3M Telecommunications
Solutions for Networks

Design, Planning and Installation Manual

for Enterprise Networks

3M *Innovation*

Design Planning and Installation

of the

3M Volition™ Cabling System

FOREWORD

This manual provides a comprehensive guide to the design, planning and installation of the 3M Volition Cabling System for fibre and copper. It should be used as a general reference document to supplement the training supplied through one of the 3M approved Volition training courses.

The manual is divided into six parts as described below:

Part 1: Introduction to structured cabling systems

Includes an overview of various network topologies and a brief description of common protocols. Aspects of network design including distributed and centralised architectures are also covered along with an explanation of the various cabling subsystems. Frequent references are made to the IEC/ISO, EN and EIA/TIA structured cabling standards

Parts 2 and 3: Volition fibre and copper cabling systems

Section 1: Design and planning

Most situations that a designer will encounter within a single building are covered. However, no matter how well planned, any proposed cabling system design cannot be guaranteed to be the only solution. For example, different equipment configurations or positioning could result in a more cost effective network implementation. Only through extensive industry knowledge and appropriate training will optimum designs be realised.

Section 2: Installation and testing

Basic information on installing the Volition Cabling System is provided and although some guidelines on safety are included, no attempt has been made to cover all the regulatory and safety issues associated with the system installation. It is the responsibility of the user of this manual to establish the appropriate health and safety practices and to ensure that all relevant regulatory requirements are met.

Most situations that an installer will encounter when installing cable are covered. However, no matter how well planned, a proposed cable pathway or termination space cannot be guaranteed to be fully useful. For example, conduit or trunking planned for a fibre optic cable may have already been used for a much larger copper cable – thereby reducing the space available.

Part 4 Volition copper voice cabling system

Section 1 Design and planning

A number of options related to a single building installation are described. However, different equipment configurations or positioning can affect the cost effectiveness of the final design.

One of the key decisions to be made with regard to the voice cabling system relates to whether it is to be incorporated into the system installed for data.

Electing to install a combined data/voice system places an immediate restriction on the horizontal link length and choice of cable. Although it does offer the user increased flexibility on how he can use the system.

If a centralised fibre network is being installed, 3M recommend the installation of a centralised voice network, as this will provide the most cost effective solution.

Section 2 Installation and testing

Basic information on installing the voice cabling system is provided along with some guidelines on safety, but as in Parts 2 and 3 no attempt has been made to cover all the regulatory and safety issues associated with the system installation. It is the responsibility of the user of this manual to establish the appropriate health and safety practices and to ensure that all relevant regulatory requirements are met.

Part 5:System administration and system warranty

Outlines the requirements for system administration and describes what is covered by the system warranty. Details of how to make an application for a warranty and how additions or alterations to the original system installation can be added to the warranty are also included.

Part 6: System components and glossary

Includes a brief description of all the system components and their specification. The glossary gives definitions of commonly used terms and abbreviations.

Reference Documents

The reader of this manual should be familiar with the latest editions of the following standards and bulletins.

ISO/IEC 11801	*Information technology – Generic cabling for customer premises*
ISO/IEC/TR3 8802-1	*Information technology – Telecommunications and information exchange between systems – local and metropolitan area networks – Specific requirements – Part 1 Overview of Local Area Network Standards*
ISO/IEC/8802-3	*Information technology – Telecommunications and information exchange between systems – local and metropolitan area networks – Specific requirements – Part 3 Carrier sense multiple access with collision detection access method and physical layer specifications*
ISO/IEC 61935-1	*Generic specification for the testing of generic cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling*
IEC 60364-1	*Electrical installation of buildings - Part 1: Scope, object and fundamental principles*
IEC 60950	*Safety of information technology equipment, including electrical business equipment*
EN50173	*Information technology - Generic cabling for customer premises*
EN50174-1	*Information technology – Cabling Installation. Specification and quality assurance.*
EN50174-2	*Information technology – Cabling Installation. Installation planning practices inside buildings*
ANSI/TIA/EIA-568	*Commercial Building Telecommunications Cabling Standard*
ANSI/TIA/EIA569	*Commercial Building Standard for Telecommunications Pathways and Spaces*
TIA/EIA TSB-72	*Centralized Optical Fibre Cabling Guidelines*
TIA/EIA TSB-75	*Additional Horizontal Cabling Practices for Open Offices*
IEEE 802.3	*Local Area Networks: Carrier Sense Multiple Access with Collision Detection CSMA/CD – Ethernet*

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PART 1 INTRODUCTION TO STRUCTURED CABLING SYSTEMS

1.0 Introduction

As the need to link computers together has evolved, so has the physical infrastructure of the cabling. Originally cables were provided as required and networks developed in a random fashion. Today cables are installed in an organised fashion such that the building or floor is flooded with cabling and outlets. The result of this is that wherever the user may need to install a computer or associated peripheral equipment; there will be a connection point close by. This so called flood wiring of buildings has given way to the term 'structured cabling' for which several standards have emerged. The three standards on structured cabling most frequently referred to are:

- ISO/IEC 11801 *Information technology - Cabling for customer premises*
- EN 50173 *Information technology - Generic cabling*
- ANSI/TIA/EIA-568 - C*ommercial Building Telecommunications Cabling Standard*

The 3M Volition Cabling System meets all the requirements of these standards. The following paragraphs give an overview of the different types and structures of cabling systems.

1.1 *Overview*

As defined in ISO/IEC 11801 and EN 50173, generic cabling comprises three cabling subsystems: campus backbone, building backbone and horizontal cabling. The composition of each is defined in paragraph 2.2. The Volition Cabling System covers all three subsystems. Figure 1.1 below shows the structure of generic cabling, whilst Table 1.1 indicates the terminology differences between ANS/TIA/EIA-568 and ISO/IEC 11801.

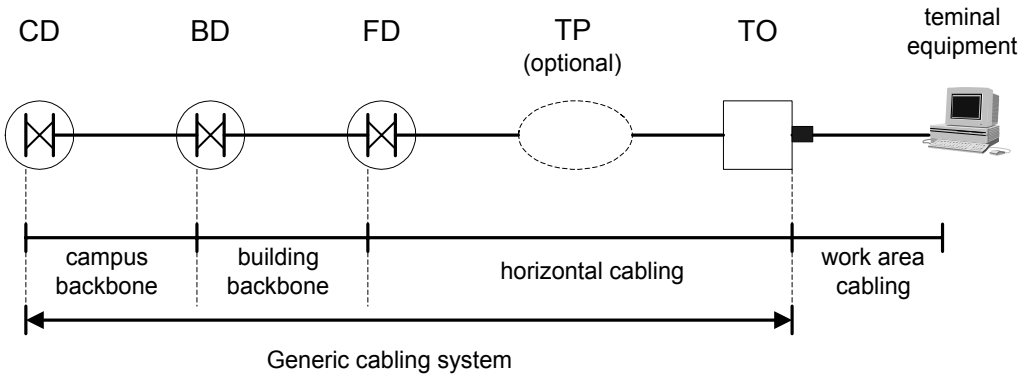


Figure 1.1 Structure of generic cabling

Where: CD Campus Distributor
BD Building Distributor
FD Floor Distributor
TP Transition Point (optional)
TO Telecommunications Outlet
⋈ Cross Connect Point

Table 1.1 Terminology differences

ISO/IEC 11801	ANS/TIA/EIA-568-A
Campus Distributor (CD)	Main Cross Connect (MC)
Building Distributor (BD)	Intermediate Cross Connect (IC)
Floor Distributor (FD)	Horizontal Cross Connect
Transition Point (TP)	Transition Point (TP) or Consolidation Point (CP)
Telecommunications Outlet (TO)	Telecommunications Outlet (TO)

1.1.1 Structure of generic cabling

The generic form of structured cabling takes the form of a hierarchical star, an example of which is shown in Figure 1.2:

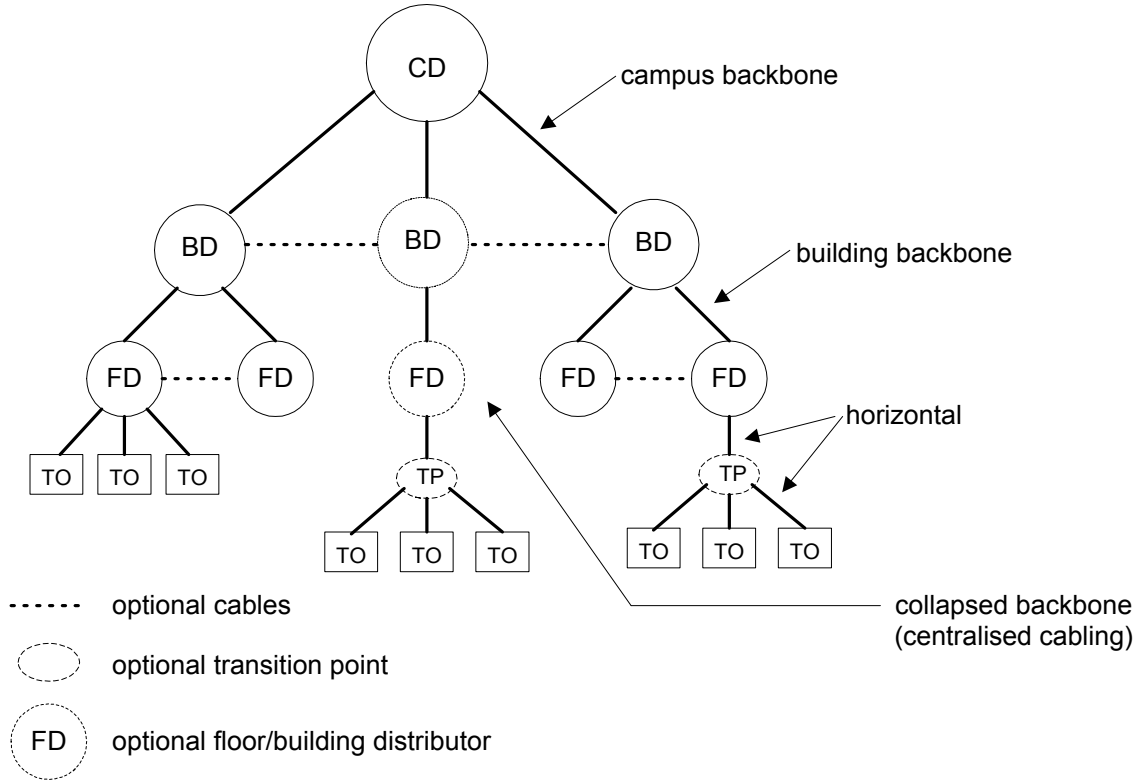


Figure 1.2 Hierarchical structure of generic cabling

The distributors provide the means to deploy the cabling in a particular topology. This is explained in greater detail below.

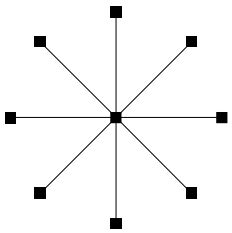
1.1.2 Network topologies

Before discussing network topologies it is important to differentiate between physical and logical topologies.

The physical topology of a network describes the actual route taken by the cable to connect terminals. The logical topology describes the communication link between terminals. Thus it is possible to have a logical ring topology implemented as a physical star installation provided all the design rules associated with the system are followed.

In order to meet the 3M design criteria for the Volition Cabling System, the system must conform to the topology shown in Figure 1.2.

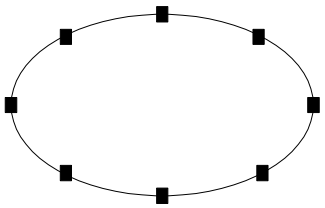
There are two main logical network topologies: Star and Ring, as can be seen in Figures 1.3 and 1.4. The centre of the star is usually the host computer, although often it will be a file server or Multiple Access Unit (MAU). This topology is the more usual form for an Ethernet™ Network, which is documented in IEEE 802.3 (also implemented as ISO/IEC 8802-3).



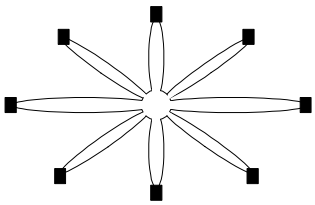
STAR

Figure 1.3 Star network topology

The ring topology is used, as its name suggests, by the IBM Token Ring system, which is documented in IEEE 802.5 (also implemented as ISO/IEC 8802-5). Although it uses a logical ring topology, the physical implementation is usually in the form of a star and will generally be compliant with the generic cabling form shown in Figure 1.2.



RING



LOGICAL RING (PHYSICAL STAR)

Figure 1.4 Ring network topology

1.2 *Network protocols*

Network protocols are used to transport information between locations. At times, several protocols are used simultaneously for this purpose. The passive components of the Volition system will be transparent to the signal protocol being transmitted. The following paragraphs describe some common protocols in use today and indicate where active Volition products are currently available for that protocol.

1.2.1 Ethernet™

Ethernet LAN systems are now almost always implemented with physical bus and physical star topologies. The more popular Ethernet systems have been deployed as 10BaseT, which denotes a 10Mbps baseband LAN delivered over twisted-pair cabling. Ethernet has evolved where switching technology is used and it can now support faster data rates such as 100Mbps and 1000Mbps.
The IEEE 802.3 Systems Networking Guide provides a series of documents that fully document the Ethernet system. Some of these documents are also implemented in ISO/IEC (see ISO/IEC TR3 8802).

The maximum number of nodes and the cabling link lengths for both copper and fibre media are identified in the Ethernet standards. Essentially, the maximum number of nodes and maximum link length (i.e. distance between nodes) of an Ethernet LAN is determined by the characteristics of the transmission equipment and transmission media used.

The entire 3M range of Ethernet network equipment (switches, media converters and network interface cards) conforms to the IEEE and ISO/IEC standards. They operate at 10Mbps, 100Mbps or 1000 Mbps (1Gbps) and are available for rack mounting or for stand-alone use at the workstation.

1.2.2 Token Ring

As its name implies, Token Ring is implemented as a logical ring topology. The transmission on a token ring network relies on the acquisition of a free token prior to transmitting information. Once the free token is acquired, packets of information are then transferred around the ring. Token ring networks typically run at 4, 16 or 100Mbps. As in the case of Ethernet LANs, the IBM Token Ring system is described in both ISO/IEC and IEEE (ISO/IEC 8802-5 and IEEE 802.5).

Although a Token Ring network operates in logical ring format, today it is most commonly implemented as a physical star as shown in Figure 4. The active equipment at the centre of the star is referred to as a Multiple Access Unit (MAU). Once again, the maximum number of nodes and maximum link length (i.e. distance between nodes) is determined by the characteristics of the transmission equipment and transmission media used.

Due to the predominance of Ethernet, 3M no longer supply Token Ring products.

1.2.3 Asynchronous Transfer Mode (ATM)

Conceived as a structural backbone protocol for use within the telecommunications industry, ATM has frequently been adopted for high performance corporate networks. ATM transmits data in fixed length blocks (cells), which is the same form of packet structure used, for example, in Ethernet. However, there are major differences between the two technologies. For example, Ethernet transmission takes place without the need for any prior communication between sending and receiving terminals (sometimes referred to as Packet Mode). A sending station simply sends packets with the address attached in the packet header. ATM communication on the other hand requires a preliminary call set up phase to define the route across the network between transmitting and receiving stations (sometimes referred to as Circuit Mode). Equipment is available to support data rates at 2,048Mbps for low speed wide area network (WAN) applications through to 25Mbps and 155Mbps (STM1) for high-speed LAN applications.

Connection of ATM equipment to a Volition structured cabling system can be made either through equipment supplied with the VF-45™ interface or through use of a hybrid patch cable.

1.2.4 Fibre Channel

The Fibre Channel protocol is specified in ANSI X3T9.3. It is a high-speed scalable serial interface offering data rates from 133Mbps to 1,06Gbps and above. Originally developed to link mainframe computers to peripherals it can also be deployed in both the backbone and the horizontal portion of a LAN.

Fibre Channel has adopted VF-45™ as a recommended interface, which will enable direct connection to a Volition, structured cabling system.

1.2.5 Fibre Distributed Data Interface (FDDI)

Defined by a set of ANSI/ISO standards, this is a 100Mbps timed-token protocol that has a ring structure. FDDI is typically installed with counter-rotating rings to mitigate cabling disasters. For instance, if one ring is severed, the other ring survives to continue the data stream.

As in the case of ATM equipment, connection of FDDI equipment to a Volition structured cabling system can be made either through equipment equipped with the VF-45™ interface or through use of a hybrid patch cable.

1.2.6 xDSL

A generic term given to the Digital Subscriber Line protocols and equipment used to increase the operating speed of the access network. The originating protocol was Asymmetric Digital Subscriber Line (ADSL), a protocol originally specified at 2Mbps to the subscriber's premises and 64kbps back. Subsequent developments worked at higher speeds and are known as HDSL (High bit rate Digital Subscriber Line) and VDSL (Very High bit rate Digital Subscriber Line), which works at 26Mbps to the subscriber and 2Mbps back.

1.2.7 Voice over Internet Protocol (VoIP)

A protocol or standard set aimed at defining the transmission of voice traffic over the Internet. One of the main drivers behind this is the VoIP Forum, a working group formed from industry members that is focused on extending the ITU-T H.323 standard such that equipment from different manufacturers can support voice communications over packet networks.

1.2.8 Universal Serial Bus (USB)

The Universal Serial Bus was originally designed as a more effective method of attaching peripherals to computers. It is designed to meet Microsoft Plug and Play (PnP) specifications meaning users can install and hot swap devices without long installation procedures and re-boots. Up to 127 devices can be connected to and will run simultaneously on the bus.

The USB1 bus operates at 1,5Mbps and 12Mbps, USB2 bus operates at 360Mbps – 480Mbps.

2.0 System architectures

The following paragraphs describe the different architectures that can be used when designing a 3M Volition Cabling System for data.

2.1 Distributed versus centralised cabling architecture

In accordance with the latest standards, two approaches are acceptable. Either the more conventional distributed cabling architecture approach can be used as detailed in paragraph 2.2 1 to 2.2.3 or a centralised cabling architecture (paragraph 2.2.4) can be used where a fibre based system is being installed. The main benefits of using a centralised cabling architecture are:

- Longer link lengths
- More efficient utilisation of equipment ports (see Figure 1.5)
- Elimination of floor distributors
- Elimination of intermediate equipment
- Easier network maintenance

2.1.1 Port utilisation

Figure 1.5 clearly shows the superior equipment port utilisation efficiency of a centralised cabling architecture.

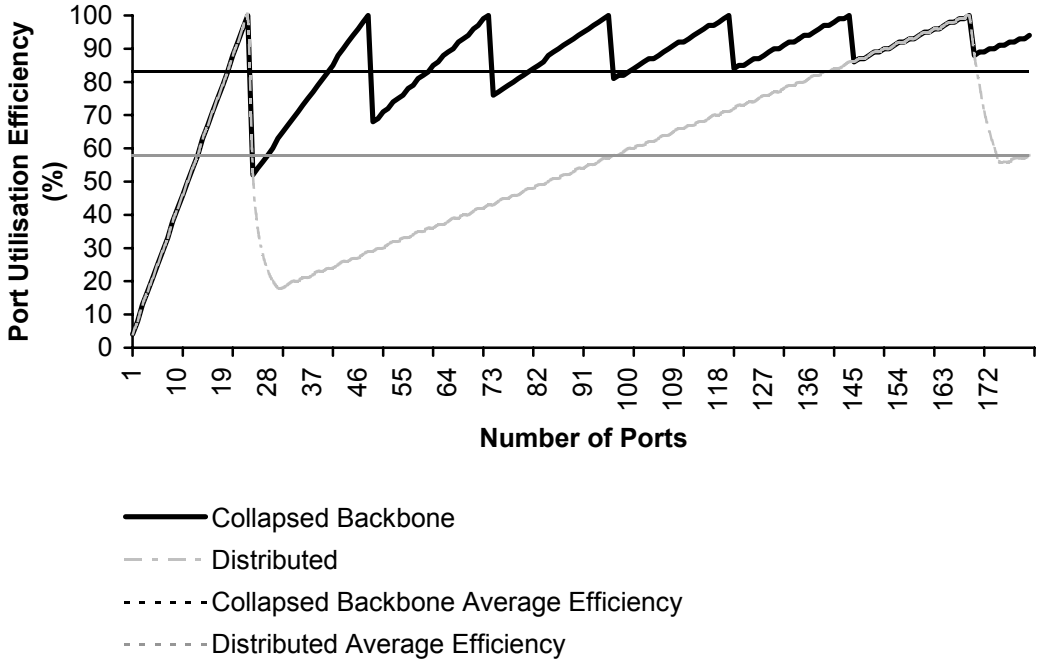


Figure 1.5 Port utilisation efficiency

In this instance it is assumed that the distributed architecture is implemented with six zones. These may be six floors of a building or three floors where the end-to-end run exceeds 100m necessitating two FDs.

With a centralised cabling architecture additional ports are added centrally irrespective of the location of the workstation, the overall effect of this is an average effective utilisation efficiency of 83%. In a distributed cabling architecture ports have to be added within 90m of the workstation. If the growth is random then it is conceivable that six extra ports could entail the addition of six extra twenty-four-port switches. The immediate effect of such a scenario is to reduce the port utilisation efficiency to less than 20%. Overall an average efficiency of just 58% could be expected.

2.1.2 Energy and administration savings

The increased efficiency and simplicity of the administration of moves and changes along with the improved security, and ease of trouble-shooting when the network is controlled from a centralised point is invaluable.

By consolidating the uninterruptible power supplies, electronics and cross connect, into one centralised communications room, not only is the cost of duplicating this equipment in every floor distributor saved, there are also significant additional savings to be gained in both administration and energy costs

2.2 *Cabling systems and subsystems*

In accordance with ISO/IEC 11801, Figures 6 and 7 and the following definitions apply:

2.2.1 Horizontal cabling subsystem

The horizontal cabling subsystem within a building extends from the FD(s) to the TO(s). The subsystem includes the horizontal cables, the termination of the horizontal cables at the FD, the cross connections at the FD and the TO(s). The work area patchcords and the equipment area patchcords are not included as part of the subsystem because they are application specific.

2.2.2 Building backbone cabling subsystem

A building backbone cabling subsystem extends from the BD to the FD(s). The subsystem includes the building backbone cable(s), the termination of the building backbone cables (at both the BD and the FD(s)) and the cross connects at the BD.

2.2.3 Campus cabling subsystem

The campus cabling subsystem extends from the CD to the BD(s) located in separate buildings. It includes the campus backbone cable(s), the termination of the campus backbone cable(s) at both the CD and the BD(s) and the cross connections at the CD.

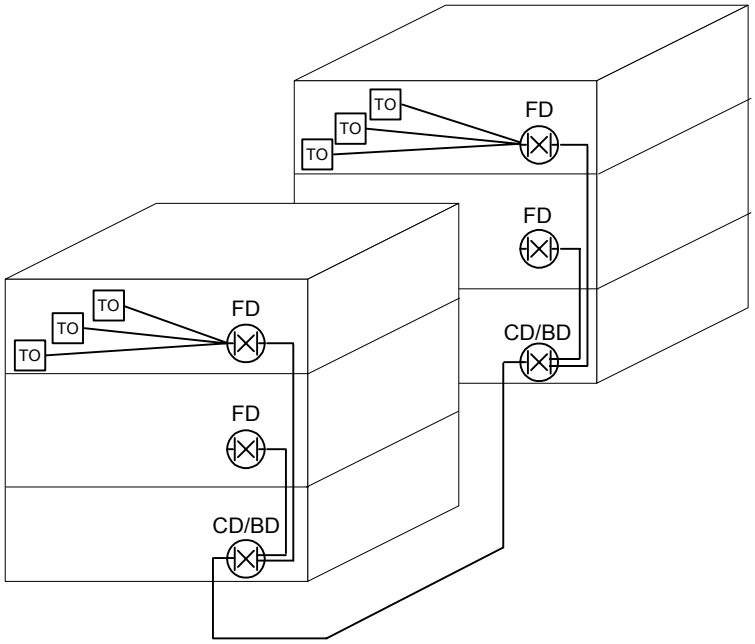


Figure 1.6 Distributed cabling architecture

2.2.4 Centralised cabling architecture

Centralised cabling architecture is shown in Figure 1.7. The cabling system combines the backbone and horizontal cabling subsystems to extend from the CD or BD, which is usually at a central point within the system, to the TO(s). The system includes the campus and building backbone cables (which may be combined as an indoor/outdoor cable), the horizontal cables, the terminations and cross connections at both the CD and/or BD(s) and the terminations at the TO(s).

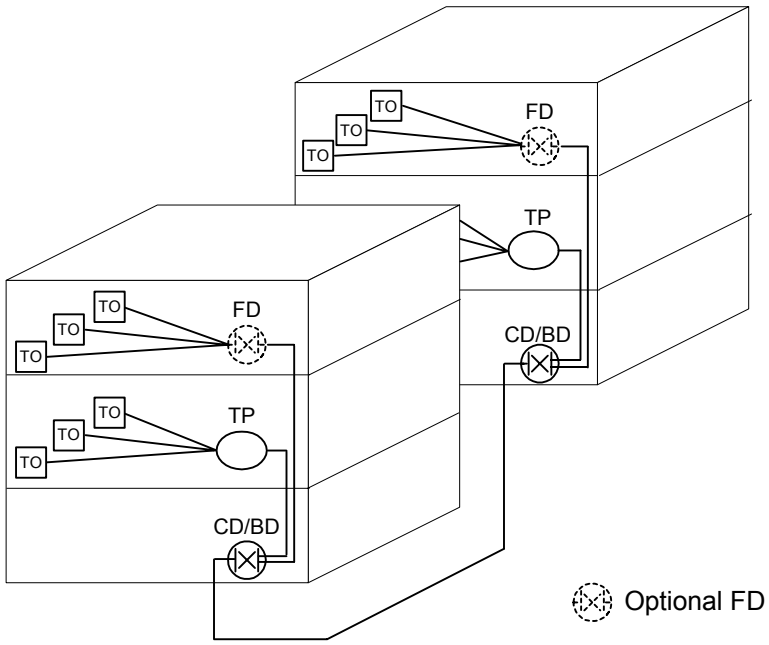


Figure 1.7 Centralised cabling architecture

2.3 *Interfaces to the cabling system*

Interfaces to the cabling system are located at the ends of each subsystem. Electronic equipment applicable to the system can be connected at these points. Figure 1.8 shows potential interfaces at the distributor and the TO.

