF	Intermediate Distribution Frame
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

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IODF	Incoming Optical Distribution Frame
IP	Internet Protocol
IPME	Internet Protocol Metro Ethernet
ISDN	Integrated Services Digital Network
ISO	International Organisation for Standardisation
ISP	Internet Service Provider
ITU	International Telecommunications Union Standard
LAN	Local Area Network
LTE	Long Term Evolution
MCMC	Malaysian Communications and Multimedia Commission
MDF	Main Distribution Frame
MDP	Main Distribution Point Box
METRO E	Metro Ethernet
MGCP	Media Gateway Control Protocol
MH	Manhole
MPLS	Multi Protocol Label Switching
MS	Malaysian Standards
MTSFB	Malaysian Technical Standards Forum Bhd
NID	Network Interface Device
NPE	Network-Protection Equipment
ONU	Optical Network Unit
OODF	Outgoing Optical Distribution Frame
PABX	Public Automatic Branch Exchange
PBX	Public Branch Exchange
PRI	Primary Rate Interface
PSTN	Public Switched Telephone Network
PVC	Polyvinyl Chloride
RG	Resident Gateway
RJ11	Registered Jack 11
RJ45	Registered Jack 45
SBC	Session Border Controller
SDF	Subscribers Distribution Frame
SIP	Session Initiation Protocol
SKMM	Suruhanjaya Komunikasi dan Multimedia Malaysia
TC	Telecommunication Closet
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TE	Terminal Equipment

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TIA	Telecommunications Industry Association
UDP	User Datagram Protocol
UPE	User-facing Provider Edge
UTP	Unshielded Twisted Pair
VLAN	Virtual Local Area Network
VoIP	Voice Over Internet Protocol
VPN	Virtual Private Network
WAN	Wide Area Network
WAV	Waveform Audio File Format
WDS	Wireless Distribution System
WEP	Wired Equivalent Privacy
WLAN	Wireless Local Area Network
WMM	Wi-Fi Multimedia
WPS	Wi-Fi Protected Setup