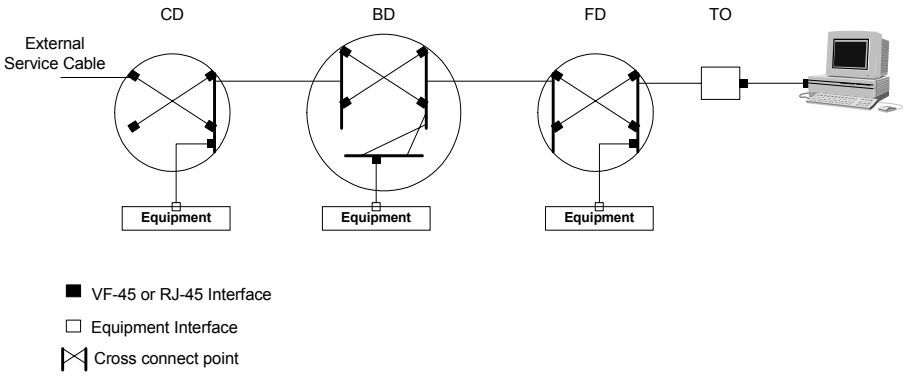


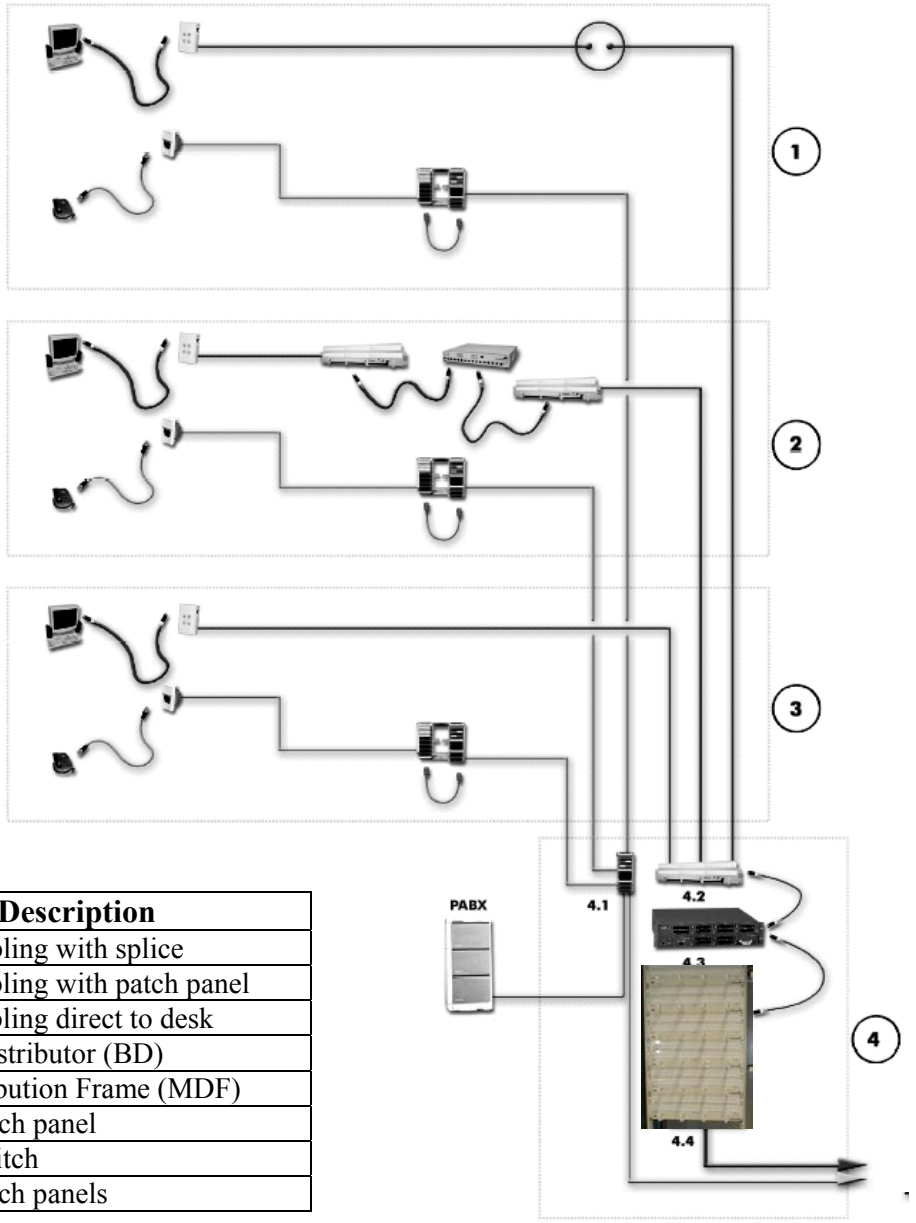
Figure 1.8 Interfaces to the cabling system

N.B. The use of a cross connect is optional at all locations.

2.4 Typical schematic diagrams

The following figures show typical network schematic diagrams with examples of components used.

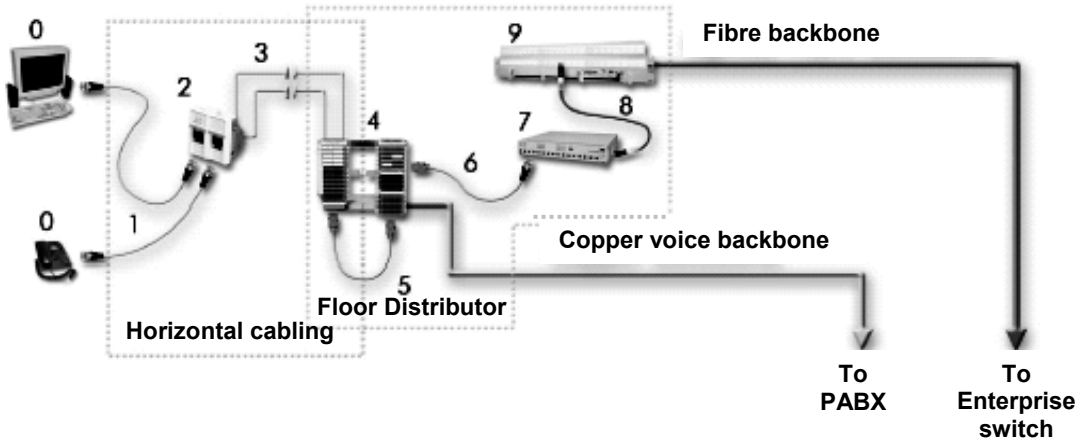
2.4.1 Volition fibre system



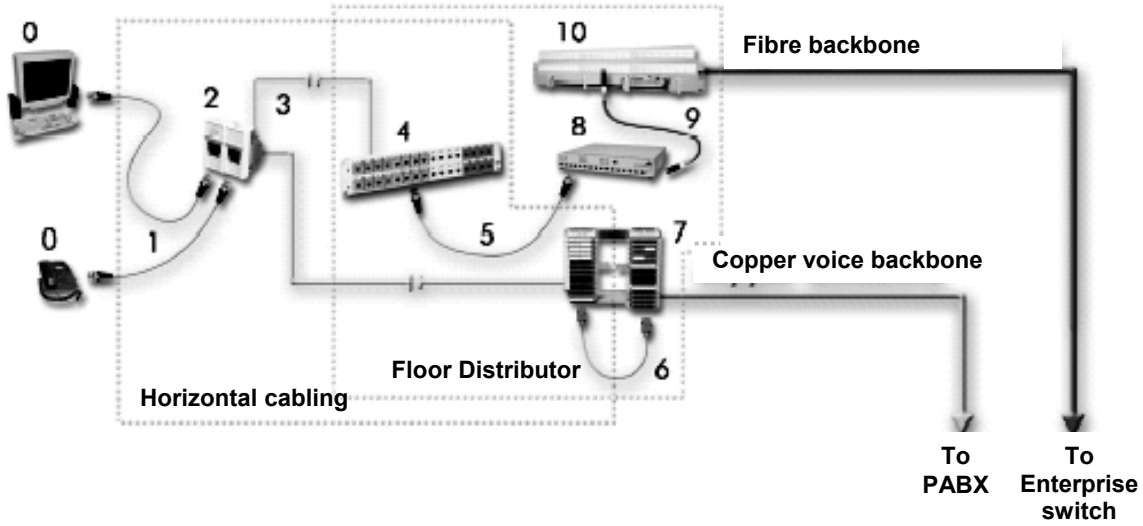
Item	Description
1	Volition cabling with splice
2	Volition cabling with patch panel
3	Volition cabling direct to desk
4	Building Distributor (BD)
4.1	Main Distribution Frame (MDF)
4.2	Volition patch panel
4.3	Volition switch
4.4	Volition patch panels

Figure 1.9 Volition fibre system

2.4.2 Volition copper system

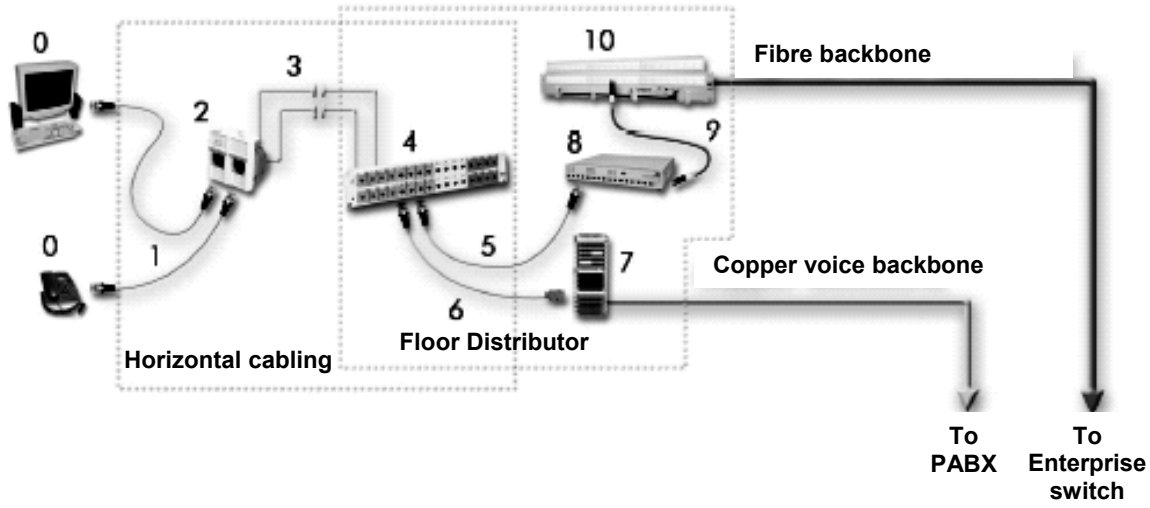


Item	Description	Item	Description
0	Workstation/Telephone	5	CBE to CBE patchcord
1	RJ45to RJ45 patchcord	6	CBE to RJ45 patchcord
2	RJ45 jack	7	Copper Hub or Switch
3	Horizontal cable	8	VF-45™ to VF-45™ patchcord
4	RCP or STG block	9	Volition optical fibre patch panel



Item	Description	Item	Description
0	Workstation/Telephone	6	CBE to CBE patchcord
1	RJ45 to RJ45 patchcord	7	RCP or STG block
2	RJ45 jack	8	Copper switch or hub
3	Horizontal cable	9	VF-45™ to VF-45™ patchcord
4	Volition copper patch panel	10	Volition optical fibre patch panel
5	RJ45 to RJ45 patchcord		

Figure 1.10 Volition copper system

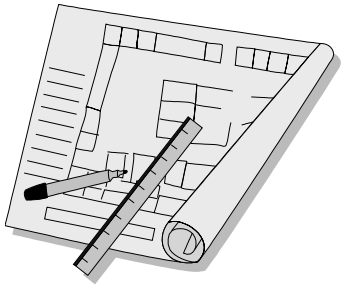


Item	Description	Item	Description
0	Workstation/Telephone	6	CBE to CBE patchcord
1	RJ45to RJ45 patchcord	7	RCP or STG block
2	RJ45 jack	8	Copper switch or hub
3	Horizontal cable	9	VF-45™ to VF-45™ patchcord
4	Volition copper patch panel	10	Volition optical fibre patch panel
5	RJ45 to RJ45 patchcord		

Figure 1.11 Volition copper system

PART 2 FIBRE CABLING SYSTEM

SECTION 1: - DESIGN AND PLANNING



This section of Part 2 gives detailed information relating to the design and planning of the Volition fibre cabling system. In defining the maximum permissible link lengths, due consideration has been taken to ensure that the system complies with the appropriate transmission protocol standard.

3.0 *Link design criteria*

The fibre cabling system meets all the performance requirements of the existing and known forthcoming national and international cabling standards and will support the most stringent laser and LED based applications. This includes the Gigabit Ethernet standard for operating distances up to 275 and 550 metres with 62,5/125 and 50/125µm fibre respectively. The following design criteria must be observed in order to satisfy the extended warranty requirements for the Volition system.

3.1 Maximum link lengths

The maximum link lengths, overall operating distances and maximum channel attenuation values for 50/125µm and 62,5/125µm multimode fibre and where appropriate, singlemode fibre for all standardised protocols are given in Tables 2.1 and 2.2. All channel attenuation values are based on Volition fibre and VF-45™ specifications. When designing the network, due attention should be given to how easy it will be to upgrade in the future e.g. it will not be possible to upgrade a 100baseFX network to 1000base LX unless the maximum operating distance of the latter (550m) has been observed.

Table 2.1 Standard applications

Application	Wave-length (nm)	Maximum Operating Distance[1] (m)			Maximum Channel Attenuation (dB)		
		62,5µm	50µm	sm	62,5µm	50µm	sm
ISO/IEC 8802-3 FOIRL	850	1000	1000	n/a	9,0	3,3	n/a
ISO/IEC 8802-3 10 BASE-FL and FB	850	2000	2000	n/a	12,5	6,8	n/a
ISO/IEC 8802-3 100 BASE-FX	1300	2000	2000	n/a	11,0	6,0	n/a
ISO/IEC 8802-3z 1000 BASE-LX	1300	550	550	5000	4,0[4]	3,5[4]	4,7
ISO/IEC 8802-3z 1000 BASE-SX	850[3]	275	550	n/a	3,2[4]	3,9[4]	n/a
ISO/IEC 8802-3ae 10G BASE-SR/SW	850	35	86/ 300[5]	n/a	1,63	1,81/ 2,59[6]	n/a
ISO/IEC 8802-5 4/16Mbps Token Ring	850	2000	2000	n/a	13,0	8,3	n/a
CD 9314-9 FDDI LCF-PMD	1300	500	500	n/a	7,0	2,0	n/a
DIS 9314-3 FDDI PMD	1300	2000	2000	n/a	11,0	6,0	n/a
ISO/IEC 9314-4 FDDI SMF-PMD	n/a	n/a	n/a	2000	n/a	n/a	10,0
ATM @ 52Mbps	1300	2000	2000	2000	10,0	5,3	10,0
ATM @ 155Mbps	1300 850[3]	2000 1000	2000 1000	2000 n/a	10,0 7,2	5,3 7,2	7,0 n/a
ATM @ 622Mbps	1300 850[3]	330 300	330 300	2000 n/a	6,0 4,0	2,0 4,0	 n/a
FC-PI 100-SM-LC-L @ 1,06GBd FC-PI 100-M#-SN-I @ 1,06GBd	1300[3] 850[3]	n/a 300	n/a 500	10000 n/a	n/a 3,0	n/a 3,8	7,8 n/a
FC-PI 200-SM-LC-L @ 2,12GBd FC-PI 200-M#-SN-I @ 2,12GBd	1300[3] 850[3]	n/a 150	n/a 300	10000 n/a	n/a 2,1	n/a 2,6	7,8 n/a
FC-PI 400-SM-LC-L @ 4,25GBd FC-PI 400-M#-SN-I @ 4,25GBd	1300[3] 850[3]	n/a 70	n/a 150	10000 n/a	n/a 1,8	n/a 2,0	7,8 n/a

Notes:
1. Includes patchcords.
2. Channel attenuation is based on link attenuation plus unallocated margin from IEEE 802.3z.
3. Laser based application. All others are LED based.
4. # will be 5 for 50µm fibre and 6 for 62,5µm fibre
5. 86m for OM2 fibre, 300m for OM3 fibre
6. 1.81dB for OM2 fibre, 2,59dB for OM3 fibre

3.2 Optical fibre

ISO/IEC 11801 specifies four types of optical fibres to support various classes of applications, three multimode fibre types (OM1, OM2, and OM3) and one singlemode type (OS1). The fibre supplied in Volition horizontal and backbone cable meets or exceeds the requirements of types OM1, OM2, and OS1 as standard. Cable containing OM3 fibre is available to special order if required. Table 2.2 gives details of the various fibre types.

Table 2.2 ISO/IEC 11801 fibre types

Optical fibre type	Nominal core diameter (μm)	Minimum overfilled launch bandwidth (Mhz.km)		Effective laser launch bandwidth (MHz.km)	Maximum attenuation (dB/km)		
		850nm	1300nm		850nm	1300nm	1550nm
OM1	50 or 62,5	200	500	-	3,5	1,5	-
OM2	50 or 62,5	500	500	-	3,5	1,5	-
OM3	50	1500	500	2000	3,5	1,5	-
OS1	9	-	-	-	-	1,0	1,0

3.3 Channel attenuation

For fibre optic installations, ISO/IEC 11801 defines three different channel specifications. These are shown in Table 2.3 below. The attenuation of a channel and permanent link at a specified wavelength shall not exceed the sum of the specified attenuation values for the components at that wavelength (where the attenuation of the cable is calculated from its attenuation coefficient multiplied by its length)

Table 2.3 ISO/IEC 11801 Channel attenuation (dB)

Channel attenuation			
Channel	**Multimode**		**Singlemode**
	850nm	**1300nm**	**1310nm**
OF – 300	2,55	1,95	1,8
OF – 500	3,25	2,25	2,0
OF – 2000	8,50	4,50	3,50

Table 2.4 Maximum Volition channel attenuation (dB)

ISO/IEC Channel	Link Length (m)	62,5μm MMF		50μm MMF		SMF
		850nm	1300nm	850nm	1300nm	1300nm
	≤50	1,7	1,6	1,7	1,6	1,6
	>50 – 100	1,9	1,6	1,9	1,6	1,6
	>100 - 150	2,1	1,7	2,1	1,7	1,7
	>150 - 200	2.2	1,7	2.2	1,8	1,7
	>200 - 250	2.4	1,8	2.4	1,8	1,7
OF300	>250 - 300	2,6	1,8	2,6	1,9	1,8
	>300 - 350	2,8	1,9	2,8	2,0	1,8
	>350 - 400	2,9	1,9	2,9	2,0	1,8
	>400 - 450	3,1	2,0	3,1	2,1	1,9
OF500	>450 - 500	3,3	2,0	3,3	2,1	1,9
	>500 - 550	3,5	2,1	3,5	2,2	1,9
	1000(2)	5,0	2,5	5,0	2,7	2,2
	1500(2)	6,8	3,0	6,8	3,3	2,6
OF2000	2000(2)	8,5	3,5	8,5	3,9	2,9
	3000(2)	12,0	4,5	12,0	5,1	3,6
	5000(2)	-	-	-	-	5,0

See following page for notes to table

Notes:

1. The maximum channel attenuation values in Table 2.4 are based upon:

   62,5/125µm fibre cable with attenuation of 3,5dB/km at 850nm, and 1,0dB/km at 1300nm
   50/125µm fibre cable with attenuation of 3,5dB/km at 850nm and 1,2dB/km at 1300nm
   Singlemode fibre cable with attenuation of 0,7dB/km at 1300nm (N.B. the VF-45™ connector is not specified for use at 1550nm)

   Two VF-45™ connections (one VF-45™ connection comprises a VF-45™ plug and socket) with a maximum attenuation of 0,75dB per connection.

2. For intermediate distances between 550m and 3000m the maximum link should be calculated using the formula;

   Maximum link attenuation (dB) = (max cable attenuation/km) x (link length in km) + 1.5

3. If a transition splice between campus/building backbone and horizontal cable has been installed an additional allowance of 0,3dB must be made.

3.4 Additional connectors

More than two VF-45™ connections can be installed in the link between the CD, BD or FD and the TO provided the maximum channel attenuation requirement is not exceeded. In such cases 0,75dB should be allowed for each additional connection installed.

3.5 Use of media converters

Where Ethernet media converters are used it is recommended that no more than four be installed on a 10Mbps link and no more than two on a 100Mbps link. This is to avoid problems associated with latency occurring in the transmission system.

3.6 Use of Ethernet and Fast Ethernet switches

Where Ethernet and Fast Ethernet switches are used the following guidelines on cascading and stacking should be followed.

3.6.1 Cascading

It is recommended that no more than four Ethernet switches (VOL-0215) or two Fast Ethernet switches (VOL-4000 or VOL-5000) be cascaded in order to avoid problems occurring in the transmission system associated with latency.

3.6.2 Stacking

The VOL-0215 is not stackable. Up to four VOL-4000 can be stacked from a master unit. A maximum of two VOL-5000 can be stacked from a master unit. It is not possible to stack a VOL-4000 with a VOL-5000. Refer to the appropriate equipment manuals for more details

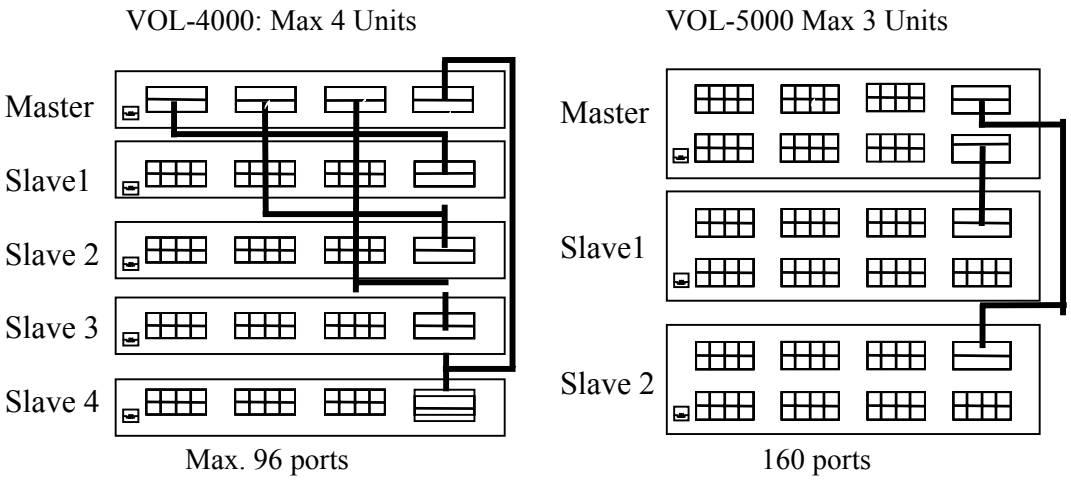


Figure 2.1 Stacking of switches

4.0 Planning guidelines

The following paragraphs give guidelines on planning a Volition fibre cabling system. The same approach should be adopted irrespective of whether a distributed or a centralised cabling architecture is being used. However, where a centralised architecture is being deployed the inclusion of floor distributors is optional and transition points can be included if required.

For safety reasons, 3M recommend the separation of fibre optic cable from power cabling. This can be achieved either through use of a separate cable support structure or by physical restraint of the cabling within the same support structure. In addition, where cabling has to pass through a fire rated wall, floor or other barrier, it is essential that an appropriate fire stop material be used.

4.1 *Horizontal fibre cabling*

The horizontal fibre cabling is the first element of the system to be considered. From the floor layout drawing (Figure 10) showing the positions of the outlets, determine the best location for the floor distributor or transition point. Factors that should be considered with regard to floor distributor location are:

- position in relation to floor distributors on other floors
- position in relation to the building distributor and backbone cable
- size in relation to number of anticipated users.

Factors that should be considered with regard to transition point location are:

- position in relation to the building distributor and backbone cable
- size in relation to number of cables to be spliced

Having decided on the best position for the floor distributor/transition point, plan the best route for the horizontal cable to take to each outlet point (TO). The route chosen should allow access for cable placement and meet cable bend radius requirements. Cables should not be routed within lightning conductor voids or lift shafts.

Generally as a minimum, the TO should provide one interface for voice and one for data. In some cases more interfaces will need to be provided and this should be planned accordingly. Open office cabling, sometimes referred to as zone cabling is also an option and provides a multiple TO location that enables several work area cables to be routed from the same point. Repeat this procedure for each floor of the building.

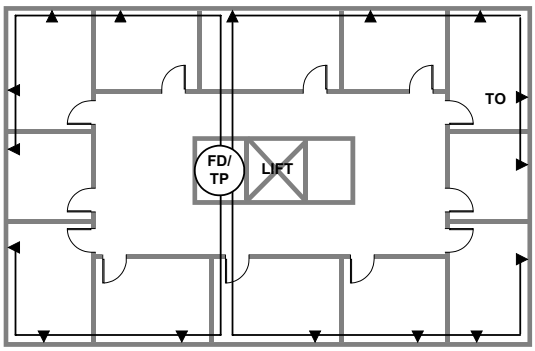


Figure 2.2 Floor layout drawing

4.1.1 Floor distributors

It is recommended that at least one floor distributor be provided for every 1000m^2 of office floor space (ISO/IEC11801). EIA/TIA 569A gives details of the recommended size requirements for floor distributors and Table 2.5 suggests alternative floor area sizes more suitable to the European market.

Table 2.5 Floor distributor size

Serving Area (m^2)	Floor distributor size (m)
1000	3,0 x 2,5
800	3,0 x 2,5
500	2,5 x 2,0

The location of racks and cabinets shall permit the installation of all necessary cabling. Adequate space must also exist to allow the installation and removal of larger items of equipment. In particular racks and cabinets shall not be installed:

- in toilet facilities and kitchens
- in emergency routes
- in ceiling or sub-floor spaces
- in the same spaces occupied by fire hose reels or other fire extinguishing equipment

4.1.2 Transition points

Also referred to as a consolidation point in ISO/IEC11801, a transition point can be provided where centralised cabling combines the backbone and horizontal cabling subsystems to form a single channel. The channel will then extend from the work area to the centralised cross connect by the use of pull-through cables (where no transition point is required) interconnects or splices. In the last two cases a transition point is required to provide protection for the VF-45™ connectors or splices.

There is no recommendation for the number of transition points required as they are optional and will depend on such factors as

- the number of outlets to be served
- the number of fibres in the backbone cable
- the floor layout
- the position of the CD/BD

4.1.3 Wall mount and under floor splice boxes for transition points

Volition wall mount splice boxes serve to protect a transition point in a centralised cabling scheme. They are available in a number of different sizes as shown in Table 2.6. Access to the box is via a pair of hinged doors and a range of accessories is available for cable management and splice accommodation. Care should be taken to ensure that access to the box would still be obtainable at a later date. Select the appropriate size box according to the cabling requirements and ensure that the minimum bend radius requirements of both backbone and horizontal cables are met.

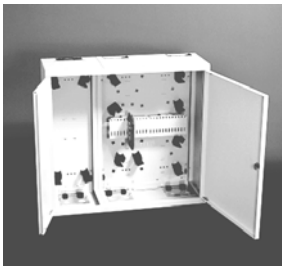


Table 2.6 Wall mount and under floor splice boxes

Model Number	Number of Fibres	Dimensions (mm) (W x H x D)
VOL-0450	48 – 96	300 x 300 x 85
VOL-0451	144 – 288	225 x 600 x 210
VOL-0452	288 – 576	425 x 600 x 210
VOL-0453	288 – 864	650 x 600 x 210
VOL-0454	576 – 1182	875 x 600 x 210

4.1.4 19" Patch panels for floor distributors

The Volition VOL-0430-ES series patch panels are available in a variety of configurations (see Part 6). Table 2.7 shows the maximum density that can be obtained using VOL-0430-ES patch panels.

It is essential that adequate patchcord management features are provided to ensure minimum bend radius specifications of the patchcord are not exceeded. These features can be provided on the front face of the rack, using the VOL-0499 management panel. One VOL-0499 management panel should be provided for every 48 ports to be patched. Alternatively, if 800mm wide racks are being used the rack manufacturer will normally be able to supply cable management features that locate on each side of the front face of the rack or at the side of the rack. Sufficient features should be used to ensure the minimum bend radius of the patch cable is not exceeded.

Table 2.7 Patch panel requirements

Work Stations	19" Rack Space (u)	19" Rack Space (u) including cable management
≤24	1	1
25-48	2	2
49-72	3	4
73-96	4	5
97-120	5	7
121-144	6	8
145-168	7	10
169-192	8	11
193-216	9	13
217-240	10	14

4.1.5 Wall mount patch panels for floor distributors

There are three sizes of wall mount patch panels available for six, twelve and twenty-four sockets. These patch panels can be used where space is limited and there are only a small number of outlets to be served. The panels can be mounted on the wall or even under the floor (the 2552A outlet could also be considered for an under floor application). Details are shown in Table 2.8.

Table 2.8 Wall mount patch panels

Model Number	Maximum Number of Sockets	Dimensions (mm) (W x H x D)
VOL-0406	6	198 x 163 x 54
VOL-0412	12	198 x 255 x 54
VOL-0414	24	198 x 439 x 54

4.1.6 Telecommunication outlets

Outlets can be located on the wall, floor or elsewhere in the work area (e.g. in trunking or in custom modular furniture). The cabling shall be planned in such a way that the outlets will be readily accessible and the outlets shall be positioned such that the plug on the patchcord can easily be inserted into the VF-45™ socket. It is preferable that the sockets do not face upwards where dirt and dust can collect on the door and possibly contaminate the v groove when the plug is introduced. A high density of outlets will enhance the flexibility of the installation.

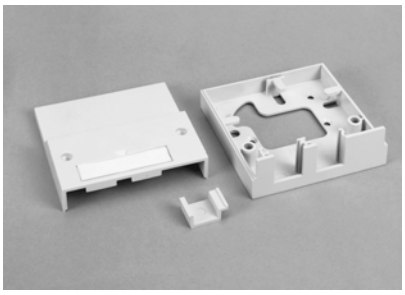
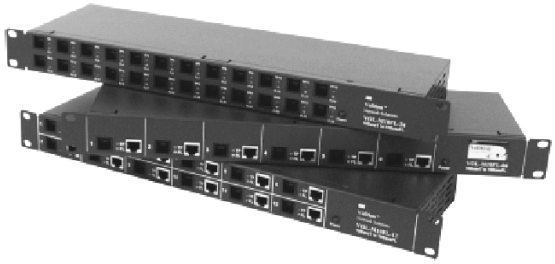


Table 2.9 Telecommunication outlets

Model Number	Maximum Number of Sockets			Application	Dimensions (mm) (L x W x H)
	VF-45™	RJ45	Total		
VOL-0250	2	4	6	Wall mounting	121 x 75 x 24
VOL-0255	2	2	2	Wall mounting	80 x 80 x 28
VOL-0256	2	2	2	Wall mounting	86 x 86 x 28
VOL–0257	2	0	2	Trunking(1)	45 x 90 x 58
VOL-0258	2/3	2/3	4/6	Floor	163 x 75 x 42
VOL-0259	2/3	2/3	4/6	Floor	163 x 75 x 42
2552SA	6	0	6	Floor	204 x157 x34
VOL-0350	2	0	2	Furniture	118 x 75 x 30

Notes:
1. Minimum dimensions of trunking 100 mm x 50 mm (W x D)

4.1.7 Rack mounted media converters



The VOL-M10FL – 06, M10FL – 12, M10FL –24 and M100FX - 12 media converters are available with six, twelve or twenty-four VF-45™ ports. All rack mounted media converters include an integrated power supply.

- **VOL-M10FL – 06/12 and 24**

Table 2.10 shows the minimum rack space requirements when using the VOL-M10FL-XX media converters. The units provide six, twelve or twenty-four VF-45™ ports in 1U of rack space and operate at 10Mbps. Table 10 shows the minimum rack space requirements, assuming a dedicated fibre rack is provided (i.e. the associated copper based electronics is located on an adjacent rack). If copper and fibre electronic equipment is co-located on the rack, only the space occupied by the copper electronic equipment need be planned since the RJ45 input ports and VF-45™ output ports are both mounted on the front of the unit.

Table 2.10 VOL-M10FL-XX rack space requirements

Work Stations	19" Rack Space (u)		
	Media Conv.	Patch Panel	Total
≤6	1	1	2
7-12(1)	2	1	3
13-18(1)	2	1	3
19-24(2)	1	1	2
25-30(2)	2	1	3
31-36(2)	2	1	3
37-42(2)	3	1	4
43-48(2)	2	1	3

Notes:
1. Where more than six ports are required at the same location the VOL-M10FL-12 will provide a more cost-effective solution.
2. Where more than twelve ports are required at the same location the VOL-M10FL-24 will provide a more cost-effective solution

- **VOL-M100FX-12**

Table 2.11 shows the minimum rack space requirements when using the VOL-M100FX-12 media converter. The unit provides twelve VF-45™ ports in 1U of rack space and operates at 100Mbps. The table shows the minimum rack space requirements, assuming a dedicated fibre rack is provided (i.e. the associated copper based electronics is located on an adjacent rack). If copper and fibre electronic equipment is co-located on the rack, only the space occupied by the copper electronic equipment need be planned since the RJ45 input ports and VF-45™ output ports are both mounted on the front of the unit.

Table 2.11 VOL-M100FX-12 requirements

Work Stations	19" Rack Space (u)		
	Media Conv.	Patch Panel	Total
≤12	1	1	2
12-24	2	1	3
25-36	3	2	5
37-48	4	2	6
49-60	5	3	8
61-72	6	3	9
73-84	7	4	11
75-96	8	4	12
97-108	9	5	14
109-120	10	5	15
121-132	11	6	17
133-144	12	6	18

4.1.8 Workstation media converters

All workstation media converters require a separate power supply, therefore it is essential to plan extra power outlets at the workstation.

Table 2.12 Workstation media converters

Description	Media converter type	Power supply	Power outlet required
VOL-0201	10BaseT RJ45 - 10BaseFL	Separate	Yes
VOL-M100FX	100BaseTX RJ45 - 100BaseFX	Separate	Yes

4.1.9 Ethernet and fast Ethernet switches

The following switches are currently available:

- **VOL-0215**

The VOL-0215 is a 1U high 10BaseFL managed switch having twenty-four VF-45™ ports, one 10BaseT/100BaseTX fixed up-link port and one slot for a fibre up-link module. The front panel also includes an RJ45 console port for connection to a PC for configuration purposes. The following up-link modules are available for the VOL-0215 switch:

Table 2.13 Uplink modules for VOL-0215

Description	Type	Connector Interface
VOL-0217-UPL-TX	10/100BaseT/Tx	RJ45
VOL-0219-UPL-100VF	100BaseFX	VF-45™

- **VOL-4000**

The VOL-4000 is a 1,5U high modular managed switch, having four slots into which a range of modules can be plugged. The front panel also includes an RJ45 console port for connection to a PC for configuration purposes. These units can be stacked to increase the number of ports available. Table 2.14 gives details of the modules available.

Table 2.14 Plug-in modules for VOL-4000 and VOL-5000

Description	Type	Connector Interface
VOL-4001	8 Port 10BaseFL	VF-45™
VOL-4008	8 port 100BaseFX	VF-45™
VOL-4008T	8 port 10/100BaseT/TX	VF-45™
VOL-4100VF	1 port 1000BaseSX	VF-45™
VOL 4100-LX	1 port 1000BaseLX	Dual SC

- **VOL-5000**

The VOL-5000 is a 3U high modular managed switch, having eight slots into which a range of modules can be plugged. The front panel also includes an RJ45 console port for connection to a PC for configuration purposes. Like the VOL-4000, these units can also be stacked to increase the number of ports available. Table 2.14 details the modules available.

4.1.10 Mini switch, dual speed.

The VOL 1081 is an eight port dual speed mini switch having eight 10/100BaseT/TX ports and a single 100BaseFX up-link port with the VF-45™ interface.

4.1.11 Network interface cards

Network interface cards are available with VF-45™ connector ports eliminating the need for media converters at the workstation. The VOL-N100VF + TX has both a fibre (VF-45™) and a copper (RJ45) port making it an ideal choice when it is known that the network will be upgraded to fibre in the future. Table 2.15 details the cards currently available.

Table 2.15 Network interface cards

Description	Type	Connector Interface
VOL-N100VF +TX	100Mbps PCI bus	VF-45™ and RJ45
VOL-N1000VF-SX	1Gbps PCI bus	VF-45™
VOL-N2000VF-SX	1Gbps PCI bus	2 x VF-45™
VOL-N1000 SC-SX	1Gbps PCI bus	Duplex SC
VOL-N2000 SC-SX	1Gbps PCI bus	2 x Duplex SC
VOL-N1000 SC-LX	1Gbps PCI bus	Duplex SC
VOL-N2000 SC-LX	1Gbps PCI bus	2 x Duplex SC
VOL-N1000TX	1Gbps PCI bus	RJ45
VOL-N2000TX	1Gbps PCI bus	2 x RJ45

4.2 Building backbone cabling

The building backbone cable is the second element of the system to be considered. From the building layout drawing, determine the best location for the building distributor (this may often coincide with the point of entrance of the telecommunications cables into the building). Select the best route(s) to connect each floor distributor to the building distributor. As in the case of horizontal cabling, cables should not be installed within lightning conductor voids or lift shafts. The route should not result in the minimum bend radius of the cable being exceeded. This figure varies depending on whether the cable is under load or not. Table 2.19 gives details.

4.2.1 Building distributors

EIA/TIA 569A gives details of the recommended space requirements for building distributors. Table 2.16 suggests alternative floor area sizes more suitable to the European market.

Table 2.16 Building distributor size

Work Stations	Building Distributor size (m^2)
≤100	10
101-400	20
401-800	40
801-1200	70

4.2.2 Patch panels, racks and cabinets for backbone cabling

Volition wall mount or VOL-0430-ES series patch panels shall be provided at each end of the building backbone cable. See paragraph 4.1.4 for planning guidance on rack space requirements and paragraph 13.1.3 for information on racks and cabinets

4.3 *Centralised cabling*

A collapsed backbone structure is shown in Figure 2.3.

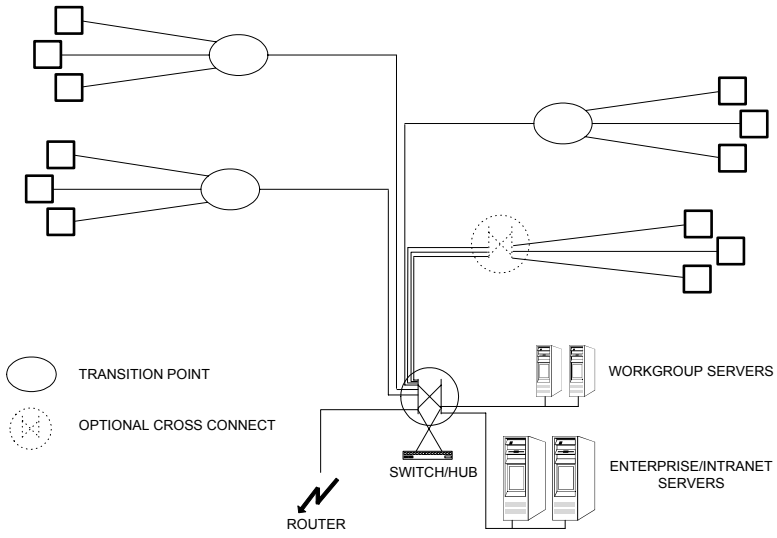


Figure 2.3 Centralised cabling architecture

Installations using a centralised cabling architecture shall be planned using the same guidelines given in the preceding paragraphs. Particular attention shall be given to the maximum permissible link lengths given in Table 2.1. In this case, the horizontal cable can be "pulled through" from the TO to the BD without any intermediate transition point or floor distributor. Alternatively, it is permissible to use a higher fibre count building backbone cable and join (splice) it to the horizontal cable at a transition point conveniently located in the building.

The building backbone cable can be joined to the horizontal cable using any of the following:

a) Fibrlok™ mechanical splice
b) VF-45™ connector
c) fusion splice

In all three cases the transition point must promote orderly storage of the fibres such that the minimum bend radius requirement is maintained. The transition point shall also be capable of being labelled in accordance with the administration requirements outlined in Part 5.

Fibrlok splice

A centralised fibre cabling network is often much less expensive than a distributed fibre network. Floor distributors can be eliminated thus saving costs associated with the provision of electrical and HVAC equipment and the floor space can be utilised for other purposes.

SECTION 2 – INSTALLATION AND TESTING

5.0 Safety and pre-installation preparations

The following paragraphs are written to ensure a quick, error-free installation that minimises risk to the installer, his equipment and the end user. It covers matters relating to:

- safety
- use of tools and equipment
- pathway planning
- cable construction and handling procedures.

Although Volition fibre cables use glass instead of copper to carry the transmission signal, many of the installation practices and procedures are identical to those followed when installing a copper cable. The main factors affecting fibre cable installation are cable pull strength, cable bend radius, cable weight, and termination practices.

5.1 *Safety*

Adopt safe working practices at all times. Failure to observe safety rules could result in a serious or fatal injury. In general, observe company safety practices and the following points for safety before and during the installation:

- clothing
- planning
- secure the work area
- identify the location of electrical cabling
- use tools that are suitable for the job.

5.1.1 Optical fibre safety

The following practices shall be adopted:

- exposed optical fibre ends shall be kept away from the skin and eyes
- the quantity of optical fibre waste shall be minimised
- waste fibre fragments shall be treated with care and collected and disposed of in suitable containers.

Optical fibre transmission equipment emits infra red (non-visible) light. It is impossible to detect the presence of such optical signals with the human eye. Connector end faces, prepared optical fibres or broken optical fibres shall not be viewed directly unless the power source is known to be safe and under control.

5.1.2 Clothing

Wearing the proper clothing will promote personal safety. Some work operations will require safety glasses (e.g. for cable termination operations), hard-hat (e.g. on new construction sites), and gloves (e.g. for cable pulling and cleaning operations).

5.1.3 Planning

Plan the job with safety in mind. Walk out areas to be cabled and identify potential hazard sites. If in doubt, consult the person in your organisation responsible for safety.

5.1.4 Secure the work area

Ensure that the work area is safe before, during and after the installation. Before commencement of any work, set out cones or safety tape as appropriate where cables will be pulled. Arrange tools so as not to create a hazard.

5.1.5 Electrical cabling

Eliminate the risk of drilling or cutting through a power cable by identifying the position of any electrical cabling. This is particularly important when installing Volition outlets close to electrical outlets. When working in new construction, check drawings for areas that may be unsafe. In existing buildings, use maintenance drawings to identify areas to avoid. Always assume an electrical cable is live until verified otherwise.

5.1.6 Tools

Always use the correct tool for the job. Ensure all tools are safe to use and in good working order. In particular, make sure cutting tools are sharp, use double insulated power tools where power tools are needed and keep all tools in good condition.

5.1.7 Volition Quick Install Termination Kit

Pay particular attention to the termination kit. Always store it in the protective tool case when not in use and keep all working surfaces clean and grease free (this is particularly important when working with indoor/outdoor cable). When replacing the cleave blade it is important not to touch the cutting edge as this may cause damage.

5.2 *Pathway planning*

Although the shortest route between two points is a straight line, it is most unlikely that this will be practical. Check with the cabling designer for the correct route to use.

For large installations it is recommended to stage the project and to plan the quantity and type of materials needed for each stage with a storage location nearby.

The area should be surveyed to estimate the number of people required to install the cable, and to ascertain if any special installation aids will be required. While conducting the survey, the positions where a change in direction of the cable pull will be necessary should also be noted.

Having an understanding of building construction methods will help when planning the cable installation, e.g. it is usually possible to install cable between two wall studs without hitting a cross-member. Familiarity with other construction methods associated with ceilings (plastered, suspended, vaulted), floors (suspended, concrete, ducted) and walls (insulated, masonry, partition, stud, plastered) will also be useful.

Identify existing cable routes. In many cases the same route can be used. Identifying the existence of a pull cord will save considerable time during the installation. When using a pull cord, a replacement should always be left for later installations.

The entry points for cable pathways shall be accessible and not blocked with permanent building installations, they should allow for cable installation, repair and maintenance without risk to personnel or equipment. Cable pathways should also avoid localised sources of heat, humidity and vibration that could increase the risk of damage to the cable.

Cable supports i.e. cable trays must be used at all times. These may exist from a previous installation or should be installed prior to the cable installation phase. Supports shall be designed and installed to eliminate the risk of sharp edges or corners that could damage the cable. Pathways constructed using tray work should use preformed bends, compatible with the trays to execute changes in pathway direction. Pathways shall be located to:

- provide a minimum clearance of 25mm from the fixing surface
- provide the maximum amount of working space with a minimum of 150mm free space above the floor of the tray
- provide the maximum protection to the installed cable

Cable trunking, ducting or conduit systems where used, should have access provided at least every 12m to enable the use of draw boxes. Draw boxes shall be large enough to maintain the minimum bend radius of the cable being installed.

Cables lying directly on ceiling tiles are unacceptable as they could injure the next person needing access to the ceiling or damage the cable.

5.3 Cable handling

The following techniques are commonly used during the cable installation process.

Care should always be taken to ensure the method used and the final cable placement does not degrade cable performance.

Installation requirements for cable placement are also found in standards such as ISO/IEC 11801, EN50173, EN50174 and ANSI/TIA/EIA-568.

5.3.1 Cable on reels

A “cable dispenser” should be used to dispense the Volition fibre cable. The reel(s) are installed on rollers and the cable is pulled for smooth and even feeding. Alternatively, the reel(s) can be placed on a steel bar that is then supported securely on stands at each end. When pulling cable from a reel, it is important to pull the cable from the bottom of the reel.

5.3.2 Volition horizontal fibre cable construction/sheath colour code

Volition horizontal fibre cable has a low smoke zero halogen sheath. Multimode cables are blue singlemode cables are green. Two fibre and four fibre horizontal cable construction is shown in Figure 2.4 The specification is shown in Part 6.

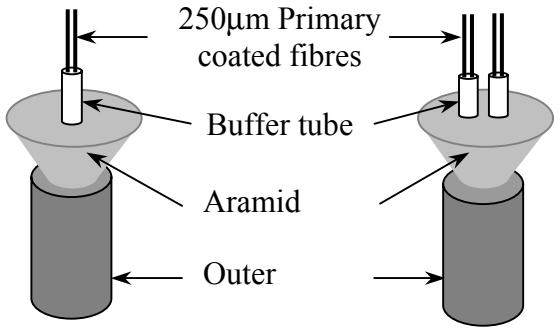


Figure 2.4 Two and four fibre horizontal cable construction

5.3.3 Volition horizontal fibre cable fibre colour code

Table 2.17 gives the fibre colour coding details of Volition horizontal fibre cable

Table 2.17 Horizontal fibre cable fibre colour code

Number of Fibres	Number of Buffer Tubes	Buffer Tube Colour(s)	Fibre Numbers	Fibre Colours
2	1	Blue	1/2	Blue/Orange
4	2	Blue	1/2	Blue/Orange
		Orange	3/4	Blue/Orange

5.3.4 Volition indoor fibre backbone cable construction/sheath colour code

All Volition indoor fibre backbone cables have a low smoke zero halogen sheath. Multimode cables are blue and singlemode cables are green. Details of Volition indoor fibre backbone cable construction are given in figure 2.5 and tables 2.18 and 2.19 give details of the fibre code and cable installation specification.

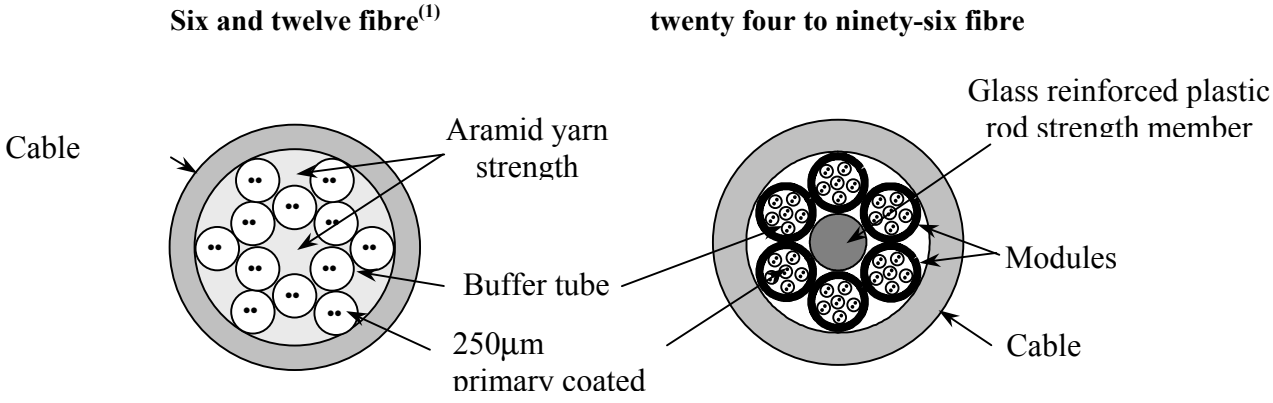


Figure 2.5 Indoor fibre backbone cable construction

Notes:

1. For 62,5/125µm fibre only. The 50/125µm fibre cable incorporates a central strength member for cables having more than twelve fibres

Table 2.18 Indoor fibre backbone cable fibre colour code

No of Fibres	No of Buffer Tubes	Buffer Tube No	Buffer Tube Colour	No of Fibres	No of Modules(1)	Module No	Module Colour
6	3	1	Blue	48(2)	4	1	Blue
		2	Orange			2	Orange
		3	Green			3	Green
12	6	4	Brown			4	Brown
		5	Slate	72(2)	6	5	Slate
		6	White			6	White
24	12	7	Red	96(2)	8	7	Red
		8	Black			8	Black
		9	Yellow				
		10	Violet				
		11	Pink				
		12	Aqua				

Notes:
1. Each module contains six two fibre buffer tubes
2. Cables of 48 fibres and above have a central strength member

Table 2.19 Indoor fibre backbone cable installation specification

Cable Type	Minimum Bend Radius (mm) Short Term/Long Term(1)	Nominal Cable Diameter (mm)	Nominal Cable Weight (kg/m)	Maximum Pulling Load(2) (N)
6 Fibre	75/50	4,5	25,0	660
12 Fibre	75/50	5,0	30,0	660
24 Fibre	90/60	6,0	40,0	1320
48 Fibre	190/120	12,0	110,0	5618
72 Fibre	250/150	15,0	170,0	5618
96 Fibre	275/190	19,0	300,0	5618

Notes:
1. The short term bending radius is under installation condition when the cable is being subjected to a pulling load.
2. Applied to the cable strength member(s)

5.3.5 Volition indoor/outdoor fibre backbone cable construction/sheath colour code

Volition indoor/outdoor cables have two basic constructions, unitube for up to twenty-four fibres all contained within a single tube, or loose tube where there are twelve fibres in a tube. The loose tube design is used for cables containing more than twenty-four fibres and incorporates a central strength member. Sheath colour is coded the same as other Volition cables, blue for multimode, green for singlemode.

As there is always more than one loose tube in the cable, the tubes and fillers are colour coded. The first tube is green and the last is red. The tubes in between are yellow for singlemode fibres and white for multimode fibres.

Hybrid cables contain singlemode fibres in the first (green) tube then a number of yellow tubes as appropriate with singlemode fibres, then a number of white tubes as appropriate with multimode fibres. The last tube is red with multimode fibres.

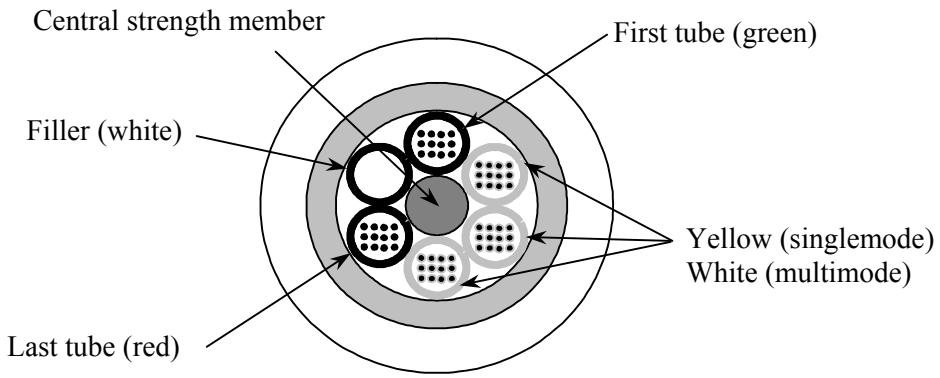


Figure 2.6 Loose tube cable colour code

Indoor/Outdoor cable with aramid yarn or glass reinforced plastic (GRP) strength member

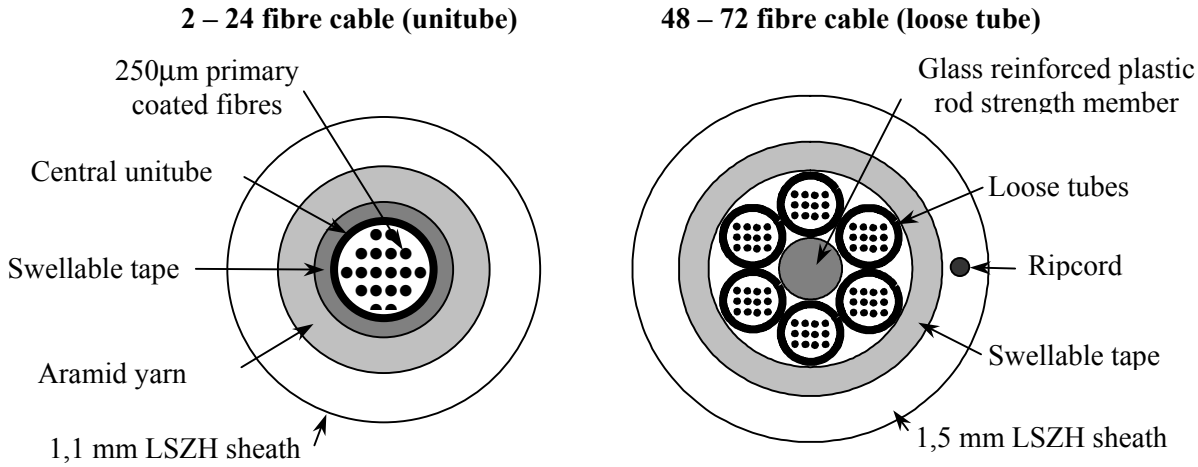


Figure 2.7 Cable construction

Table 2.20 shows the colour code used for fibres in cables having a unitube construction.

Table 2.20 Unitube cable fibre colour code

No of Fibres	No of Unitubes	Fibre Pair Number	Fibre Number	Fibre Colour
2	1	1	1/2	Red/Green
4	1	2	3/4	Blue/Yellow
6	1	3	5/6	White/Grey
8	1	4	7/8	Brown/Violet
12	1	5	9/10	Turquoise/Black
24	1	6	11/12	Orange/Pink
		7	13/14	Yellow w/marker 1*/White w/marker 1*
		8	15/16	Grey w/marker 1*/Turquoise w/marker 1*
		9	17/18	Orange w/marker 1*/Pink w/marker 1*
		10	19/20	Yellow w/marker 2*/White w/marker 2*
		11	21/22	Grey w/marker 2*/Turquoise w/marker 2*
		12	23/24	Orange w/marker 2*/Pink w/marker 2*

* Marker 1 is spaced approx. at 70mm intervals, Marker 2 is spaced approx. at 35mm intervals

Table 2.21 shows the colour code used for fibres in cables having a loose tube construction.

Table 2.21 Loose tube cable fibre colour code

No of Fibres	No of Loose tubes	Loose tube Number	Fibre Number	Fibre Colour
48	4	1	1/2	Red/Green
		2	3/4	Blue/Yellow
		3	5/6	White/Grey
		4	7/8	Brown/Violet
96	8	5	9/10	Turquoise/Black
		6	11/12	Orange/Pink
		7		
		8		

- **Indoor/outdoor cable with glass yarn**

2 – 24 fibre cable (unitube) **48 – 72 fibre cable (loose tube)**

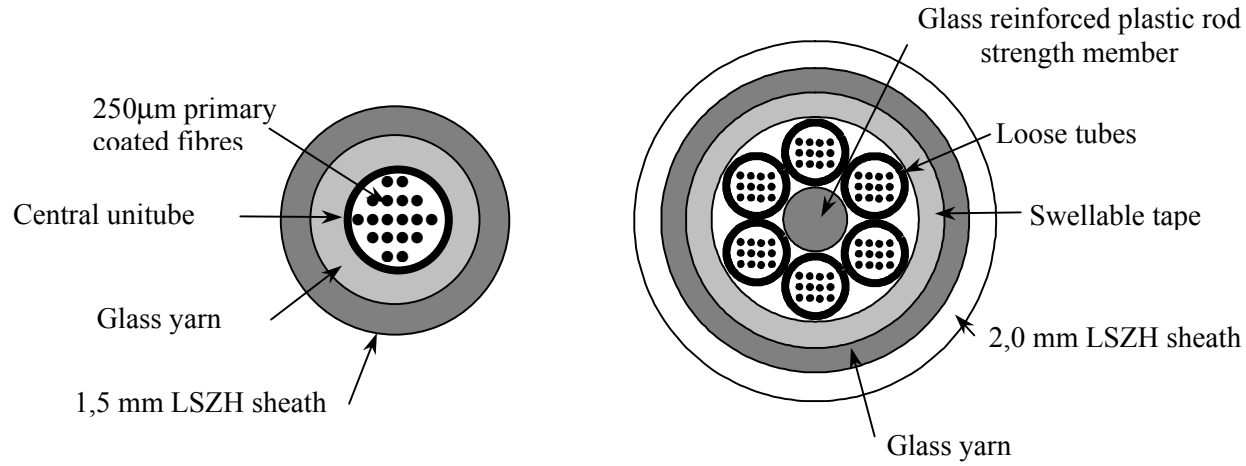


Figure 2.8 Cable construction

For details of colour coding of fibres see tables 2.20 and 2.21.

- **Indoor/outdoor cable with corrugated steel armouring**

2 – 24 fibre cable (unitube) **48 – 72 fibre cable (loose tube)**

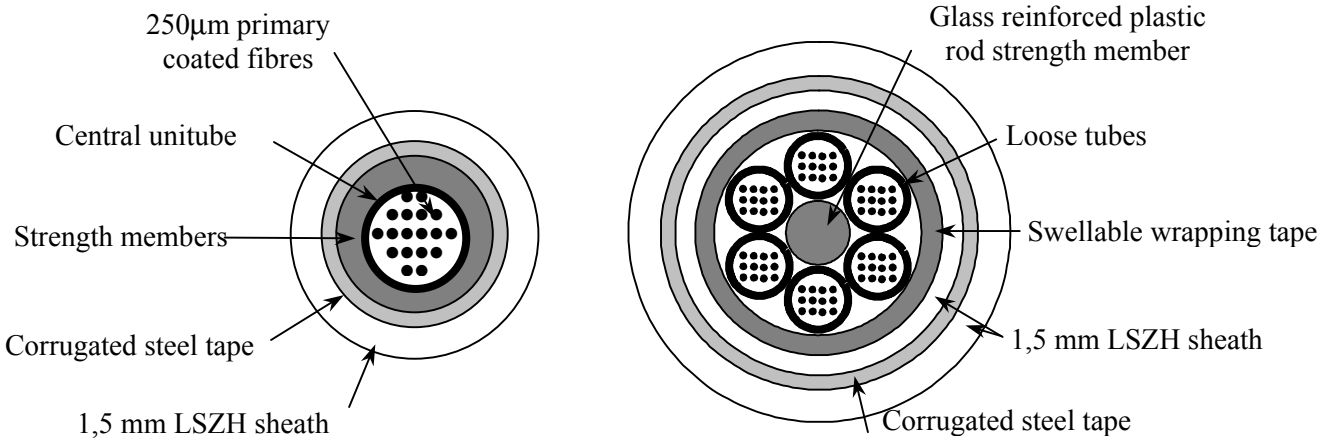


Figure 2.9 Cable construction

For details of colour coding of fibres see tables 2.20 and 2.21.

5.4 Cable pulling

Although Volition fibre horizontal cable is significantly lighter and the diameter much smaller than four-pair twisted copper cable, it can be installed in a similar way. However, it is essential that all Volition cables are never subjected to a bend tighter than the minimum bend radius specification and that the maximum pulling load is never exceeded. The minimum bend radius varies according to whether the cable is under load (during the pulling operation) or unloaded (after the pulling operation). Also note that within the termination area itself, where the cable sheath has been removed, the bend radius can be as low as 25mm.

Cables are pulled along the planned routes – usually with a rope or a rod. The pulling rope and the connection between the rope and the cable should be strong enough to withstand the load required to pull the cable into place. The connection between the rope and the cable should be as smooth as possible to ensure it will not snag along the pull route.

> **CAUTION:** ***Do not exceed the maximum pulling load of the cable and do not apply the maximum pulling load to the cable sheath.***

5.4.1 Preparing Volition fibre horizontal cable for pulling

As a guide, up to 12 horizontal Volition fibre cables can be pulled at a time. If the route is short (<30m) and straight with easy access to the cable path, the cable may be pulled off the reel and laid into place directly without accessing the strength members**.**

Care should be taken however to ensure that the cable sheath is not stretched as this could result in excess attenuation being induced into the fibre at a later stage when the sheath contracts.

For routes that require the cable to be pulled into position, ***the pulling load must not under any circumstances be applied directly to the cable sheath.*** In this case, it is important that the load is applied to the cable strength members (aramid yarn). This will prevent stretching of the cable sheath and possible damage to the fibre. A tool can be used to clamp directly onto the exposed aramid yarns and the pulling load applied to the tool. In such a case it is usually only necessary to expose about 5cm of aramid yarn.

Alternatively, the following procedure can be adopted:

1. Strip the sheaths of the cables approximately 30cm.
2. Cut the fibres at the cable jacket.
3. Group the aramid yarn into two bunches.
4. Weave the two bunches to create a loop, twisting the ends.
5. Place the pulling rope through the loop and tie a knot.
6. Tape the end along with the rope to make a smooth and compact pulling end.

5.4.2 Preparing Volition fibre backbone cable for pulling

The construction of the backbone cable makes the cable sheath less susceptible to being stretched and if the route is short (<30m) and straight, this will only require the cable end to be wrapped over the sheath with tape together with a rope.

The transition between the end of the cable and the rope should be as smooth as possible to prevent it getting caught. As a guide, backbone cables of 48 fibres and above are normally installed individually although where space and the nature of the route permits, it is possible to pull more than one cable at a time.

For long and or difficult routes, as in the case of the horizontal cable, the pulling load should never be applied directly to the cable sheath. In such cases the following procedure should be adopted:

1. Strip the sheath of the cable approximately 50cm.
2. Cut the fibres at the cable jacket and

   either
   a) Group the aramid yarn into two bunches
   b) Weave the two bunches to create a loop, twisting the ends
   c) Place the pulling rope through the loop and tie a knot
   d) Tape the end along with the rope to make a smooth and compact pulling end,

   or
   e) Attach the central strength member to the pulling rope using a suitable attachment

In both cases if a winch is being used to pull the cable, a suitable overload protection device shall be used to prevent the maximum pulling load of the cable from being exceeded.

6.0 Installing Volition fibre backbone cable

Indoor backbone cables and indoor/outdoor cables can be installed in either closed or open shafts. Indoor/outdoor cables can also be installed in underground ducts. Closed shafts are used to route cables from floor to floor through a sleeve, slot, conduit or rack that can be fire-stopped (Figures 3.1, 3.2, 3.3 and 3.4). Open shafts typically refer to distribution systems in older buildings where abandoned ventilation or elevator shafts are used for extending cables. Open shafts usually extend from the basement of a building to the top floor and have no separation between floors. Copper power cables and Volition optical fibre cables should either be installed in separate shafts or in separate sections of the shaft.

3M recommend the use of closed shafts for Volition building backbone cable installation.

6.1 Installation procedure

Decide whether the cable is to be dropped down from an upper floor, or pulled up from a lower floor. In both cases, safety is of prime importance. Loose cables should be tied off so as not to cause an obstruction. Cable reels should be secured so they cannot roll. If it has been decided that the cable will be dropped, ensure that the cable reel is equipped with a brake. If the cable is being pulled up through closed shafts, a key piece of equipment is a portable electric winch. Always follow the manufacturer's guidelines when operating this equipment.

During installation, ensure that the minimum bend radius specification and the maximum pulling load of the cable are not exceeded (see Table 2.19). One way to ensure this is to first install an inner duct (usually manufactured from a corrugated material). Inner ducts come in a variety of plastics and should be specified to meet local flammability regulations. If an inner duct is not used, consideration should be given to using a break-away swivel. If a winch is used in the pulling operation, a break-away swivel should always be used and the pulling load applied to the cable strength member.

Cables for different purposes (e.g. power and data cables should not be in the same bundle. See Figure 2.10

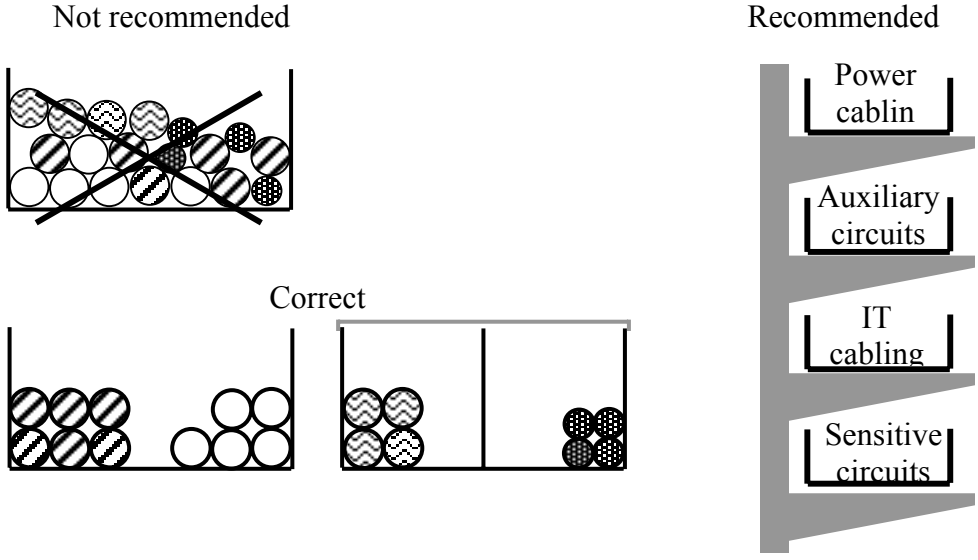


Figure 2.10 Separation of cables in cable pathways

Finally, ensure that the cable is secured on each floor. Generally, a split mesh grip that is connected to a bolt on the floor above is used to support the cable.

6.2 Cable preparation in the CD/BD/FD termination area

The procedure for preparing the cable will depend on the cable type and construction. Care should be taken to ensure that the fibres are not damaged during this operation.

6.2.1 Indoor cable with aramid yarn or glass reinforced plastic (GRP) strength members

1. Ensure there is sufficient length of cable at the rack to reach the patch panel (or splice box) and trim any strength members flush with the end of the cable.
2. Ensure the cable sheath cutter is correctly adjusted so as not to damage the fibre tubes.
3. Measure and cut through the cable sheath at a distance of 1,0m from the cable end.
4. Hold the cable firmly in both hands with the ring cut between the hands.
5. Separate the cable sheath end from the main cable.
6. Cut the aramid yarn flush with the end of the cable sheath (do not cut the GRP rod).
7. Pull the end of the cable sheath with the aramid yarn from the cable and discard.
8. Cut the GRP rod flush with the end of the cable sheath.
9. Follow the instructions included with the patch panel, splice box or socket termination kit.

* In some cases it may be necessary to remove the cable sheath in small sections

6.2.2 Indoor/outdoor cable with aramid yarn or glass reinforced plastic (GRP) strength members

Follow the same procedure as given in paragraph 6.2.1. However as this cable is filled with grease, before attempting to install it into a patch panel or splice box, the grease should be removed using a suitable solvent.

It is particularly important to ensure that the VF-45™ Quick Install Kit does not become contaminated with grease.

6.2.3 Indoor/outdoor cable with glass yarn

Follow the same procedure as given in paragraph 6.2.2 . However the glass yarn makes the sheath much more difficult to remove and therefore it is most likely that it will have to be removed in several short sections. As before pay particular attention to ensure that all traces of grease are removed from the fibres and the tubes in which they are contained.

6.2.4 Indoor/outdoor cable with corrugated steel armouring

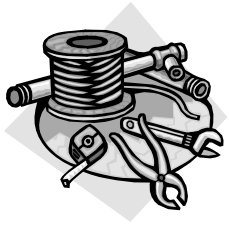
As this cable incorporates layer(s) of steel tape for guaranteed rodent protection, removal of the sheath is far more difficult than in the previous cases. In this case special tools are needed in order to cut through the steel tape before the sheath can be removed.

7.0 Installing Volition fibre horizontal cable

As for backbone cable, 3M strongly recommend that Volition horizontal cable and copper power cables should either be installed on separate cable supports or in separate sections of the support. This is not because of electrical interference issues but to minimise the risk of the fibre cable being subsequently damaged by the weight of copper cable placed on top of it at a later date.

7.1 Installation procedure

The cable should be installed on a cable support located above a ceiling, in a wall or under a floor. The cable should take the most practical direct route, ensuring that the minimum bend radius specification (30mm along the route, 25mm in the termination area) and maximum pulling load (440N) is never exceeded. Several cables can be pulled at the same time in order to reduce the time taken for the installation. Remember never to apply the pulling load directly to the cable sheath. Follow the instructions given in paragraph 5.4.1.



If the route incorporates tight bends or obstruction points, extra help should be deployed in these areas to guide the cables to ensure they do not get trapped. This will also reduce the pulling load that needs to be applied to the cable.

After installation, ensure a minimum of 1,5m of cable slack is available at each end of the link (i.e., patch panel/splice box and outlet) for termination of the VF-45™ socket.

7.1.1 Cable rodding equipment

Cable rodding sets are used for installing horizontal cable in hard-to-get-to locations, or to route the cable past obstructions. The rod is attached to the strength members of the cables being installed. Depending on the nature of the location, the length of the rod can be extended by screwing on additional rods. The rod can be used to bridge through difficult locations with the cable attached. These steps may have to be repeated several times along a cable route.

7.1.2 Pull cords

Generally, pull cords are placed by blowing them into conduit, or by placing them along a cable support (cable tray) with a rod. It is important to pull a replacement pull cord with the cable in order to facilitate the installation of subsequent cables.

7.1.3 Floor distribution systems

Floor distribution systems include under-floor trunking systems, conduit systems and access floor systems. Except for conduit systems, cable routes should either run parallel to, or perpendicular to, the building lines.

Under-floor trunking systems are characterised by having either trunking or duct running from the telecommunications closet to strategically placed junction boxes in the floor. The trunking generally extends at 90-degree angles from the telecommunications closet and feeds into junction boxes. Distribution trunking is then used from the junction boxes to feed the floor outlet locations that are placed to serve a predetermined area of the floor.

Access floor systems are mostly found in computer rooms. However, they are being used more extensively in densely populated areas where a significant number of outlets may be installed.

7.1.4 Ceilings

Volition cables shall not be placed directly onto suspended ceiling tiles. Cable support systems such as cable trays, or conduit, shall be employed. When pulling cables through a suspended ceiling space, every two to three tiles should be removed for access. This will assist in the routing of the cable around obstructions etc. and facilitate the installation of cables in the support system employed.

7.1.5 Walls

Cables installed above a suspended ceiling will need to be dropped down to the work area. The cable may be routed down a distribution column into which the outlet is located, or dropped down a wall cavity. Dropping cables down an empty wall cavity is generally not difficult. A rod may be used or even a string tied to a weight. A rod is most suitable for insulated walls.

7.2 Cable preparation in the TO termination area

To prepare the cable in the TO termination area the following procedure should be adopted:

1. Ensure there is a minimum of 1,0m of excess fibre at the TO. Trim any excess cable so that the fibre and aramid yarn are flush with the end of the cable sheath
2. Ensure the cable sheath cutter is correctly adjusted so as not to damage the fibre sub-unit.
3. Measure and cut through the cable sheath 1,0m from the end of the cable.
4. Hold the cable firmly in both hands with the ring cut between the hands.
5. Separate the cable sheath end from the main cable sheath to expose the aramid yarn.
6. Cut the aramid yarn flush with the end of the cable sheath at the point of the ring cut.
7. Pull the end of the cable with the aramid yarn from the cable and discard.
8. Follow the instructions included with the Volition outlet and VF-45™ Quick Install Kit to complete the termination

8.0 Installing centralised fibre cabling

Centralised cabling results in all the electronic equipment being located centrally with the cable routing directly to the telecommunications outlet (TO). This may be accomplished using Volition horizontal cable only or a combination of Volition horizontal and backbone cable. Fusion splicing, mechanical splicing or patching is used to make the transition between horizontal and backbone cable.

When making this type of installation, the procedures documented for the installation of horizontal and backbone cable shall be followed.

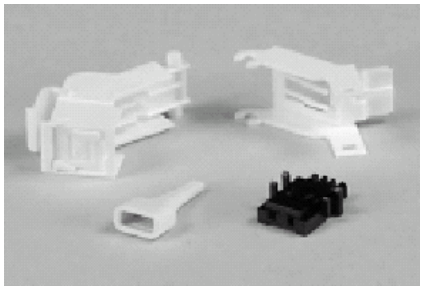
However, the maximum link length must always comply with the design guidelines given in Section 1 in order for the extended warranty requirements to be met.

9.0 Installing patch panels splice boxes and wall/floor outlets

Follow the instructions supplied with the patch panel, splice box and wall/floor outlet carefully. Where grease filled indoor/outdoor cable has been used it is recommended where possible that the cables enter from below. This is to minimise the flow of grease out of the cable.

Care should be taken to ensure that the 25mm minimum bend radius of the fibre in the termination area is not exceeded when the socket is placed into its final position.

10.0 VF-45™ socket installation



The VF-45™ socket is used at both ends of the link. Follow the installation instructions supplied with the VF-45 Quick Install Kit carefully.

It is important when installing the socket to maintain the correct polarity of the fibres throughout the system. For example, if the socket at the patch panel has the blue fibre on the right (as viewed from the rear of the socket), the fibre on the right at the outlet termination must be orange.

To meet the conditions of the warranty, the VF-45™ socket must be installed in a 3M approved patch panel or telecommunications outlet.

10.1 VF-45™ Plug and Socket Cleaning

After installation of the socket and before insertion of a patchcord, clean both the socket and the patchcord plugs using the Volition Maintenance Cleaning Kit. Follow the instructions supplied with the kit carefully.

Cleaning is particularly important prior to commencing any testing. Always allow at least 90 seconds between cleaning and testing to ensure that the cleaning fluid has evaporated.

11.0 Testing

Once installed, the system must be tested in accordance with the procedure described below. Tests shall be performed at either 850nm and/or 1300nm. When tests are conducted using a power meter and stabilised light source, testing in one direction is sufficient. When tests are conducted using an OTDR, testing in both directions is required. In both cases, 100% of installed links shall be tested.

In addition to testing link loss, an OTDR can give information on link length, the insertion loss of individual events in the fibre and, in some instruments, return loss of individual events. An OTDR is also useful for fault finding.

The test procedure described here complies with the requirements of the generic cabling standards ISO/IEC 11801 and EN 50173.

11.1 Test equipment requirements

The test equipment does not have to be manufactured by 3M, although if an OTDR is to be used the 3M Mini-OTDR is recommended.. Other than in an OTDR, the use of a laser source is not recommended for testing multimode fibre. For testing singlemode fibre either a laser or an LED source can be used provided the dynamic range of the equipment is sufficient to test the link. The source characteristics of the transmitter in the test set are given in table 2.22.

Table 2.22 Source characteristics

System Type	Nominal wavelength (nm)	Minimum wavelength (nm)	Maximum wavelength (nm)	Reference test wavelength (nm)	Spectral width (FWHM) (nm)
Multimode	850	790	910	850	150
Multimode	1300	1285	1330	1300	150
Singlemode	1300	1290	1330	1310	10

11.2 Launch Conditions – Multimode fibre

A mandrel wrap mode filter must be used to remove unwanted transient higher order modes and reduce measurement inaccuracies.

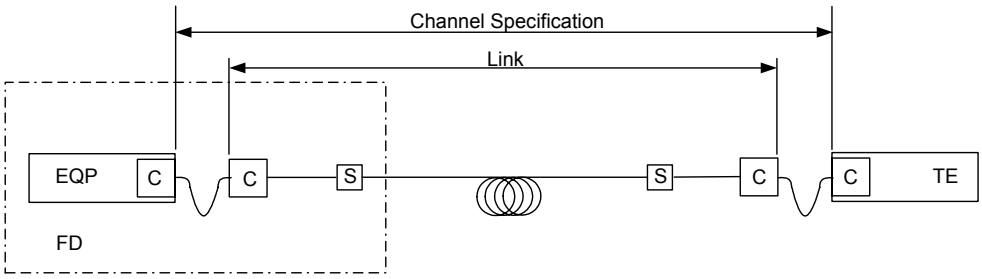
The mode filter for multimode fibres consists of five closely wound turns on a smooth cylindrical mandrel of the following diameter:

Fibre core size (μm)	Mandrel diameter (mm)
50	15
62.5	17
Singlemode	No mandrel required
Note: These figures are for Volition 3mm diameter test cables	

Important: Only the transmit leg of the test cord should be wound on the mandrel. The cord attached to the detector should not be mandrel wrapped.

11.3 Link and channel definition

Both the International Standard ISO/IEC 11801 and the European Standard EN 50173 define a permanent link and a channel. The permanent link is the permanently installed part of the cabling. The channel is the full end to end connection including the equipment and work area cables (note however that the channel does not include the loss attributable to the equipment connectors). See figure 2.11, taken from Figure 7 in EN 50173.



EQP Equipment in FD
FD Floor Distributor
C Connection
S Splice
TE Terminal Equipment

Figure 2.11 Permanent link and channel definition

Notes:
1. The link, the permanently installed part, contains two VF-45™ connections (not connectors!).
2. The link is allowed to have two splices. This facilitates implementations with pigtails, but is not necessary with the VF-45 socket, which is field terminateable. However, one splice could be present in the installation in the transition between building backbone and horizontal cables.
3. The channel, and therefore the generic cabling, does not include the connections to the equipment on both ends of the link, because these connections are considered to be application specific.

11.4 Testing procedure

Because of the plug and socket arrangement of the VF-45™, the following procedures must be adopted.

11.4.1 Light source and power meter

First, ensure all plugs and sockets on the links to be tested and the reference leads to be used are clean. In addition to the reference leads, the patch lead added in Figure 20 plays an important part of the measurement and all should be treated with care. The working end of this lead should be cleaned after a maximum of twenty-four matings to avoid an accumulation of dirt on the end face of the fibre. For cleaning testing plugs the VF-45™ Plug cleaner should be used (VOL-0570B).

Reference the output from the source as shown in Figure 2.12

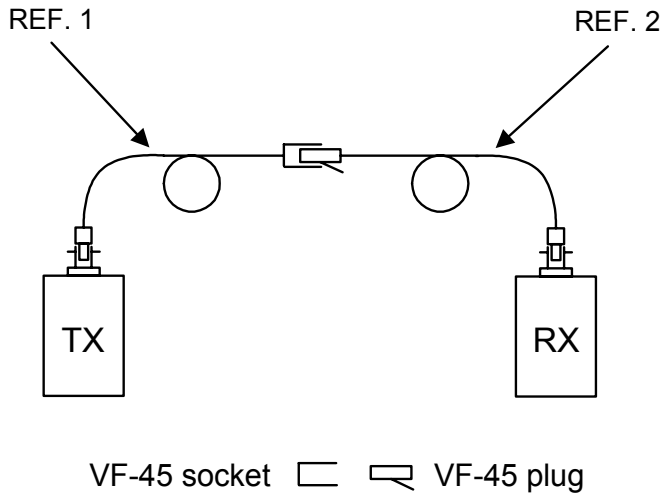


Figure 2.12 Power meter referencing

Since the Volition link has a VF-45™ socket on each end of the installed cable, the socket on REF. 1 now needs to have a VF-45 plug on the free end. Adding a VF-45™ to VF-45™ patch cable as shown in Figure 2.13 does this.

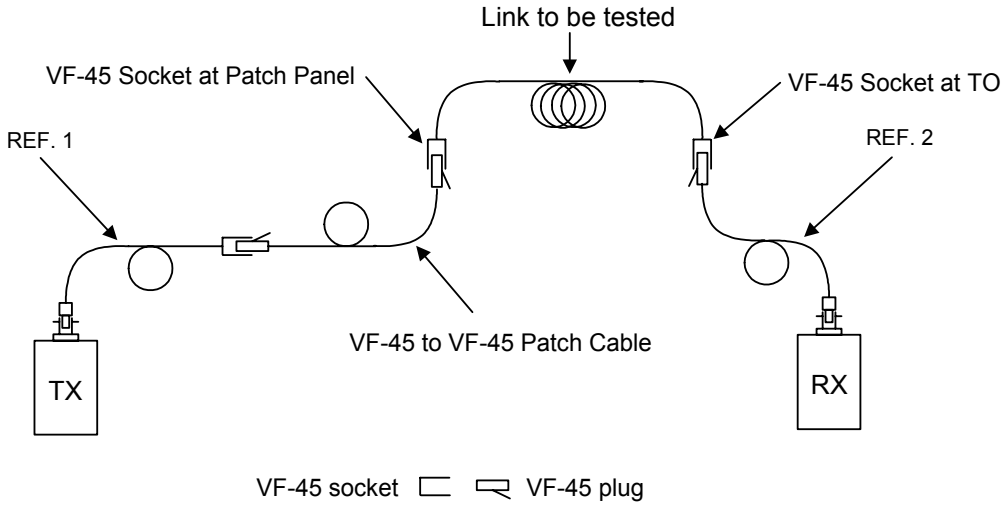


Figure 2.13 Measurement of channel attenuation

Refer back to figure 2.11, showing the channel definition. It can be seen that the channel consists of the horizontal cable, 2 connections and an allowance for the equipment and work area cables (given by the cable in the patch leads and the REF 2 cable).

NB: To estimate the performance of an individual connection it is necessary to divide the test result by two and subtract the attenuation due to the fibre.

It is also necessary to keep in mind that the patchcord used to test the link is not part of the reference measurement. If the patchcord is damaged in any way it will affect the test results for the links under test. If link attenuation results are found which are consistently higher than expected, the patch cable is suspect.

11.4.2 OTDR Method

An OTDR measures the decrease in backscatter returned to the instrument as a light pulse, emitted from the instrument, passes through the fibre and device under test. Figure 2.14 shows the set up that must be used to test the link. The launch lead must be longer than the near end dead zone of the OTDR being used. 3M has a range of launch boxes in its product portfolio that can be used for this purpose. It is essential that the specification of the OTDR being used be checked to ensure that a suitable length lead is obtained. Similarly, the far end tail lead must be longer than the event dead zone of the OTDR. In most cases, a 100m launch box should be adequate, but again the OTDR specification should be checked.

Note that both the near end and event dead zones of the OTDR will be affected by the pulse width being used. In order to improve the accuracy of the measurement, the shortest pulse width option that gives the required distance range should be selected. Use the shortest pulse width that will give a smooth trace in the required averaging time. Using a short pulse width will also result in the shortest near end and event dead zones for the particular test configuration being used.

Use of the launch box and far end fibre patchcord is essential in order that both connections on the link can be clearly seen on the OTDR trace allowing accurate positioning of the cursors.

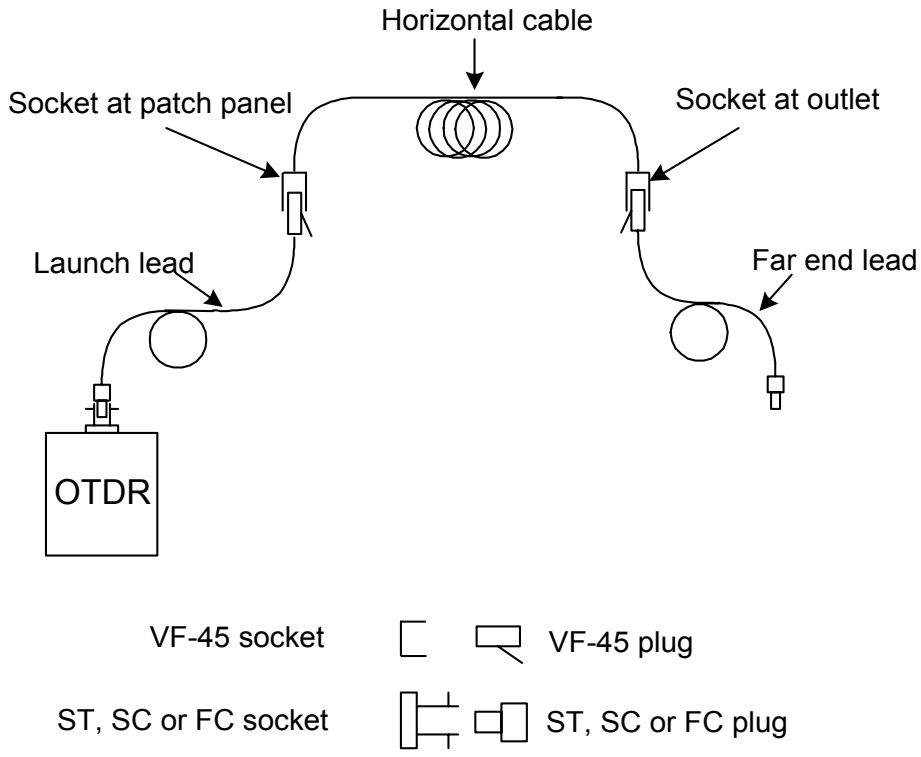


Figure 2.14 Channel attenuation measurement using an OTDR

Trace Analysis: Method 1 - to measure link attenuation

Once the link to be tested has been connected to the OTDR as shown in Figure 2.14, the fibre should be scanned and the results averaged until a suitable trace is displayed on the OTDR screen. The

averaging time will be determined by a number of factors related to the performance characteristics of the OTDR and pulse width used. The resulting display will however look like that shown in Figure 2.15. The peak reflections correspond to the initial launch into the fibre and the connectors present on the link.

Analysis of the trace should be accomplished using the two point method. The cursors A and B must be carefully positioned as shown in the figure. Great care must be taken to ensure that the cursors are positioned at the correct points on the trace.

Cursor A must be positioned before the point at which the trace begins to rise at the leading edge of the reflection corresponding to the first connector.

The curve on the trailing edge of each reflection peak in the trace corresponds to the decay response of the OTDR detector and is typical of most OTDR's. The length of the decay is a function of the detector and of the amplitude of the peak (reflected pulse). Cursor B must be positioned such that it is clear of the trailing edge and on the straight portion of the trace. A total allowance of approximately 10m should be made (5m in front of the first connector, 5m behind the second connector) to allow for the work area cords.

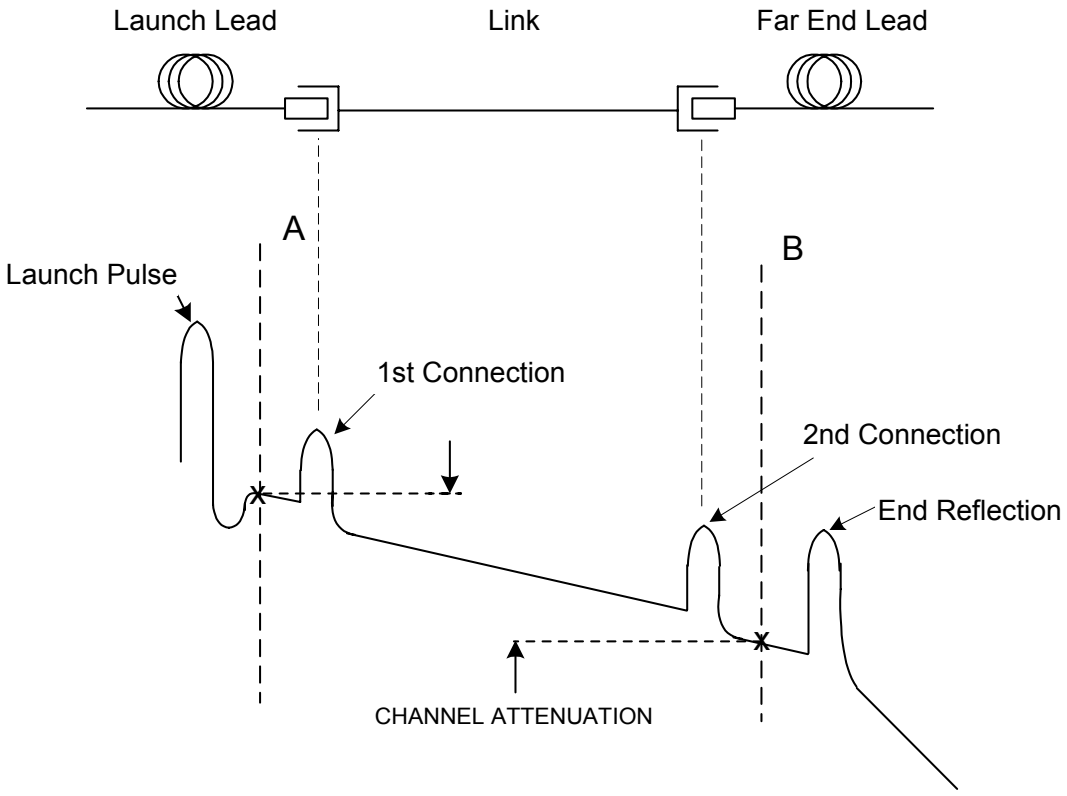


Figure 2.15 Trace analysis – two point method

Using this method the OTDR calculates the vertical distance between the two points A and B on the trace and displays the result as attenuation in dB.

To obtain an accurate value for channel attenuation, the OTDR must be taken to the other end of the link and the measurement repeated. The two results are then added together and divided by two to obtain the average attenuation for the channel.

Trace Analysis: Method 2 - to measure connector attenuation

If required it is possible to measure the attenuation of an individual connection (mated connector). This would be useful if the channel attenuation was out of specification and it was required to measure the attenuation attributable to the connection at each end of the channel. In this case method 2, the four-point (least squares approximation) method should be used.

The same configuration as previously described should be used and the resulting display should still look like that shown in Figure 2.15. However the analysis of the trace should be as shown in Figure 2.16.

Analysis of the trace should be accomplished using the four-point method. The cursors A, B, C and D should be carefully positioned as shown in the figure. Great care should be taken to ensure that the cursors are positioned at the correct points on the trace.

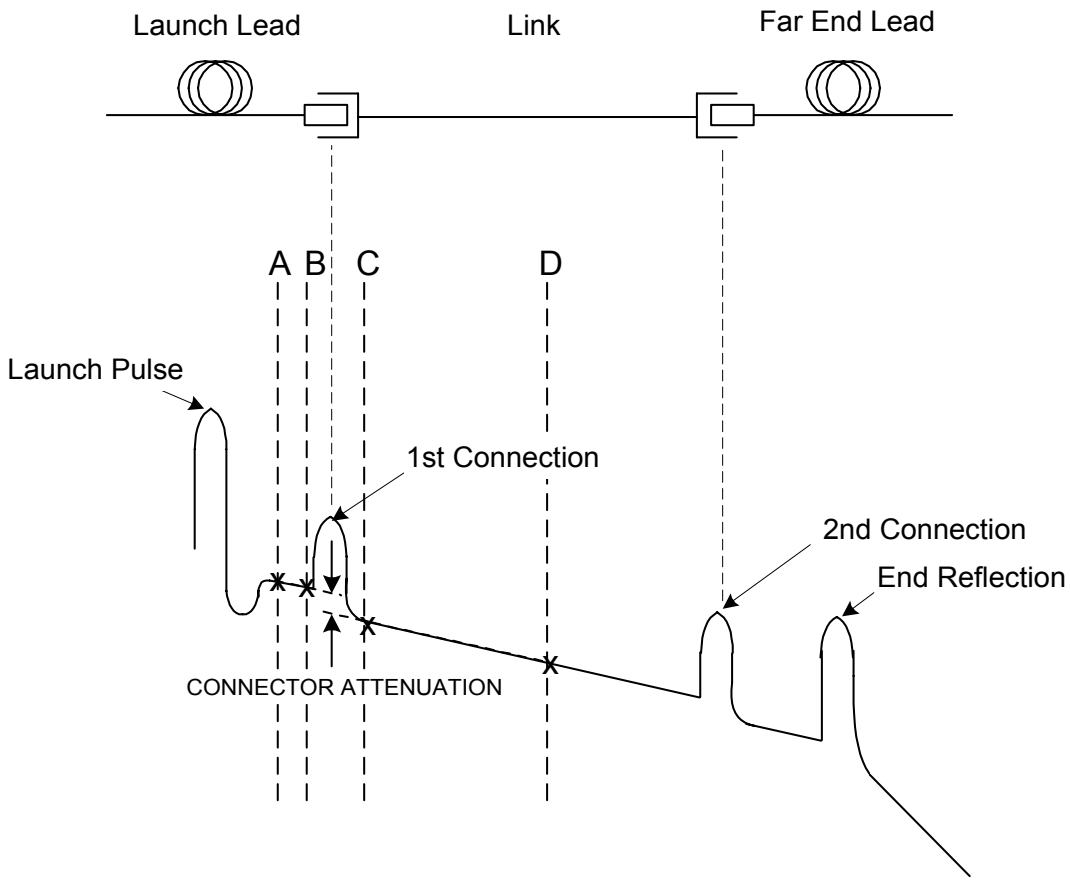


Figure 2.16 Trace analysis – four point method

Cursor B should be positioned just before the point at which the trace begins to rise at the leading edge of the reflection corresponding to the first connector. Cursor A should be positioned as far away from B as possible while remaining on the straight portion of the trace.

Cursor C should be positioned such that it is just clear of the trailing edge and on the straight portion of the trace. Cursor D should be positioned as far away as possible from cursor C while remaining on the straight portion of the trace.

When using this method the OTDR calculates** (using the least squares approximation formula) the best fit straight line between points A and B on the trace and between points C and D on the trace. It then projects these lines to a point where the vertical distance between them can be calculated and displays the result as attenuation in dB.

This procedure can be repeated by repositioning the cursors about the second connection on the link.

To obtain a value for connection attenuation, the OTDR must be taken to the other end of the link and the measurement repeated. The two results are then added together and divided by two to obtain the average attenuation for the connection.

** The 3M Mini-OTDR will automatically take measurements if 'scan trace' is selected

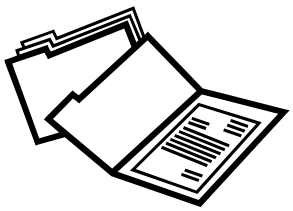
11.5 Link performance requirements

It is only required to measure the attenuation performance of the link. Bandwidth and return loss measurements are not required.

The maximum attenuation shall not exceed the values specified in Table 5 of this manual.

11.6 Test Report

Upon completion of the testing a fully documented test report must be produced. The contents of the test report shall include at least the following information:



- system location
- testing date
- type of test equipment with calibration date
- name of person(s) performing test
- attenuation details of each link tested
- for power meter and light source tests either a data reader should be supplied or the results should be in 'Excel' format
- if an OTDR was used viewer software should be supplied

PART 3 COPPER CABLING SYSTEM

SECTION 1 DESIGN AND PLANNING

This section of Part 3 gives detailed information relating to the design and planning of the Volition copper cabling system. In defining the maximum permissible link lengths, due consideration has been taken to ensure that the system complies with the appropriate transmission protocol standard.

12.0 Link design criteria

Depending on the products used, the copper cabling system meets all the performance requirements of the existing and known forthcoming national and international cabling standards up to and including Class E link and Category 6 hardware (ISO/IEC 11801 and EN 50173) and Category 6 link and hardware (EIA/TIA 568) requirements. The following design criteria must be observed in order to satisfy the extended warranty requirements for the Volition system.

12.1 Maximum link and channel length

The maximum link length for all copper cabling shall not exceed 90m (this excludes the work area patch cables and patch cables used to connect to electronic equipment). The maximum overall length of the channel shall not exceed 100m.

12.2 Use of Ethernet and Fast Ethernet switches

Where Ethernet and Fast Ethernet switches are used the following guidelines on cascading and stacking should be followed.

12.2.1 Cascading

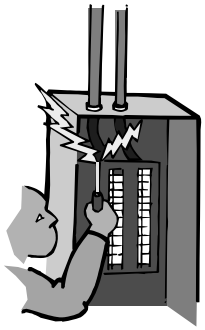
It is recommended that no more than four Ethernet switches or two Fast Ethernet switches be cascaded in order to avoid problems occurring in the transmission system associated with latency.

12.2.2 Stacking

Follow the instructions supplied by the switch manufacturer to ensure that the switches are stacked correctly.

13.0 Planning guidelines

The following paragraphs give guidelines on planning a Volition copper cabling system.



For safety and transmission performance reasons, 3M recommend the separation of copper data cable from power cabling and certain items of electrical equipment. This can be achieved either through use of separate cable support structures or by physical restraint of the cabling within the same support structure. Recommended separation distances are given in Table 3.1 taken from EN 50174-2. In addition, where cabling has to pass through a fire rated wall, floor or other barrier, it is essential that an appropriate fire stop material be used.

Table 3.1 Minimum distances between IT and power cables

Type of installation	Minimum separation distance (mm)		
	Without metallic divider	With aluminium divider	With steel divider
Unscreened power cable and unscreened IT cable	200	100	50
Unscreened power cable and screened IT cable	50	20	5
Screened power cable and unscreened IT cable	30	10	2
Screened power cable and screened IT cable	0	0	0

Notes:

1. Power and data cabling, when installed in a sub-floor installation, should preferably be run at right angles to one another with appropriate bridging points, giving the required separation being provided at the crossing points.
2. If the horizontal cable length is < 35m and screened IT cabling is used, no separation is required.
3. If the horizontal cable is > 35m and screened IT cabling is being the separation distance does not apply to the final 15m of horizontal cable.

13.1 Screening

A cable screen creates a barrier between the external electromagnetic environment and the transmission line inside the screen. The performance of the screen depends on the design of the screen, the material from which it is constructed and on the way it is connected to local earth.

If screened cable is being installed, 3M recommend the following:

- The cable screen should be continuous from one end of the link to the other and shall be connected at both ends to the RJ45 jack.
- Special attention shall be paid to the assembly of the screened RJ45 jacks. The screen contact should be applied over 360 degrees.

13.1 *Horizontal copper cabling*

The horizontal fibre cabling is the first element of the system to be considered. From the floor layout drawing (Figure 2.2) showing the positions of the outlets, determine the best location for the floor distributor or transition point. Factors that should be considered with regard to floor distributor location are:

- position in relation to floor distributors on other floors
- position in relation to the building distributor and backbone cable
- size in relation to number of anticipated users.

Factors that should be considered with regard to transition point location are:

- position in relation to the building distributor and backbone cable
- size in relation to number of cables to be spliced

Having decided on the best position for the floor distributor/transition point, plan the best route for the horizontal cable to take to each outlet point (TO). The route chosen should allow access for cable placement and meet cable bend radius requirements.

Generally as a minimum, the TO should provide a minimum of one interface for voice and one for data. In some cases more interfaces will need to be provided and this should be planned accordingly. Open office cabling, sometimes referred to as zone cabling is also an option and provides a multiple TO location that enables several work area cables to be routed from the same point.

Repeat this procedure for each floor of the building.

13.1.1 Floor distributors

It is recommended that at least one floor distributor be provided for every 1000m^2 of office floor space (ISO/IEC11801). EIA/TIA 569A gives details of the recommended size requirements for floor distributors and Table 2.5 suggests alternative sizes more suitable to the European market.

13.1.2 19" Patch panels for floor distributors

The Volition range of copper patch panels covers a variety of configurations (see Part 6).

It is essential to choose the correct patch panel for the jack that is to be installed in it (the One-Click Giga, K5E and K6 RJ45 jacks have different mounting arrangements). Adequate patchcord management features must be provided to ensure minimum bend radius specifications of the patchcord are not exceeded Depending on the patch panel chosen, these features can be provided on the front face of the rack, using the P33340AA0000 (1U) and/or P33345AA0000 (2U) cable management panels, or alternatively, if 800mm wide racks from the QVSL range are being used, cable management rings that locate on each side of the rack should be used. If cable management panels are being used, 1U of cable management space should be provided for every 24 ports to be patched. If rack mounted management features are being used, sufficient features should always be used to ensure the minimum bend radius of the patch cable is not exceeded.

Table 3.2 Patch panel requirements

Work Stations	19" Rack Space (u)	19" Rack Space (u) including cable management panel
≤24	1	1
25-48	2	2
49-72	3	4
73-96	4	5
97-120	5	7
121-144	6	8
145-168	7	10
169-192	8	11
193-216	9	13
217-240	10	14

13.1.3 19" Racks and cabinets for floor distributors

There are two ranges of 19" racks, the BCCS range which is available in three heights and 800 x 800 and 600 x 800 formats and the QVSL 2000 range which is available a number of heights in both free standing and wall mounting versions.

OVSL Basic

The QVSL 2000 range of floor standing 19" racks and cabinets offers a comprehensive solution to housing patch panels and through special adapter frames (sub-racks), STG 2000 and RCP 2000 modules, which are both rated up to Category 5E performance.

QVSL Compact

All versions are manufactured from sheet steel and finished in a grey (RAL 7022) powder coating. Lockable doors are provided front and back and the front door is attractively finished with a smoked glass viewing panel. The QVSL Basic rack is 2m (42U) high, for smaller installations, the QVSL Mini that is just 1,1m (20U) high is available. If space is limited and neither of these options is acceptable, then there is also the QVSL Compact family of wall mountable cabinets to select from, with cabinets ranging in height from 6U to 15U. Table 3.3 gives outline dimensions, further details are included in Part 6.

Table 3.3 Racks and cabinets for floor distributors

Description	Height (U)	Size (mm) (H x W x D)
BCCS rack 24U high (steel rear door, glass front door)	24	800 x 600
BCCS rack 36U high	36	600 x 600
BCCS rack 42U high	42	2000 x 600 x 600
Basic Type 1 without mounting frame	42	2000 x 800 x 600
Basic Type 2 including 19” frame	42	2000x 800 x 600
Basic Type 3 including 19” swing frame	40	2000 x 800 x 600
Basic Type 4 without mounting frame	42	2000 x 800 x 800
Basic Type 5 including 19” frame	42	2000 x 800 x 800
Basic Type 5A including 19” frame +	40	2000 x 800 x 800
Basic Type 5B including 19” frame +	40	2000 x 800 x 800
Basic Type 6 including 19” swing frame	40	2000 x 800 x 800
Server	42	2000 x 600 x 900
Server mini	20	1100 x 600 x 900
Mini no 19”	20	1100 x 800 x 600
Mini w /glass door	20	1100 x 800 x 600
Compact 15	15	770 x 600 x 580
Compact 12	12	645 x 600 x 580
Compact 9	9	495 x 600 x 580
Compact 6	6	370 x 600 x 580
Pico 1	4	550 x 450 x 215
Pico 3	6	550 x 450 x 315

13.1.4 Telecommunications outlets

Many different designs of telecommunications outlets are offered and it is important to choose the correct design for the application. The RJ45 Giga jack and the K5E and K6 RJ45 jacks have different mounting arrangements that are not compatible with each other, however the K5E and K6 jacks do use the same mounting arrangement (keystone) as the VF-45™ socket. Whilst it is not possible to mount the VF-45™ socket into the copper TOs described here, it is possible to mount the K5E and K6 jack into the VOL-0256 outlet as shown in the picture opposite.

Outlets can be located on the wall, floor or elsewhere in the work area (e.g. in trunking or in custom modular furniture). The cabling shall be planned in such a way that the outlets will be readily accessible and the outlets shall be positioned such that the plug on the patchcord can easily be inserted into the jack. It is preferable that the sockets do not face upwards where dirt and dust can collect on the door and possibly contaminate the contacts when the plug is introduced. A high density of outlets will enhance the flexibility of the installation.

13.2 Building backbone cabling

The building backbone cable is the second element of the system to be considered. The backbone is the main feeder cable route within the building carrying all the signals from the FDs to the BD and or CD. It ultimately provides the interface to the external network

The backbone must not only be cable of supporting current networking needs, it must also be capable of supporting future network growth.

Factors to consider regarding the backbone include:

- The size of the network (e.g. number of TOs, link lengths required to get from the FD to the furthest TO)
- The network operating speed to the workstation and hence the bandwidth required in the backbone to support that speed without causing transmission "bottlenecks")
- The position of any workgroup and enterprise servers (which will also have an impact on the bandwidth requirement of the backbone)
- The requirements to expand the network in the future

The design process for the backbone has three main steps:

1. Determine the backbone requirements for each floor
2. Determine the best route(s) for backbone cable
3. Determine the supporting structures required

Step 1. Determine backbone requirements for each floor

Determine the backbone requirements based on the above factors. Because of the technical problems associated with the sharing of voice and data signals in the same sheath, 3M recommend separate backbone cables for voice and data. Except in the smallest of installations, 3M recommend a fibre backbone cable. The number of fibres in the cable should be determined based on the total number of uplinks to be provided. It is recommended that extra fibres be provided to each FD to allow for future expansion of the network. In this case the backbone cable should not contain any splices.

Step 2. Determine the best route for backbone cable

From the building layout drawing, determine the best location for the building distributor (this may often coincide with the point of entrance of the telecommunications cables into the building). Select the best route(s) to connect each floor distributor to the building distributor. The route should not result in the minimum bend radius of the cable being exceeded. This figure varies depending on whether the cable is under load or not. If a fibre backbone is being installed, Table 2.19 gives details.

Although there are two major types of shafts (closed and open), local *codes* usually mandate the much safer closed shaft. However variations are sometimes necessary as the structure of an existing building may not allow for a single continuous route.

The following paragraphs explain the options available for locating the backbone cables through the building.

Vertical riser shaft options include:

- sleeve method
- slot method

Sleeve Method

Used in the riser shaft, sleeves are short lengths of conduit, usually made of rigid metal pipe 100mm in diameter. They are placed in a concrete floor as it is being poured and protrude 25 mm to 100 mm above the floor. Cables are often tied to a steel support strand that, in turn, is fastened to a metal strap bolted on the wall. Sleeves are used when the closets are vertically aligned

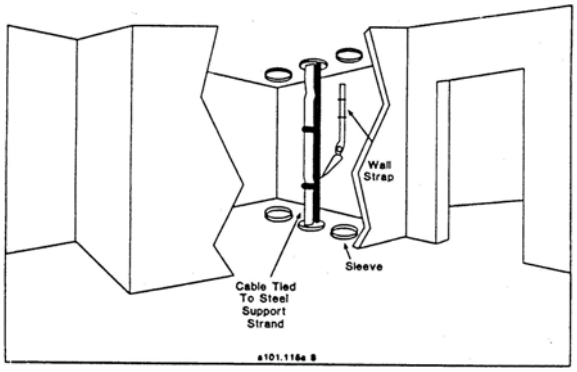


Figure 3.1 Sleeve method

Slot Method

The slot method is sometimes used in riser shafts. Slots are rectangular openings in each floor that enable cables to pass through from floor to floor, as shown opposite, The size of the slot varies with the number of cables used. As in the sleeve method, cables are tied or clamped to a steel support strand fastened to a wall strap or floor bracket. Vertical racks on the wall adjacent to the slot can support large cable distributions. Slots are very flexible, allowing any combination of cable sizes. Although more flexible, slots are more expensive to install than sleeves in an existing building. Another disadvantage is that unused slots are difficult to fire stop. They may also damage the structural integrity of the floor if care is not taken during installation to avoid cutting floor support.

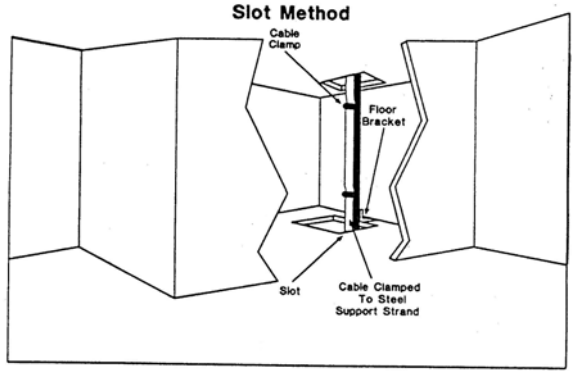


Figure 3.2 Slot method

In multi-storey buildings, lateral (or horizontal) runs of the backbone cable are often necessary to cover the distance from the BD to the riser shaft and, up on the floors, from the riser shaft to the FD. Remember that lateral runs, which need to follow a convenient, easily installable pathway, are rarely simple straight lines between endpoints.

Horizontal riser shaft options include:

- conduit method
- rack method

Conduit Method

In conduit backbone systems, metal conduit is used to house and protect the cables. Conduit allows pulling of cables in vertically offset paths caused by a horizontal offset between backbone closets on adjacent floors. In open shafts and in lateral backbone distribution, such as through a basement area, conduit provides mechanical protection for cables. Conduit offers the advantage of being fireproof and providing a concealed, unobstructed housing for pulling cable to a location. Conduit is, however, difficult to relocate and, therefore, relatively inflexible. It is also expensive and requires extensive planning to run the proper sizes to the correct locations.

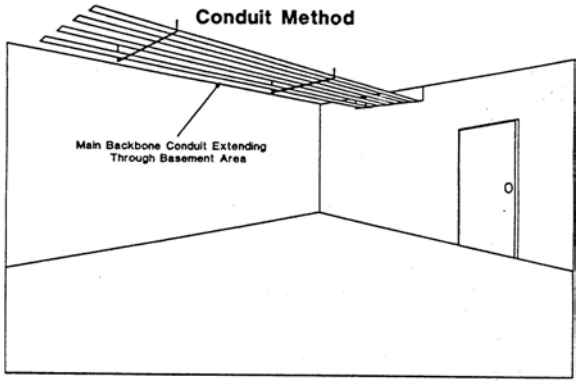


Figure 3.3 Conduit method

Rack Method

Racks, sometimes called cable trays, are aluminium or steel assemblies that resemble ladders. They are attached to the building wall for vertical cable runs and to the ceiling for horizontal runs. Cables are laid along the rack and tied to its horizontal support members, as shown above. The rack method is preferred when large numbers of cables are used. The size and number of cables for installation determines the size of the rack. Racks allow easy placing of cable and eliminate the problems associated with pulling cables through conduits. However, cable racks and supports are expensive. This method leaves cables exposed, is difficult to fire stop and is sometimes not aesthetically acceptable.

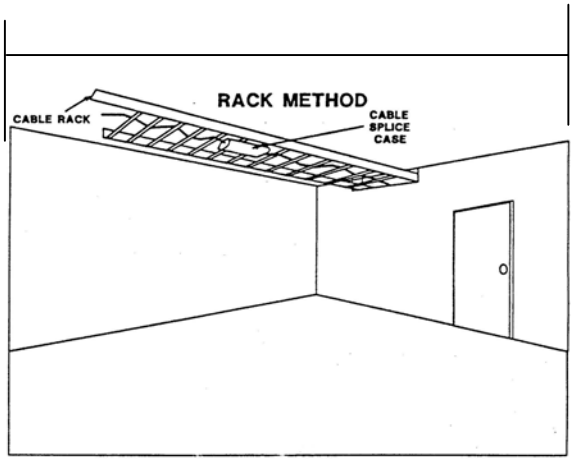


Figure 3.4 Rack method

Step 4 Determine the supporting structures required

Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support the cable. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit the installation. If necessary, in stud walls, provide special supports from the floor to the structure above. For pre-cast panels/planks and metal decks, support all communication cables to the satisfaction of the owner's representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. The size, gauge, and strength of any mounting plates used shall be sufficient for the size, weight, and desired rigidity of the cable(s) being installed.

13.2.1 Building distributors

EIA/TIA 569A gives details of the recommended space requirements for building distributors. Table 2.16 suggests alternative floor area sizes more suitable to the European market.

13.2.2 Patch panels, racks and cabinets for backbone cabling

Refer to paragraphs 4.1.4 and 4.1.5 for information on patch panels and 13.1.3 for information on racks and cabinets suitable for use in BDs and CDs for backbone applications.

SECTION 2 – INSTALLATION AND TESTING

14.0 Safety and pre-installation preparations

The following paragraphs are written to ensure a quick, error-free installation that minimises risk to the installer, his equipment and the end user. It covers matters relating to:

- safety
- use of tools and equipment
- pathway planning
- cable construction and handling procedures.

Refer to paragraphs 5.1 to 5.1.6 for guidance on safety and 5.2 for guidance on planning the installation.

14.1 Pathway planning

Refer to paragraph 5.2 for guidance on planning cable pathways

14.2 Cable handling

The following techniques are commonly used during the cable installation process.

Care should always be taken to ensure the method used and the final cable placement does not degrade cable performance.

Installation requirements for cable placement are also found in standards such as ISO/IEC 11801, EN50173, EN50174 and ANSI/TIA/EIA-568.

14.2.1 Cable on reels

A “cable dispenser” should be used to dispense cable supplied on a reel. The reel(s) are installed on rollers and the cable is pulled for smooth and even feeding. Alternatively, the reel(s) can be placed on a steel bar that is then supported securely on stands at each end. When pulling cable from a reel, it is important to pull the cable from the bottom of the reel.

14.2.2 Cable in boxes

Cable supplied in boxes can be pulled straight from the box. Care should be taken to pull the cable smoothly to avoid twisting and kinking the cable. If necessary secure the box(es) to prevent them from being pulled along the floor as the cable is dispensed.

14.2.3 Volition horizontal copper cable construction/sheath colour code

Volition horizontal copper cables have either a PVC or a low smoke zero halogen sheath. In both cases the sheath is coloured green. Category 5E and Category 6 cables are constructed as shown in Figures 3.5 and 3.6, The installation specification for each is shown in table 3.4. Detailed specifications for each cable are included in Part 6.

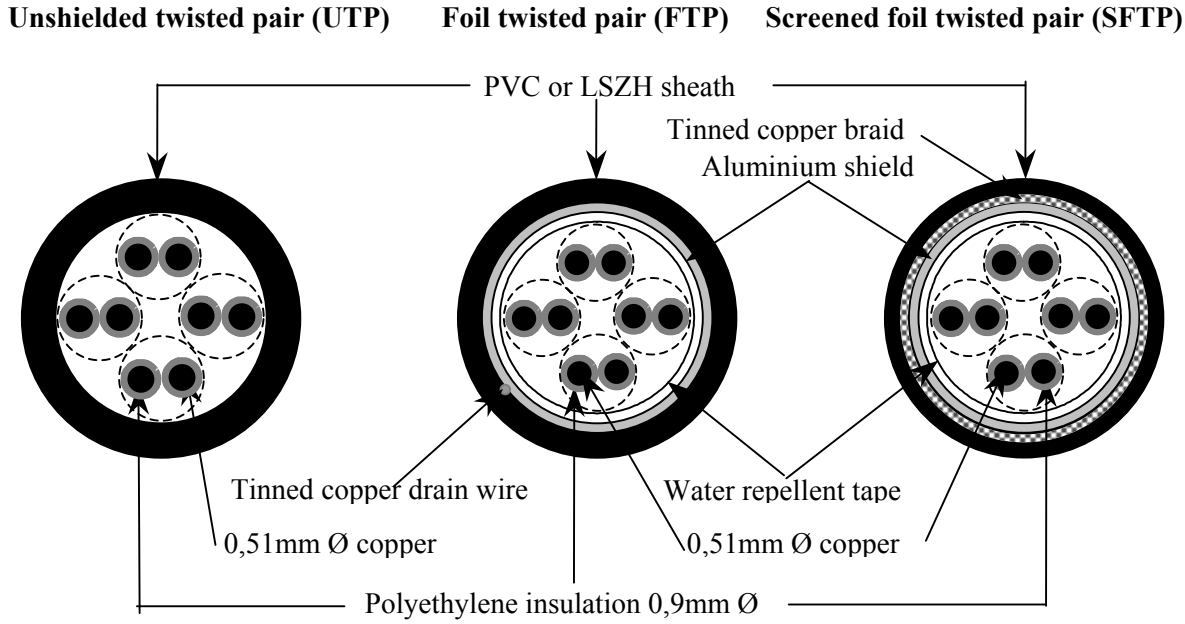


Figure 3.5 Category 5E cable constructions

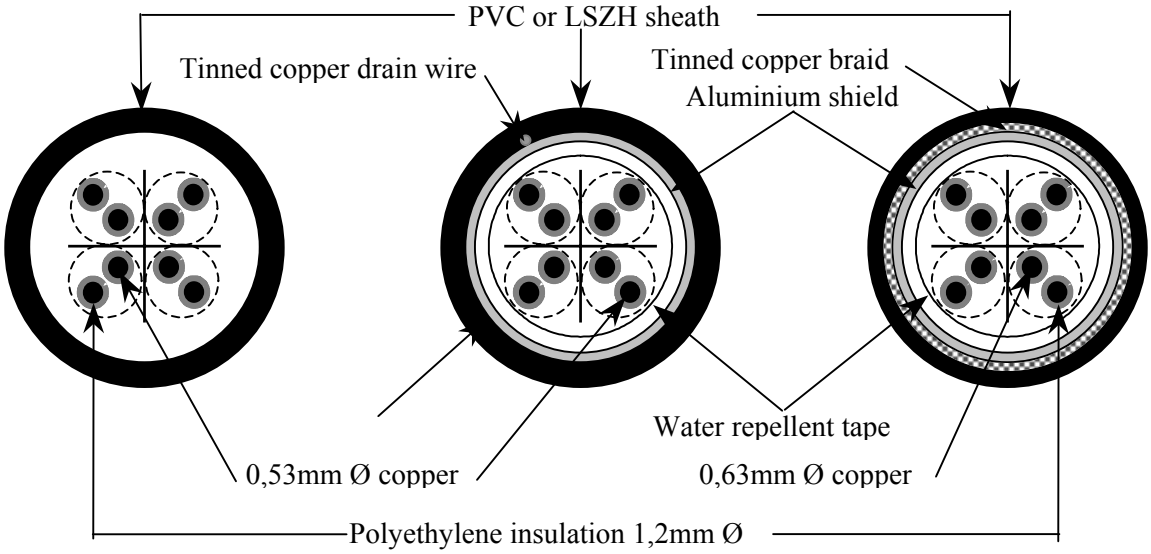


Figure 3.6 Category 6 cable constructions

Table 3.4 Horizontal copper cable installation specification

Cable type	Minimum bend radius (mm) Short term/long term	Nominal cable diameter (mm)	Nominal cable weight (kg/km)	Maximum pulling load (N)
Cat 5E UTP	40/20	5,1	32	100
Cat 5E FTP	50/25	6,0	40	115
Cat 6 UTP	52/26	6,5	48	100
Cat 6 FTP	58/29	7,1	55	140
Cat 6 SFTP	60/30	7,5	63	140

14.2.4 Volition horizontal copper cable conductor colour code

Table 3.5 gives the fibre colour coding details of Volition horizontal cable

Table 3.5 Colour coding

Pair Number	Colour
1	White blue/blue
2	White orange/orange
3	White green/green
4	White brown/brown

14.3 Cable pulling

It is essential that Volition copper cables are never subjected to a bend tighter than the minimum bend radius specification and that the maximum pulling load is never exceeded. The minimum bend radius varies according to whether the cable is under load (during the pulling operation) or unloaded (after the pulling operation).

Cables are pulled along the planned routes – usually with a rope or a rod. The pulling rope and the connection between the rope and the cable should be strong enough to withstand the load required to pull the cable into place. The connection between the rope and the cable should be as smooth as possible to ensure it will not snag along the pull route.

14.3.1 Preparing Volition cable for pulling

As a guide, up to 12 horizontal Volition copper cables can be pulled at a time. If the route is short (<30m) and straight with easy access to the cable path, the cable may be pulled off the reel and laid into place directly without accessing the strength members**.**

Care should be taken however to ensure that the cable is not damaged or kinked as this could impair the transmission performance of the cable.

For routes that require the cable to be pulled into position, it is important that the load is applied to all the cables and distributed through all the conductors evenly. This will prevent stretching of the conductors and damage to the cable sheath

The following procedure should be followed:

1. Strip the sheaths of the cables approximately 30cm.
2. Tape over the sheaths of the cables to form a single bundle
3. Group the conductors in all the cables and twist them together.
4. Form the twisted conductors into a loop, taping the conductors alongside the cables.
5. Place the pulling rope through the loop and tie a knot.
6. Tape over the entire assembly make a smooth and compact pulling end.

14.3.2 Preparing Volition fibre backbone cable

The construction of fibre backbone cable makes the cable sheath less susceptible to being stretched and if the route is short (<30m) and straight, this will only require the cable end to be wrapped over the sheath with tape together with a rope. The transition between the end of the cable and the rope should be as smooth as possible to prevent it getting caught. As a guide, backbone cables of 48 fibres and above are normally installed individually although where space and the nature of the route permits, it is possible to pull more than one cable at a time.

For long and or difficult routes, the pulling load should never be applied directly to the cable sheath. In such cases the following procedure should be adopted:

1. Strip the sheath of the cable approximately 50cm.
2. Cut the fibres at the cable jacket and

either

3. Group the aramid yarn into two bunches
4. Weave the two bunches to create a loop, twisting the ends
5. Place the pulling rope through the loop and tie a knot
6. Tape the end along with the rope to make a smooth and compact pulling end,

or

7. Attach the central strength member to the pulling rope using a suitable attachment

In both cases if a winch is being used to pull the cable, a suitable overload protection device shall be used to prevent the maximum pulling load of the cable from being exceeded.

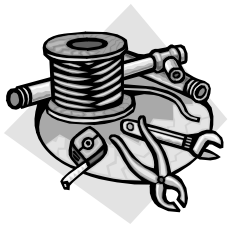
15.0 Installing Volition fibre backbone cable

Refer to paragraph 6.0 for detailed information on installing Volition fibre backbone cable.

16.0 Installing Volition copper horizontal cable

16.1 Installation procedure

The cable should be installed on a cable support located above a ceiling, in a wall or under a floor.



Where multiple supports are being used, each support should be filled to its maximum fill ratio before using the next support. Where cable trays or conduits are stacked, the top support should be filled to its maximum before cable is installed on the lower supports.

The cable should take the most practical direct route, ensuring that the maximum permitted link length (90m), minimum bend radius specification and maximum pulling load is never exceeded. Several cables can be pulled at the same time in order to reduce the time taken for the installation. Remember never to apply the pulling load directly to the cable sheath. Follow the instructions given in paragraph 14.3.1.

If the route incorporates tight bends or obstruction points, extra help should be deployed in these areas to guide the cables to ensure they do not get trapped. This will also reduce the pulling load that needs to be applied to the cable. Use cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on: long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 30m with bends of opposing directions and in conduit runs that exceed 180 degrees of accumulated bends. The use of tensile rated cords (e.g. fishing line) should be considered for difficult or questionable pulls.

Cable tie wraps shall be used such that they can spin freely on cable bundles. Over-tightening and crushing of cables can affect the transmission performance of the cable.

After installation, ensure a minimum of 1,5m of cable slack is available at each end of the link (i.e., patch panel/splice box and outlet) for termination of the “one-click” jack.

16.1.1 Cable rodding equipment

Cable rodding sets are used for installing horizontal cable in hard-to-get-to locations, or to route the cable past obstructions. The rod is attached to the strength members of the cables being installed. Depending on the nature of the location, the length of the rod can be extended by screwing on additional rods. The rod can be used to bridge through difficult locations with the cable attached. These steps may have to be repeated several times along a cable route.

16.1.2 Pull cords

Generally, pull cords are placed by blowing them into conduit, or by placing them along a cable support (cable tray) with a rod. It is important to pull a replacement pull cord with the cable in order to facilitate the installation of subsequent cables.

16.1.3 Floor distribution systems

Floor distribution systems include under-floor trunking systems, conduit systems and access floor systems. Except for conduit systems, cable routes should either run parallel to, or perpendicular to, the building lines.

Under-floor trunking systems are characterised by having either trunking or duct running from the telecommunications closet to strategically placed junction boxes in the floor. The trunking generally extends at 90-degree angles from the telecommunications closet and feeds into junction boxes. Distribution trunking is then used from the junction boxes to feed the floor outlet locations that are placed to serve a predetermined area of the floor.

Access floor systems are mostly found in computer rooms. However, they are being used more extensively in densely populated areas where a significant number of outlets may be installed.

16.1.4 Ceilings

Volition cables shall not be placed directly onto suspended ceiling tiles. Cable support systems such as cable trays, or conduit, shall be employed. When pulling cables through a suspended ceiling space, every two to three tiles should be removed for access. This will assist in the routing of the cable around obstructions etc. and facilitate the installation of cables in the support system employed.

16.1.5 Walls

Cables installed above a suspended ceiling will need to be dropped down to the work area. The cable may be routed down a distribution column into which the outlet is located, or dropped down a wall cavity. Dropping cables down an empty wall cavity is generally not difficult. A rod may be used or even a string tied to a weight. A rod is most suitable for insulated walls.

16.2 Cable preparation in the TO termination area

To prepare the cable in the TO termination area the following procedure should be adopted:
Do not untwist cable pairs more than 0.5 in. when terminating.

1. Trim any excess cable so that the conductors are flush with the end of the cable sheath
2. Ensure the cable sheath cutter is correctly adjusted so as not to damage the conductors
3. Measure and cut through the cable sheath 30mm from the end of the cable.
4. Separate the cable sheath end from the main cable sheath to expose the conductors
5. **Do not untwist cable pairs until ready to install the “one-click” jack**
6. Follow the instructions included with the jack to complete the termination

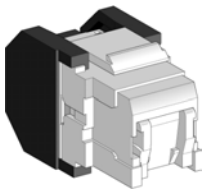
17.0 Installing patch panels splice boxes and wall/floor outlets

Follow the instructions supplied with the patch panel, splice box and wall/floor outlet carefully. Where grease filled indoor/outdoor cable has been used it is recommended where possible that the cables enter from below. This is to minimise the flow of grease out of the cable.

Care should be taken to ensure that the 25mm minimum bend radius of the fibre in the termination area is not exceeded when the socket is placed into its final position.

18.0 RJ45 jack installation

The RJ45 Giga, K5E or K6 RJ45 jacks are used at both ends of the link. Follow the installation instructions supplied with jack carefully.



It is important when installing the jack to use the correct wiring code and to maintain the twist in each pair of conductors as close to the idc contacts in the jack as possible.

To meet the conditions of the warranty, the jack must be installed in a 3M approved patch panel or telecommunications outlet.

19.0 RCP 2000 or STG 2000 module installation

The RCP 2000 or STG 2000 module is used at the FD or BD. Follow the installation instructions supplied with the module carefully.

It is important when installing the module to use the correct wiring code and to maintain the twist in each pair of conductors as close to the idc contacts in the module as possible.

20.0 Testing

Upon completion of the installation, the horizontal copper cabling system must be tested in accordance with the procedure described below. Tests shall be performed using a level II field tester as defined in ISO/IEC 11801. The backbone fibre cabling system shall be tested in accordance with the instructions given in paragraph 11.

20.1 Test equipment requirements

It is important to note that the latest editions of ISO/IEC 11801 and EN 50173 and EIA/TIA 568 all now require the permanent link to be tested and not the basic link as in previous editions. The difference is significant. The permanent link does not include the patchcords at each end of the system (Figure 3.7). Many older testers on the market are not capable of making the new permanent link test. It is essential that the test equipment used is capable of making a permanent link test in accordance with the requirements of the latest edition of the standards.

20.2 Link and channel definition

Both the International Standard ISO/IEC 11801 and the European Standard EN 50173 define a permanent link and a channel. The permanent link is the permanently installed part of the cabling. The channel is the full end to end connection including the equipment and work area cables (note however that the channel does not include the loss attributable to the equipment connectors). Figure 3.7 shows how the definitions of channel and permanent link apply to the backbone and horizontal cabling.

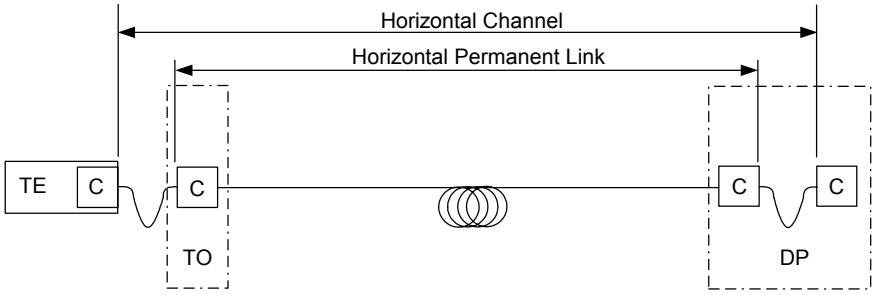


Figure 3.7 Permanent link and channel of horizontal cabling

20.3. Testing requirements

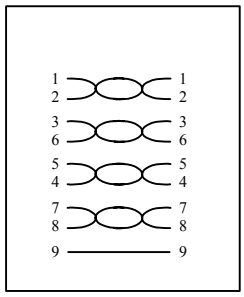
Testing shall be performed using an automatic tester or scanner. The following parameters of the link shall be verified:

- Headroom report (The worst-case margin for a parameter determined by the selected standard (this may be NEXT, ACR, PSNEXT, or another measurement.)
- Wire map
- Resistance

- Link length
- Insertion loss
- Return loss
- Near end crosstalk (NEXT)
- Power sum near end crosstalk (PSNEXT)
- Equal level far end crosstalk (ELFEXT)
- Power sum equal level far end crosstalk (PSELFEXT)
- Attenuation to crosstalk ratio (ACR)
- Power sum attenuation to crosstalk ratio (PS ACR)
- Delay Skew
- Impedance
- DC loop resistance

A wire map test is intended to verify correct pin termination at each end of the link and to check for connection errors in the installation. For each of the conductors in the cable, and the screen(s), if any, the conductor map indicates:

- continuity to the remote end
- shorts between any two or more conductors/screen(s)
- transposed pairs
- reversed pairs
- split pairs
- any other connection errors.



Correct pairing

A reversed pair occurs when the polarity of one wire pair is reversed at one end of the link. Note this is also sometimes referred to as a tip and ring reversal

A transposed pair occurs when the two conductors in a wire pair are connected to the position for a different pair at the remote connection. Note transposed pairs are sometimes referred to as crossed pairs.

Split pairs occur when pin to pin continuity is maintained but physical pairs are separated. Figure 32 gives an illustration of all three conditions.

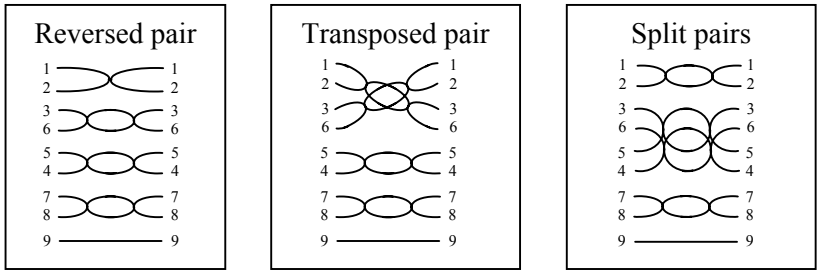


Figure 3.8 Incorrect pairing

20.4 Performance requirements

Each permanent link shall meet the requirements for Class D or Class E link as defined in ISO/IEC 11801. Alternatively if specified by the customer, each permanent link shall meet the requirements for a Category 6 link as defined in EIA/TIA 568

The Class D and Class E permanent link requirements are summarised in Tables 3.6 and 3.7 and for Category 5E and 6 link requirements, Tables 3.8 and 3.9. It should be noted that values are only given for frequencies of specific interest. Between these frequency values the performance requirements must be calculated using the formulae given in ISO/IEC 11801. Automatic testers calculate the intermediate values using the software imbedded in the machine and display the results graphically and in tabular format.

Table 3.6 Class D permanent link performance requirements

Frequency (MHz)	Maximum IL (dB)	Minimum RL (dB)	Minimum NEXT (dB)	Minimum PS NEXT (dB)	Minimum EL FEXT (dB)	Minimum PS ELFEXT (dB)	Minimum ACR (dB)	Minimum PS ACR (dB)	Maximum Skew (ns)	Maximum Propagation delay (µs)
1	4,0	19,0	60,0	57,0	58,6	55,6	56,0	53,0	44	0,521
16	7,7	19,0	45,2	42,0	34,5	31,5	37,5	34,5	44	0,496
100	20,4	12,0	32,3	29,3	18,6	15,6	11,9	8,9	44	0,491

Note: DC loop resistance shall be ≤ 21Ω

Table 3.7 Class E permanent link performance requirements

Frequency (MHz)	Maximum IL (dB)	Minimum RL (dB)	Minimum NEXT (dB)	Minimum PS NEXT (dB)	Minimum EL FEXT (dB)	Minimum PS ELFEXT (dB)	Minimum ACR (dB)	Minimum PS ACR (dB)	Maximum Skew (ns)	Maximum Propagation delay (µs)
1	4,0	21,0	65,0	62,0	64,2	61,2	61,0	58,0	44	0,521
16	7,1	20,0	54,6	52,2	40,1	37,1	47,5	45,1	44	0,496
100	18,5	14,0	41,8	39,3	24,2	21,2	23,3	20,8	44	0,491
250	30,7	10,0	35,3	32,7	16,2	13,2	4,7	2,0	44	0,490

Note: DC loop resistance shall be ≤ 21Ω

Table 3.8 Category 5E UTP permanent link performance requirements

Frequency (MHz)	Maximum IL (dB)	Minimum RL (dB)	Minimum NEXT (dB)	Minimum PS NEXT (dB)	Minimum EL FEXT (dB)	Minimum PS ELFEXT (dB)	Minimum ACR (dB)	Minimum PS ACR (dB)	Maximum Skew (ns)	Maximum Propagation delay (µs)
1	2,0	20,0	65,3	64,0	63,8	60,8	n/a	n/a	45	0,570
16	8,3	25,0	47,2	44,2	39,7	36,7	n/a	n/a	45(1)	0,545(1)
100	22,1	20,1	35,3	32,3	23,8	20,8	n/a	n/a	45	0,538

(1) at 10MHz

Table 3.9 Category 6 UTP permanent link performance requirements

Frequency (MHz)	Maximum IL (dB)	Minimum RL (dB)	Minimum NEXT (dB)	Minimum PS NEXT (dB)	Minimum EL FEXT (dB)	Minimum PS ELFEXT (dB)	Minimum ACR (dB)	Minimum PS ACR (dB)	Maximum Skew (ns)	Maximum Propagation delay (µs)
1	3,0	19,1	65,0	62,0	64,2	61,2	62,0	59,0	44	0.521
16	7,1	23,9	54,6	52,2	40,1	37,1	47,6	45,3	44	0.496
100	18,6	14,0	41,8	39,3	24,2	21,2	23,4	20,8	44	0.491
250	31,1	10,0	35,3	32,7	16,2	13,2	4,6	1,6	44	0.490

20.5 Testing procedure

It is important before commencing any testing to ensure that the test equipment hardware is correctly configured and that the correct link interface adapter cords are being used. This is particularly important when testing Class E/Category 6 link performance. Table 3.10 gives details of the hardware configuration to be used for the most popular testers. For other testers consult 3M for advice before testing.

In addition to the hardware configuration of the test equipment, the correct information regarding the link performance standard being tested to and the type of cable used for the permanent link must be entered into the tester. For accurate distance and resistance measurements it is also necessary to enter a value for the nominal velocity of propagation (NVP) for the cable.

Finally, ensure that the equipment is calibrated correctly. Master-slave units normally need to be calibrated to each other so it is important not to mix units unless this is taken into consideration.

Once the correct set up, self test and calibration instructions have been followed, testing can begin.

Follow the tester manufacturers' instructions carefully. For guidance a typical auto test sequence is given below:

1. Attach the appropriate link interface adapters to the master and slave units.
2. Turn on the slave.
3. Connect the slave to the far end of the cable link
4. Turn the switch on the master unit to AUTOTEST.
5. Verify that the settings displayed are correct. You can change these settings in the SETUP mode.
6. Connect the master unit to the near end of the cable link.
7. Start the Auto test.

Table 3.10 Class D and E Test set configuration requirements

<table>
<tr><td colspan="5">Fluke DSP 4000, 4100 & 4300 Setup</td></tr>
<tr><td colspan="5">Software, Standard version & PC Software</td></tr>
<tr><td colspan="5">Get the latest versions on Fluke Networks Web Site : http://www.flukenetworks.com</td></tr>
<tr><td colspan="3">3M Volition Solution</td><td colspan="2">ClassD/Class E / Cat 6</td></tr>
<tr><td>Cables</td><td>Jacks</td><td>Cords</td><td>Permanent Link</td><td>Channel Link</td></tr>
<tr><td>UTP</td><td>GIGA UTP</td><td>UTP</td><td rowspan="4">DSP-LIA101S & DSP-PM03</td><td rowspan="7">DSP-LIA012S or DSP-LIA013 in combination with the 3M Volition patch cords</td></tr>
<tr><td>FTP</td><td rowspan="2">GIGA FTP or STP</td><td rowspan="3">FFTP or SSTP</td></tr>
<tr><td>FFTP</td></tr>
<tr><td>SSTP</td><td>GIGA STP</td></tr>
<tr><td>UTP</td><td>K6 UTP</td><td>UTP</td><td>DSP-LIA101S & PM02 or DSP-LIA101S & PM25</td></tr>
<tr><td>FTP</td><td rowspan="2">K6 FTP or STP</td><td rowspan="3">FFTP or SSTP</td><td rowspan="3">DSP-LIA101S & DSP-PM01</td></tr>
<tr><td>FFTP</td></tr>
<tr><td>SSTP</td><td>K6 STP</td></tr>
</table>

<table>
<tr><td colspan="5">FLUKE OMNISCANNER LT, I & II Setup</td></tr>
<tr><td colspan="5">Software, Standard version & PC Software</td></tr>
<tr><td colspan="5">Get the latest versions on Fluke Networks Web Site : http://www.flukenetworks.com</td></tr>
<tr><td colspan="3">3M Volition Solution</td><td colspan="2">Class D/Class E / Cat 6</td></tr>
<tr><td>Cables</td><td>Jacks</td><td>Cords</td><td>Permanent Link</td><td>Channel Link</td></tr>
<tr><td>UTP</td><td>GIGA UTP</td><td>UTP</td><td rowspan="4">OMNI-LIA101S & DSP-PM03</td><td rowspan="7">8262-02 or 8262-42 in combination with the 3M Volition patch cords</td></tr>
<tr><td>FTP</td><td rowspan="2">GIGA FTP or STP</td><td rowspan="3">FFTP or SSTP</td></tr>
<tr><td>FFTP</td></tr>
<tr><td>SSTP</td><td>GIGA STP</td></tr>
<tr><td>UTP</td><td>K6 UTP</td><td>UTP</td><td>OMNI-LIA101S & PM02 or OMNI-LIA101S & PM25</td></tr>
<tr><td>FTP</td><td rowspan="2">K6 FTP or STP</td><td rowspan="3">FFTP or SSTP</td><td rowspan="3">8262-27</td></tr>
<tr><td>FFTP</td></tr>
<tr><td>SSTP</td><td>K6 STP</td></tr>
</table>

AGILENT WIRESCOPE 350 Setup				
Software, Standard version & PC Software				
Get the latest versions on Agilent Web Site : http://www.agilent.com				
3M Volition Solution			Class D/Class E / Cat 6	
Cables	Jacks	Cords	Permanent Link	Channel Link
UTP	GIGA UTP	UTP	N2604-063	N2604A-100 in combination with the 3M Volition patch cords
FTP	GIGA FTP or STP	FFTP or SSTP		
FFTP				
SSTP	GIGA STP			
UTP	K6 UTP	UTP		
FTP	K6 FTP or STP	FFTP or SSTP		
FFTP				
SSTP	K6 STP			

IDEAL LANTEK 6 & 7 Setup				
Software,Standard version & PC Software				
Get the latest versions on Ideal Web Site : http://www.idealindustries.com				
3M Volition Solution			Class D/Class E / Cat 6	
Cables	Jacks	Cords	Permanent Link	Channel Link
UTP	GIGA UTP	UTP	CAT6LADP-C6-0001in combination with the 3M Volition patch cords	
FTP	GIGA FTP or STP	FFTP or SSTP		
FFTP				
SSTP	GIGA STP			
UTP	K6 UTP	UTP		
FTP	K6 FTP or STP	FFTP or SSTP		
FFTP				
SSTP	K6 STP			

IDEAL LT8600 Setup				
Software,Standard version & PC Software				
Get the latest versions on Ideal Web Site : http://www.idealindustries.com				
3M Volition Solution			ClassD/Class E / Cat 6	
Cables	Jacks	Cords	Permanent Link	Channel Link
UTP	GIGA UTP	UTP	B6IDEAL001	LT8 CHANNEL in combination with the 3M Volition patch cords
FTP	GIGA FTP or STP	FFTP or SSTP		
FFTP				
SSTP	GIGA STP			
UTP	K6 UTP	UTP		
FTP	K6 FTP or STP	FFTP or SSTP		
FFTP				
SSTP	K6 STP			

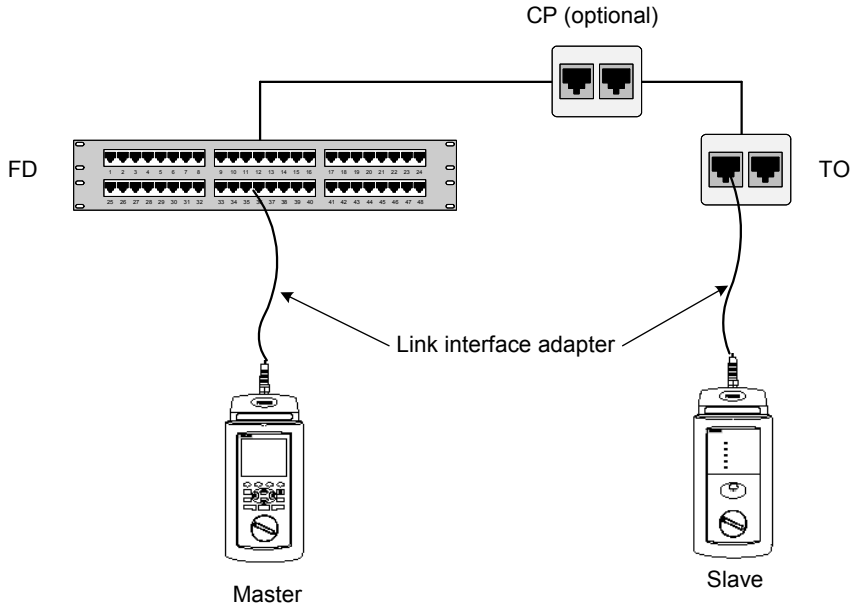
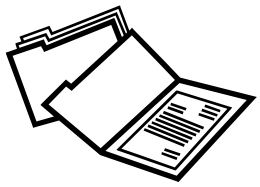


Figure 3.9 Test configuration

20.6 Test report



Test results for all links need to be stored and upon completion of the testing a fully documented test report must be produced. The contents of the test report shall include at least the following information:

- system location
- testing date
- name of person(s) performing test
- performance details of each link tested.

PART 4 COPPER VOICE CABLING SYSTEM

SECTION 1 DESIGN AND PLANNING

21.0 Introduction to voice cabling systems

Although this section deals specifically with voice cabling, many of the market drivers that have lead to the development of "structured cabling" for data transmission are just as relevant. The requirement for flexibility in office space places just as much demand on the voice cabling system as it does on the data cabling system. Each access point must deliver voice as well as data and it must be possible to rearrange telephones and workstations quickly without having to dismantle wall or ceiling voids. The result of this is that the cabling system used for carrying voice is very often installed alongside the data cabling system with the telephone jack either co-located in the same outlet as the data point or adjacent to it.

When installing a Volition fibre cabling system the installer has two options with regard to the structure of the voice system and two options with regard to the type of cable he uses. The type of fibre system being installed will influence the most suitable option in each case.

If a distributed architecture is being used for the fibre data network, then it is recommended that a distributed architecture be used for the voice network. Building and floor distributors can be shared and if a data grade (i.e. Volition four-pair twisted 100Ω copper) cable is used and the wiring scheme detailed in table 4.12 followed, the system can be used for both voice and data. This can be achieved by patching the horizontal copper cabling to the fibre backbone cabling.

If however a centralised architecture is being installed for the fibre data network then either a distributed or a centralised architecture can be used for the voice network. The distributed network option would entail the provision of distribution points, however there would be little flexibility since there would be no access to the fibre backbone. In this case, a centralised architecture and the use of a voice grade cable is recommended. Installing a centralised voice network would not require the provision of distribution points and would therefore augment the benefits offered by collapsing the data network backbone. In both cases voice grade cable would be used.

Note that in this section the term voice is only applicable for circuits carrying signals up to 144kbps (e.g. basic rate ISDN). Higher speed voice circuits carrying multiple voice channels (i.e. 30 channels or more) are not covered.

Paragraph 22 gives further details of the different cabling options available to the installer.

21.1 Overview

Although ISO/IEC 11801, EN 50173 and EIA/TIA 568 all give similar descriptions of Generic Cabling, none cover the provision of voice cabling in any detail. Figure 1.1 shows the structure of generic cabling given in ISO/IEC 11801 but this cannot be easily applied to the voice model. Figure 4.1 shows a typical structure for voice cabling.

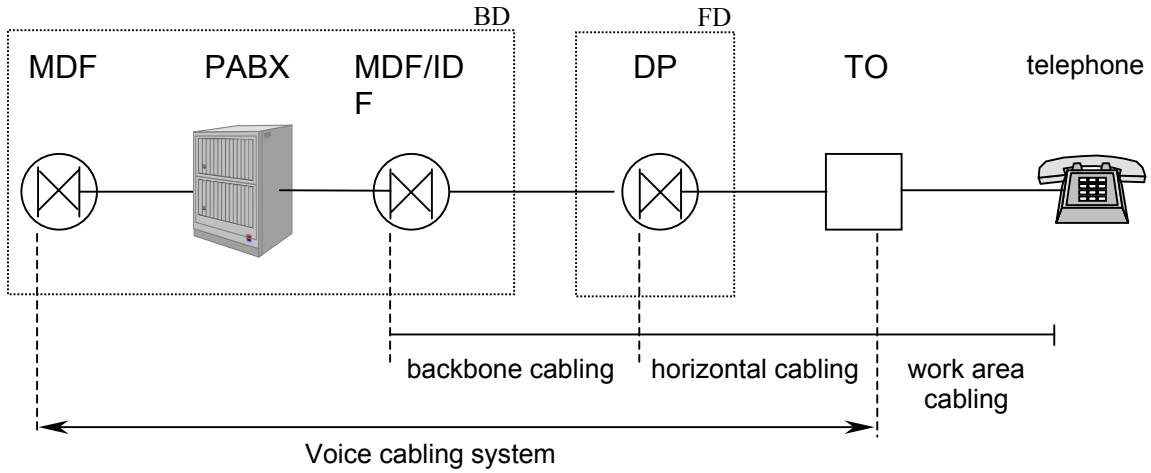


Figure 4.1 Structure of voice cabling

Where: MDF Main Distribution Frame
IDF Intermediate Distribution Frame
PABX Private Automatic Branch Exchange
DP Distribution Point
TO Telecommunications Outlet
Cross Connect Point

Note that in the figure the BD is expanded to show the MDF and PABX, the DP now represents the FD.

21.1.1 Voice network topologies

Unlike the situation with data, voice-cabling systems have always followed a simple point-to-point star topology as shown in Figure 3.

21.2 Network Protocols

Fundamentally, voice networks can carry two types of signal – analogue or digital.

Analogue signals are essentially for voice transmission but can also be used (with the addition of a modem) for the transfer of data e.g. Group 3 fax. The signal is usually carried over a single pair of conductors.

Digital signals have the advantage that they carry coded information, which means that various types of information can be carried simultaneously. ISDN (Integrated Services Digital Network) is one example of digital transmission that can transmit all the major types of communications (voice, data, video, Group 4 fax etc). Other systems have been developed on a proprietary basis and are typically linked to the PABX supplier. One advantage of ISDN is that as it is internationally standardised, this means that equipment from different manufacturers will work together. Proprietary systems will only work with equipment supplied from one manufacturer.

21.2.1 Pulse code modulation (PCM)

This is the most common method of encoding an analogue voice signal into a digital bit stream. It involves sampling the voice signal at a constant rate (8kbps). Each time the signal is sampled the

amplitude of the signal is encoded into an eight bit word corresponding to the nearest standard or discrete level determined by the encoding technique. The basic transmission rate is derived from the number of simultaneous conversations (or voice channels) transmitted in a frame of information, the number of frames transmitted in a second and the sampling rate. In Europe, there are thirty-two channels to a frame giving an overall transmission rate of 2,048Mbps (the E1 rate). In North America there are only twenty-four channels in a frame, which results in an overall transmission rate of 1,544Mbps (the T1 rate).

21.2.2 Time division multiplexing (TDM)

This is a technique for transmitting a number of separate digital bit streams simultaneously by interleaving fragments of each stream one after the other. It is this way that the E1 and T1 bit streams are developed and the way in which they can be extended to increase the number of channels being carried simultaneously. Table 37 shows the hierarchy of transmission rates.

Table 4.1 Hierarchy of digital transmission rates

Hierarchical level Europe/North America	No of voice channels Europe/North America	Nominal transfer rate (Mbps)
E1/T1	30/24	2/1,5
E2/T2	120/96	8/6,3
E3/T3	480/672	34/45
E4/T4	1920/4032	140/274
E5	7,680	565

21.2.3 Integrated Services Digital Network (ISDN)

ISDN is a digital system, which has been available for over a decade. The system allows data to be transmitted simultaneously across the world using end-to-end digital connectivity. With ISDN, voice and data are carried by bearer channels (B channels) occupying a bandwidth of 64 kbps. Some switches limit B channels to a capacity of 56 Kbps. A data channel **(D channel)** handles signalling at 16 Kbps or 64 Kbps, depending on the service type

There are two basic types of ISDN service: Basic Rate Interface (BRI) and Primary Rate Interface (PRI). BRI consists of two 64 kbps B channels and one 16 kbps D channel for a total of 144 kbps. This basic service is intended to meet the needs of most individual users.
PRI is intended for users with greater capacity requirements. Typically, in the US, the channel structure is 23 B channels plus one 64 kbps D channel for a total of 1536 kbps. In Europe, PRI consists of 30 B channels plus one 64 kbps D channel for a total of 1984 kbps.

- **Basic rate ISDN (2B+D)**

Basic Rate ISDN is often also known, more technically, as a "2B+D" service. This means you get two "B" channels over each of which you can place or receive a call. These "B" channels run at 64kbps in both directions simultaneously. The “B” channels are also referred to as Bearer channels because they bear, or carry, the customer's signal. The third channel, the "D" channel, is there primarily to carry the dialling or signalling information from the ISDN terminal to the public telephone exchange or to the ISDN PBX. The Basic Rate "D" channel runs at 16Kbps

The service from the serving local exchange is usually provided over a single twisted pair.

- **Primary rate ISDN**

Primary Rate ISDN provides thirty (twenty three in the U.S.) "B" channels each working at 64kbps and a "D" or dialling channel this time working at 64Kbps. The service from the serving local exchange is usually provided over a screened copper or fibre optic cable.

21.2.4 xDSL

A generic term given to various Digital Subscriber Line protocols and equipment used to increase the operating speed of the access network. The originating protocol was Asymmetric Digital Subscriber Line (ADSL), a protocol originally specified at 2Mbps to the subscriber's premises and 64kbps back. Subsequent developments worked at higher speeds and are known as HDSL (High bit rate Digital Subscriber Line) and VDSL (Very High bit rate Digital Subscriber Line), which works at 26Mbps to the subscriber and 2Mbps back.

21.2.5 ITU-T V series recommendations

This series of recommendations has been produced by the International Telecommunication Union and deal with data communications operation over the telephone network. The series covers a broad range of applications some examples of which are listed below: Further information can be obtained at the ITU web site at www.itu.int

- V.24 For communication between data terminal equipment (DTE) and data communications equipment (DCE)
- V.25 Automatic calling and/or answering equipment
- V.29 Virtually all 9.6kbps modems adhere to this standard. V.29 can be full duplex on 4 wire-leased circuits or half duplex on 2 wire and dial up circuits. It is also the modulation technique used in group 3 fax .
- V.32 For 9.6kbps modems operating on 2-wire dial up circuits. Also provides fall back operation at 4.8kbps

22 0 Voice system architectures

The following paragraphs give general guidelines on designing a voice cabling system. They include definitions and descriptions of the various elements of the system and specify maximum link lengths where appropriate. They also include the minimum requirements that have to be met in order to satisfy the requirements for a Volition Cabling System 20 year warranty (see Part 5).

22.1 Distributed versus centralised architecture

As previously discussed in paragraph 21, voice cabling can be designed using a distributed or centralised architecture. However with voice cabling, there are two distinctive differences i.e.

- unless the voice network is required to support both data and voice, there are no restrictions on link lengths
- there is not (normally) any remote electronics to be sited on the floor

Options are given below for the two types of architecture.

22.2 Voice cabling systems and subsystems

Paragraphs 22.2.1 - 22.2.3 define the various elements of the voice cabling, Figures 4.2 and 4.3 show the differences between distributed and centralised voice cabling.

22.2.1 Incoming cable

Although not part of the building cabling, the incoming cable extends from the local exchange or central office to the MDF in the BD. In most cases the incoming cables will be terminated on an area of the MDF that is designated to the provider of the service.

22.2.2 Private branch exchange (PBX) cabling

The private branch exchange cabling connects the PBX (or switch) normally located within the BD to the MDF. It includes the cable, the connections at the MDF and the PBX.

22.2.3 Backbone cabling

The backbone cabling extends from the MDF in the BD to the DP(s). It includes the backbone cables the termination of the backbone cable (at both the MDF and the DP) and the cross connects at the MDF.

22.2.4 Horizontal cabling

The horizontal cabling extends from the DP(s) to the TO(s). It includes the cable, the termination of the cable at the DP, the cross connections at the DP and the TO(s). The work area cables are not included as part of the horizontal cabling.

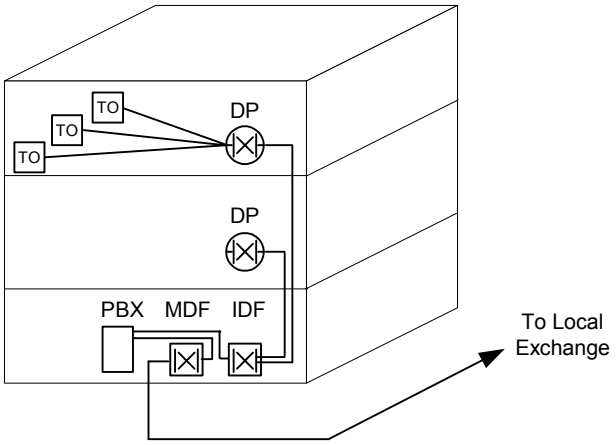


Figure 4.2 Distributed cabling architecture

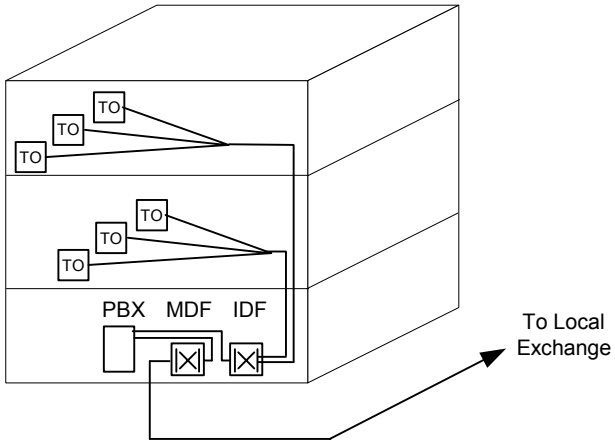


Figure 4.3 Centralised cabling architecture

22.3 Interfaces to the cabling system

Cabling system interfaces are located each end of the subsystem. Appropriate electronic equipment can be connected at these points. Figure 4.4 shows potential interfaces at the MDF and the TO.

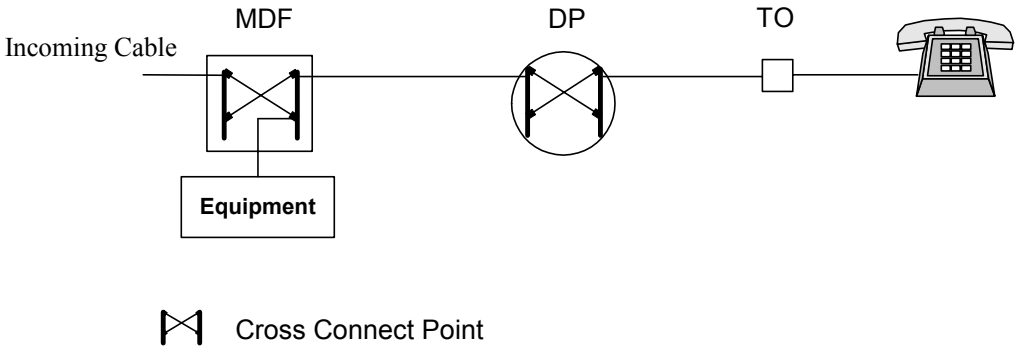


Figure 4.4 Interfaces to the voice cabling system

22.4 Link design criteria

The following design criteria must be observed in order to satisfy the extended warranty requirements for the Volition voice cabling system.

22.4.1 Maximum link lengths

Unless the system is required to support data (in which case the 90m maximum link length rule should be observed) within a building there is no restriction on the maximum length of a link. This is true irrespective of whether the system will be carrying analogue or digital voice circuits and for transmission speeds up to 144kbps. Where voice service is carried between buildings at higher speeds e.g. 30 channel PCM at 2Mbps then there may well be a restriction on the link length related to the type of cable being used. Although not within the scope of this manual, link lengths up to 2km are likely to be achievable for transmission rates up to 2Mbps when the appropriate cable is used.

23.0 Planning guidelines

The following paragraphs give guidelines on planning a Volition voice cabling system. The same approach should be adopted irrespective of whether a distributed or a centralised cabling architecture is being used. However where a centralised architecture is being deployed there are no DPs on the floor. However transition points can be included if required.

For technical as well as safety reasons, 3M recommend the separation of Volition copper voice cable from power cabling. This is particularly important if the cable may be required to carry data. This can be achieved either through use of a separate cable support structure or by physical restraint of the cabling within the same support structure. Table 3.1 taken from EIA/TIA 569 gives guidelines on the separation distance required. In addition, where cabling has to pass through a fire rated wall, floor or other barrier, it is essential that an appropriate fire stop material be used.

23.1 Horizontal cabling

The horizontal cabling is the first element of the system to be considered. From the floor layout drawing (Figure 2.2) showing the positions of the outlets, determine the best location for the DP or transition point. Factors that should be considered with regard to DP location are:-

- link length restrictions
- position in relation to the building distributor and backbone cable
- position in relation to any floor distributor located on the same floor
- position in relation to DPs on other floors
- size in relation to number of anticipated TOs

Having decided on the best position for the DP, plan the best route for the horizontal cable to take to each outlet point (TO). The route chosen should allow access for cable placement and meet cable bend radius requirements given in Table 3.4.

Generally the TO should provide a minimum of one interface for voice and one for data. In some cases more interfaces will need to be provided and this should be planned accordingly.

Open office cabling, sometimes referred to as zone cabling is also an option and provides a multiple TO location that enables several work area cables to be routed from the same point. Repeat this procedure for each floor of the building.

23.1.1 Distribution points

Depending on the horizontal cabling being used, distribution points can be planned using either "punch down" type modules mounted on a frame or RJ45 jacks mounted in a patch panel. Punch down modules e.g. from the RCP or SID product range will give optimum density. RJ45 jacks, whether installed discretely into or integrated into a patch panel will result in a lower density.

23.1.2 Transition points

A transition point can be used when using a centralised architecture and it is required to "drop off" pairs from a large pair count backbone cable. In such cases a cross-connect point (DP) is not typically provided on each floor. Instead “permanent” jumpers are used between punch down modules to interconnect between the backbone and the horizontal cable. The cross connection point in this case is provided on the MDF.

23.1 3 Patch panels for distribution points

The Volition range of copper patch panels covers a variety of configurations (see 13.1.2). Table 4.2 shows the maximum density that can be obtained using the 43018-632 30 (25 ports in 1U) and 43018-633 30 (50 ports in 1U) Category 3 patch panels. Note that it is also permitted to install Category 5E/6 patch panels if desired and if the appropriate cable is being used. This will result in a lower port density being achieved (depending on the patch panel being used).

It is essential that adequate patchcord management features be provided to ensure minimum bend radius specifications of the patchcord are not exceeded. These features can be provided on the front face of the rack, using the P33340AA0000 (1U) and/or P33345AA0000 (2U) cable management panels. 1U of cable management space should be provided for every 25 ports to be patched. Alternatively, if 800mm wide racks are being used from the QVSL range, cable management rings that locate on each side of the rack should be used.

Table 4.2 Patch panel requirements

TOs	19" Rack space (U) using 43018-632 30	Rack space (U) including cable management	19" Rack space (U) using 43018-633 30 and 43018-632 30	Rack space (U) including cable management
≤25	1	2	1	2
26-50	2	3	1	2
51-75	3	4	1+1	3
76-100	4	5	2	3
101-125	5	6	2+1	4
126-150	6	7	3	4
151-175	7	8	3+1	5
176-200	8	9	4	5
201-225	9	10	4+1	6
226-250	10	11	5	6

23.1.4 Punch down blocks for distribution points

Using punch down blocks (modules) at the DP will result in the greatest port density. A variety of modules are available and part 6 describes each type in detail. It is essential to choose the correct mounting frame for the block that is being used. Table 4.3 compares the key features of the different module types.

Table 4.3 Punch down block selection table

Block type	RCP 2000	STG 2000	SID - C	SID - CT	QSA - 2
Category	5 (155Mhz)	5 (100Mhz)	3 (2Mbps)	3 (2Mbps)	
8 pair	yes	yes	yes	yes	no
10 pair	no	yes	yes	yes	yes
Connection	yes	yes	yes	yes	yes
Disconnection	yes	yes	yes	yes	yes
Switching	yes	yes	yes	yes	
Wire handling	0,4 - 0,8	0,4 - 0,8	0,32 - 0,8	0,32 - 0,8	0,4 - 0,8
Wires/slot	2	2	1	1	1
Vertical pitch (mm)	16	14	17,5	17,5(1) or 22,5	22,5
Backmount type	CIPE or RIBE	CIPE or RIBE	SID - C	SID – C or LSA(2)	QSA/LSA(2)
Surge protection	yes	yes	yes	yes	yes

Notes:
1. 17,5mm pitch is obtained with SID-C backmount only
2. Compatible with the Krone LSA+ system

23.1.5 19” Racks and cabinets for distribution points

3M offer several ranges of floor standing and wall-mounted racks and cabinets. To complement this a large number of accessories are also available many of which are not included in this manual. Some racks are supplied pre-assembled whilst others are in kit form ready for assembly on site. Parts are also available separately allowing the planner to design and specify precisely the format and size of the rack or cabinet required. Table 4.4 lists the various options available

Table 4.4 Rack and cabinet selection table

Model Range	Type	Application	Height Range (mm)	Kit or Pre assembled
QVSL Basic	Floor standing	19”	2000	Kit/Pre
QVSL Server	Floor standing	19”	1100 – 2000	Pre
QVSL Mini	Floor standing	19”	1100	Pre
QVSL Compact	Floor or wall	19”	370 – 770	Pre
QVSN	Floor standing	QSA 2/SID – CT and SID – C	2000	Pre
QWG	Floor or wall	QSA 2/SID – CT and SID – C	1100	Pre
BT Type 500	Wall	QSA 2/SID – CT and SID – C	350 – 1000	Pre
VKA	Wall	19”	330 – 550	Pre
Double 19	Wall	19”	275 – 675	Pre
Single 19	Wall	19”	250 – 650	Pre
BCCS	Floor standing	19”	1100 – 2000	Kit
Pico				

23.1.6 Sub-racks for mounting modules into 19" format

If space is limited then sub-racks offer an ideal way to increase density. Sub-racks can be fitted into any of the above racks or cabinets having a 19" mounting format.

Table 4.5 Sub-rack selection table

Model No.	Sub-rack Type	Height (U)	Module Type	Capacity
43026-50700	FlexiRail SID - C	3	SID-C	240
43026 508000	FlexiRail SID - QSA	3	QSA	190

23.1.7 Frames for distribution points

3M offer several different floor standing and wall-mounted frame designs for use at the distribution point. Most of the frames are single sided and need securing to a supporting wall, however the Type 108 can be assembled back to back to make it double sided and free standing. For very large installations it is also possible to select a frame from table 46. If appearance is important, then ABS or steel covers with plain or glass fronted doors are available (see Part 6).

Table 4.6 Frame selection table

Model Range	Type	Application	Height Range (mm)	Kit or Pre assembled
BT Type 108	Floor/free standing	QSA 2/SID - CT (10 pair)	2000 – 2080	Kit
BT Type 205	Floor standing	QSA 2/SID - CT (10 pair)	1980	Kit
RIBE	Floor/wall	RCP (8 pair)	310 – 2000	Kit/Pre
CIPE	Floor/wall	STG (8 and 10 pair)	310 - 2000	Kit
QVG	Wall	SID – C	700 – 1600	Kit/Pre

23.1.8 Telecommunications outlets

Outlets can be located on the wall, floor or elsewhere in the work area (e.g. in trunking on pillars or posts or in custom modular furniture). The cabling shall be planned in such a way that the outlets will be readily accessible and the outlets shall be positioned such that the plug on the patchcord can easily be inserted into the jack provided. A high density of outlets will enhance the flexibility of the installation.

Table 4.7 Telecommunications outlet selection table

Outlet type	Options	Material	Mounting	Dimensions (mm) (W x H x D)
RJ 11 integrated	2, 4 or 6 contact grease filled	ABS	Flush/surface	50 x 55 x 22,5
RJ 11 faceplate	For R J11 jack	ABS	Flush/surface	116 x 71
RJ 45 integrated	1 or 2 ports flush mounted	ABS	Flush	50 x 50 x 32
RJ 45 integrated	1 or 2 ports surface mounted	ABS	Surface	80 x 65 x 50
RJ 45 faceplate	For 2 x RJ45 Giga	ABS	Flush/surface	80 x 80?
RJ 45 faceplate	For 45mm x 45mm module	ABS	Flush/surface	80 x 80?
RJ 45 faceplate	For 50mm x 50mm module	ABS	Flush/surface	80 x 80?
PBM2 box	For two 45 x 45 modules	ABS	Surface	80 x 150 x 42
PBM3 box	For three 45 x 45 modules	ABS	Surface	80 x 205 x 42
Floor box	For six 45mm x 45mm modules	ABS	Floor	170 x 20 x 88
Box	For one 45mm x 45mm module	ABS	Surface	65 x 65 x 45
Box	For one 50mm x50mm module	ABS	Surface	65 x 65 x 48
Box	For 3 x 2 module mounting plates	ABS	Surface	132 x 170 x 60
Box	For 4 x 2 module mounting plates	ABS	Surface	132 x 225 x 60
Box	For 6 x 2 module mounting plates	ABS	Surface	132 x 339 x 60
Mounting plate	45mm x 45mm format	ABS	-	
Mounting plate	50mm x 50mm format	ABS	-	
Box	Single row of two 45 x 45	Aluminium	Aluminium	80 x 140 x 48
Box	Single row of four 45 x 45	Aluminium	Aluminium	80 x 230 x 48
Box	Single row of seven 45 x 45	Aluminium	Aluminium	80 x 365 x 48
Box	Single row of two 50 x 50	Aluminium	Aluminium	80 x 155 x 48
Box	Single row of four 50 x 50	Aluminium	Aluminium	80 x 255 x 48
Box	Single row of seven 50 x 50	Aluminium	Aluminium	80 x 405 x 48
Box	Double row of three 45 x 45	Aluminium	Aluminium	120 x 185 x 60
Box	Double row of five 45 x 45	Aluminium	Aluminium	120 x 275 x 60
Box	Double row of seven 45 x 45	Aluminium	Aluminium	120 x 365 x 60
Box	Double row of three 50 x 50	Aluminium	Aluminium	120 x 185 x 60
Box	Double row of five 50 x 50	Aluminium	Aluminium	120 x 275 x 60
Box	Double row of seven 50 x 50	Aluminium	Aluminium	120 x 365 x 60

23.2 Backbone cabling

The backbone cable is the second element of the voice system to be considered. From the building layout drawing, determine the best location for the building distributor and the associated main distribution frame (MDF) and or intermediate distribution frame (IDF). This may often coincide with the point of entrance of the telecommunications cables into the building. Select the best route(s) to connect the MDF or IDF to the distribution points located on each floor.

23.2.1 Building distributors

EIA/TIA 569A gives details of the recommended space requirements for building distributors. Table 2.16 in Part 2 suggests alternative sizes more suitable to the European market.

23.2.2 Frames for MDF applications

For main distribution frame (MDF) applications in medium to large installations 3M offer several different floor standing frame designs. Some of the frames are single sided and need securing to a supporting wall whilst some designs e.g. the ID Multi, Types 105/6, 108 and the FAE can be assembled back to back making them double sided and free standing.
For smaller installations the RIBE, CIPE, QVG and 500 ranges provide the planner with a wide choice of frames from which to select. If appearance is important, then ABS or steel covers with plain or glass fronted doors are available for the CIPE range (refer to Part 6).

Table 4.8 Main distribution frame selection table

Model Range	Type	Application	Height Range (mm)	Kit or Pre assembled
ID Multi	Floor/free standing	QSA 2/SID - CT and SID – C	2000	Kit/Pre
BT Type 105/6	Free standing	QSA 2/SID – CT (10 pair)	1980 – 2010	Kit
BT Type 108	Floor/free standing	QSA 2/SID - CT (10 pair)	2000 – 2080	Kit
BT Type 205	Floor standing	QSA 2/SID - CT (10 pair)	1980	Kit
BT Type 500	Wall	QSA 2/SID - C (10 pair)	1000	Kit
FAE	Floor/free standing	RCP (8 and 10 pair)	1440 - 2300	Kit
RIBE	Floor/wall	RCP (8 pair)	310 – 2000	Kit/Pre
CIPE	Floor/wall	STG (8 and 10 pair)	310 - 2000	Kit
QVG	Wall	SID – C	700 – 1600	Kit/Pre

23.2.3 Frames for IDF applications

In many cases the service provider will have exclusive ownership of the MDF and terminate his cable directly onto it. It will then be necessary to provide a second frame, sometimes referred to as a redistribution frame or IDF to act as the building distributor. Jumpers are installed between the MDF and IDF. It is common but not essential for the MDF and the IDF to be located adjacent to each other (i.e. in the same room). Table 4.8 should be used to select the appropriate frame for the IDF application.

23.2.4 19” Racks for MDF and IDF applications

Because the incoming cable from the service provider is terminated directly onto the MDF, it is more usual that an 8 or 10 pair module is used at this point. Modules have a greater pair density than 19” patch panels and have the added benefit that electrical protection (over voltage and/or over current) can easily be included if required. It is however quite feasible to use patch panels with RJ45 jacks as an IDF, patching between the frames using a hybrid patchcord.

23.2.5 Electrical protection

The RCP 2000, STG 2000, SID –C, SID – CT and QSA modules all feature a range of over voltage and over current accessories. Protection may be in the form of a magazine, which will protect all the pairs in the module or in the form of a plug, which will provide individual pair protection.

23.2.6 IDC module blocks for MDF applications

In addition to the 8 and 10 pair modules, 3M also offers the ID 3000 connection system which has a wide range of applications from medium to large telecommunications distribution frames to MDF's for analogue and digital exchanges.

The module, which meets the requirements of IEEE 802.3 and IEEE 802.5 for Ethernet and Token Ring, has double contacts for both line and jumper sides, housed in a removable disconnection element which clips into the wire guide housing. Offering high density and low weight, the design allows the installer to fit traditional blocks or individual modules onto the associated ID 3000 frame. Alternatively, the ID 3000 can be easily mounted horizontally or vertically on conventional existing frames. By using the new MDF frame design, the blocks or modules are mounted vertically on backmount frames. The installation of line and equipment blocks on the same vertical of the MDF results in faster jumpering and improved jumper management. The modular design of the system allows the replacement of individual 8 or 10 pair modules from a block without disturbing the remaining connections.

To supplement the system 3M offers an extensive range of accessories for testing, labelling, patching and over voltage protection.

23.3 Centralised cabling

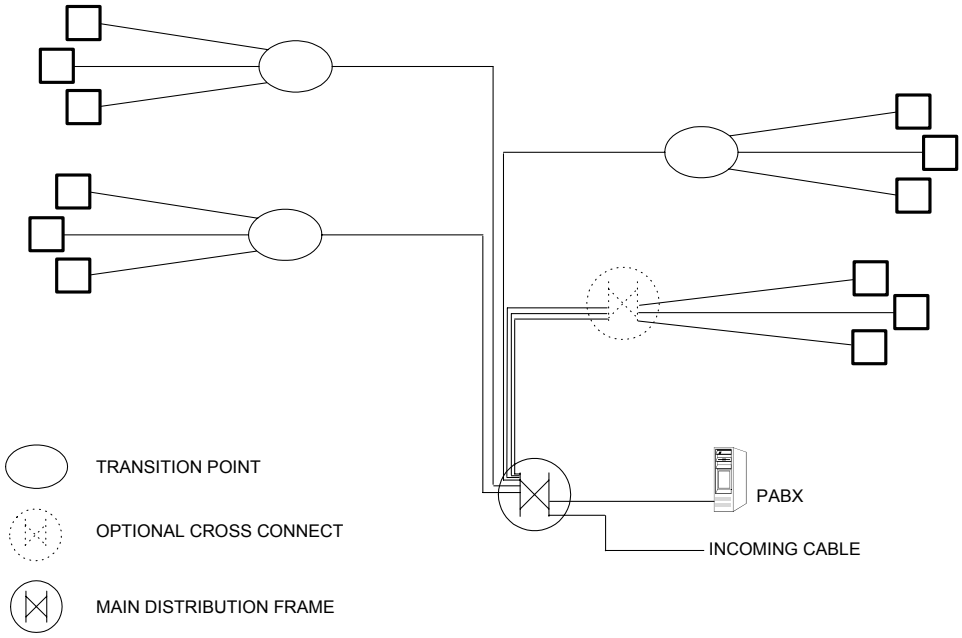


Figure 4.5 Centralised voice cabling

Installations using a centralised cabling architecture shall be planned using the same guidelines given in the preceding paragraphs. In this case, the horizontal cable can be "pulled through" from the TO to the BD without any intermediate transition point or distribution point. Alternatively, it is permissible to use a high pair count building backbone cable and join it to lower pair count horizontal cables at a transition point conveniently located in the building. The building backbone cable can be joined to the horizontal cable using any of the following:

a) MS^2 modules
b) RCP, STG, QSA2 or SID modules

In all cases the transition point must promote orderly storage of the conductors such that the minimum bend radius requirement is maintained. The transition point shall also be capable of being labelled in accordance with the administration requirements outlined in paragraph 10.

A centralised voice cabling architecture has maximum benefit when used in conjunction with an all fibre optic centralised data cabling architecture. The need for floor distributors accommodating data and voice cross connects and associated electronics can be eliminated thus saving costs associated with the provision of electrical and HVAC equipment and the floor space can be utilised for other purposes.

SECTION 2 INSTALLATION AND TESTING

24.0 Safety and pre-installation preparations

The following paragraphs are written to ensure a quick, error-free installation that minimises risk to the installer, his equipment and the end user. It covers matters relating to:

- safety
- use of tools and equipment
- pathway planning
- cable construction and handling procedures.

Refer to paragraphs 5.1 to 5.1.6 for guidance on safety and 5.2 for guidance on planning the installation.

24.1 Pathway planning

Refer to paragraph 5.2 for guidance on planning cable pathways.

24.2 Cable handling

The following techniques are commonly used during the cable installation process.

Care should always be taken to ensure the method used and the final cable placement does not degrade cable performance.

Installation requirements for cable placement are also found in standards such as ISO/IEC 11801, EN50173, EN50174 and ANSI/TIA/EIA-568.

24.2.1 Cable on reels

A “cable dispenser” should be used to dispense cable supplied on a reel. The reel(s) are installed on rollers and the cable is pulled for smooth and even feeding. Alternatively, the reel(s) can be placed on a steel bar that is then supported securely on stands at each end. When pulling cable from a reel, it is important to pull the cable from the bottom of the reel.

24.2.2 Cable in boxes

Cable supplied in boxes can be pulled straight from the box. Care should be taken to pull the cable smoothly to avoid twisting and kinking the cable. If necessary secure the box(es) to prevent them from being pulled along the floor as the cable is dispensed.

24.2.3 Volition four-pair twisted 100Ω cable construction and colour codes

If using data grade cable for voice the Volition Category 5E or Category 6 horizontal copper cable should be used. These cables have either a PVC or a low smoke zero halogen sheath. In both cases the sheath is coloured green. Category 5E and Category 6 cables are constructed as shown in Figures 3.5 and 3.6, The installation specification for each is shown in table 3.4 and colour coding in table 3.5. A detailed specification is included in Part 6.

24.2.4 High pair count twisted pair cables for backbone and horizontal applications

If a system is being installed for voice only, it is permissible to use twisted pair cables having a lower high frequency performance i.e. a voice grade cable. Table 4.9 lists the recommended cable types and sizes for both horizontal and backbone applications.

Table 4.9 recommended cable types and sizes for voice only applications

Cable construction	Grade	Conductor diameter (mm)		Application
2 wire	Voice	0,5		Jumpering
4 wire	Voice	0,5		Horizontal
6wire	Voice	0,5		Horizontal
2 x 4 pairs	Category 5E	0,51		Backbone
8 x 4 pairs	Category 5E	0,51		Backbone
16 x 4 pairs	Category 5E	0,51		Backbone
40 wire	Voice	0,5		Backbone
50 wire	Voice	0,5		Backbone
100 wire	Voice	0,5		Backbone
200 wire	Voice	0,5		Backbone
300 wire	Voice	0,5		Backbone
400 wire	Voice	0,5		Backbone

24.3 Cable pulling

Although copper cables are perceived to be stronger and more robust than fibre cables, this is not typically true. The same general rules apply to both cable types and it is also essential that Volition four-pair twisted 100Ω copper cables are never subjected to a bend tighter than the minimum bend radius specification and that the maximum pulling load is never exceeded. Failure to observe these simple precautions could result in the high frequency performance of the cable being compromised The minimum bend radius varies according to whether the cable is under load (during the pulling operation) or unloaded (after the pulling operation).

Where a voice only grade of twisted pair cable is being installed the requirements are less stringent. The main concern is that the cables should not be subjected to loads that could cause physical damage to the cable.

Cables are pulled along the planned routes – usually with a rope or a rod. The pulling rope and the connection between the rope and the cable should be strong enough to withstand the load required to pull the cable into place. The connection between the rope and the cable should be as smooth as possible to ensure it will not snag along the pull route.

CAUTION: ***Do not exceed the maximum pulling load of any cable***

24.3.1 Preparing Volition copper cable for pulling

As a guide, up to 12 four-pair twisted 100Ω copper horizontal Volition cables can be pulled at a time. If the route is short (<30m) and straight with easy access to the cable path, the cables may be pulled from their boxes and laid into place directly without accessing the conductors.

Care should be taken however to ensure that the cable sheath is not stretched or damaged and the cable itself is not deformed or distorted during the pulling operation as this could compromise the high frequency performance of the cable

For longer or difficult routes, it is important that the load is applied evenly to the conductors of all the cables being pulled and not to the cable sheaths themselves. This will help to prevent stretching of the cable sheaths

The following procedure must be adopted:

1. Strip the sheaths of the cables approximately 30cm.
2. Group the copper conductors and twist them together
3. Fold the twisted conductors back on themselves to create a loop twisting and taping the twisted conductors together
4. Place the pulling rope through the loop and tie a knot.
5. Tape along the joint to make a smooth and compact pulling end.

24.3.2 Preparing voice grade horizontal twisted pair copper cable for pulling

Although the construction of this type of cable is different from the Volition four-pair twisted copper cable and it offers a lower performance, it should be treated as described in the previous paragraph.

24.3.3 Preparing voice grade backbone twisted pair copper cable for pulling

The construction of this type of cable and its performance make it less susceptible to being damaged. High pair count cables (100 pairs and above) for backbone applications will only normally require the cable end to be wrapped over the sheath with tape together with a rope. The transition between the end of the cable and the rope should be as smooth as possible to prevent it getting caught. As a guide, high pair count backbone cables are normally installed individually although where space and the nature of the route permits, it is possible to pull more than one cable at a time.

For long and or difficult routes, as in the case of Volition four-pair twisted copper cable, the pulling load should never be applied directly to the cable sheath. In such cases the following procedure should be adopted:

1. Strip the sheath of the cable approximately 30cm.
2. Group the copper conductors and twist them together
3. Fold the twisted conductors back on themselves to create a loop twisting and taping the twisted conductors together
4. Place the pulling rope through the loop and tie a knot.
5. Tape along the joint to make a smooth and compact pulling end.

In both cases if a winch is being used to pull the cable, a suitable overload protection device shall be used to prevent the maximum pulling load of the cable from being exceeded.

25.0 Installing copper backbone cable

Backbone cables can be installed in either closed or open shafts. Closed shafts are used to route cables from floor to floor through a sleeve, slot, or conduit that can be fire-stopped. Open shafts typically refer to distribution systems in older buildings where abandoned ventilation or elevator shafts are used for extending cables. Open shafts usually extend from the basement of a building to the top floor and have no separation between floors. Copper power cables and Volition copper cables must either be installed in separate shafts or in separate sections of the shaft.

3M recommend the use of closed shafts for Volition building backbone cable installation.

25.1 Installation procedure

Refer to the cable manufacturer's installation specification for the cable being used before commencing the installation Decide whether the cable is to be dropped down from an upper floor, or pulled up from a lower floor. In both cases, safety is of prime importance. Loose cables should be tied off so as not to cause an obstruction. Cable reels should be secured so they cannot roll. If it has been decided that the cable will be dropped, ensure that the cable reel is equipped with a brake. If the cable is being pulled up through closed shafts, a key piece of equipment is a portable electric winch. Always follow the manufacturer's guidelines when operating this equipment.

During installation, ensure that the minimum bend radius specification and the maximum pulling load of the cable are not exceeded. One way to ensure this is to first install an inner duct (usually manufactured from a corrugated material). Inner ducts come in a variety of plastics and should be specified to meet local flammability regulations. If an inner duct is not used, consideration should be given to using a breakaway swivel. If a winch is used in the pulling operation, a breakaway swivel should always be used and the pulling load applied to the cable strength member.

Finally, ensure that the cable is secured on each floor. Generally, a split mesh grip that is connected to a bolt on the floor above is used to support the cable.

25.2 Cable preparation in the BD/DP termination area

The procedure for preparing the cable will depend on the cable type and construction. Care should be taken to ensure that the conductors are not damaged during this operation.

25.2.1 Volition four-pair twisted 100Ω cable

1. Ensure there is sufficient length of cable at the rack or frame to reach the patch panel (or module).
2. Ensure the cable sheath cutter is correctly adjusted so as not to damage the conductors
3. Measure and cut through the cable sheath at a distance of either:
   30mm (if terminating into an RJ45 Giga jack) or
   150mm (if terminating into an 8 pair module) from the cable end.
4. Hold the cable firmly in both hands with the ring cut between the hands.
5. Pull the end of the cable sheath from the cable and discard.
6. Follow the instructions included with the patch panel, module or RJ45 jack.

25.2.2 Voice grade backbone twisted pair copper cable

1. Ensure there is sufficient length of cable at the rack or frame to reach the patch panel (or module).
2. Ensure the cable sheath cutter is correctly adjusted so as not to damage the conductors
3. Measure and cut through the cable sheath at a distance sufficiently far away from the end of the cable to ensure that all the exposed conductors can reach the appropriate termination position. In a large pair count cable (100 pairs or larger) approximately 500mm of sheath will need to be removed (based on 12 modules at 20mm pitch plus 125mm module width) for each 100 pairs to be terminated.
4. Hold the cable firmly in both hands with the ring cut between the hands.
5. Pull the end of the cable sheath from the cable and discard*.
6. Follow the instructions included with the patch panel, module or RJ45 jack.

* it may be necessary to remove the sheath in several smaller lengths

26.0 Installing copper horizontal cable

As for backbone cable, 3M strongly recommend that copper horizontal cable and copper power cables should either be installed on separate cable supports or in separate sections of the support.

26.1 Installation procedure

The cable should be installed on a cable support located above a ceiling, in a wall or under a floor. The cable should take the most practical direct route, ensuring that the minimum bend radius and maximum pulling load is never exceeded (see Table 3.4 for information relating to Volition four pair cables, refer to the cable manufacturers installation specification if using a voice grade cable). Several cables can be pulled at the same time in order to reduce the time taken for the installation. Remember never to apply the pulling load directly to the cable sheath. Follow the instructions given in paragraph 14.3.1,

If the route incorporates tight bends or obstruction points, extra help should be deployed in these areas to guide the cables to ensure they do not get trapped. This will also reduce the pulling load that needs to be applied to the cable.

After installation, ensure a minimum of 0,5m of cable slack is available at each end of the link (i.e., patch panel/module and outlet) to allow for correct termination of the cable.

26.1.1 Cable rodding equipment

Cable rodding sets are used for installing horizontal cable in hard-to-get-to locations, or to route the cable past obstructions. The rod is attached to the cables being installed. Depending on the nature of the location, the length of the rod can be extended by screwing on additional rods. The rod can be used to bridge through difficult locations with the cable attached. These steps may have to be repeated several times along a cable route.

26.1.2 Pull cords

Generally, pull cords are placed by blowing them into conduit, or by placing them along a cable support (cable tray) with a rod. It is important to pull a replacement pull cord with the cable in order to facilitate the installation of subsequent cables.

26.1.3 Floor distribution systems

Floor distribution systems include under-floor trunking systems, conduit systems and access floor systems. Except for conduit systems, cable routes should either run parallel to, or perpendicular to, the building lines.

Under-floor trunking systems are characterised by having either trunking or duct running from the telecommunications closet to strategically placed junction boxes in the floor. The trunking generally extends at 90-degree angles from the telecommunications closet and feeds into junction boxes. Distribution trunking is then used from the junction boxes to feed the floor outlet locations, which are placed to serve a predetermined area of the floor.

Access floor systems are mostly found in computer rooms. However, they are being used more extensively in densely populated areas where a significant number of outlets may be installed.

26.1.4 Ceilings

Volition cables shall not be placed directly onto suspended ceiling tiles. Cable support systems such as cable trays, or conduit, shall be employed. When pulling cables through a suspended ceiling space, every two to three tiles should be removed for access. This will assist in the routing of the cable around obstructions etc. and facilitate the installation of cables in the support system employed.

28.1.5 Walls

Cables installed above a suspended ceiling will need to be dropped down to the work area. The cable may be routed down a distribution column into which the outlet is located, or dropped down a wall cavity. Dropping cables down an empty wall cavity is generally not difficult. A rod may be used or even a string tied to a weight. A rod is most suitable for insulated walls.

26.2 Cable preparation in the TO termination area

To prepare the cable in the TO termination area the following procedure should be adopted:

1. Ensure there is between 0,3 and 0,5m of excess cable at the TO. Trim any excess cable so that the conductors are flush with the end of the cable sheath
2. Ensure the sheath cutter is correctly adjusted so as not to damage the conductors in the cable
3. Measure and cut through the cable sheath 30mm from the end of the cable.
4. Hold the cable firmly in both hands with the ring cut between the hands.
5. Pull the end of the cable sheath from the cable and discard.
6. Follow the instructions included with the RJ45 Giga jack to complete the termination

27.0 Installing centralised copper (voice) cabling

Centralised cabling results in all the cross connection points being located centrally with the cable routing directly to the telecommunications outlet (TO). It is not necessary to limit the length of cable between termination points to 90m since it is assumed that the copper cable will never be required to carry data signals. This may be accomplished using Volition horizontal cable only or a combination of Volition horizontal and backbone cable.

When making this type of installation, the procedures documented for the installation of horizontal and backbone cable shall be followed.

28.0 Installing racks, cabinets, frames, modules and patch panels

Follow the instructions supplied with the product carefully. Care should be taken with cables and conductors to ensure that they are properly routed into and out of the termination area. If the system is required to support high-speed data as well as voice, it is essential to maintain the twist in each pair right up to the module or jack.

28.1 Module installation

All 3M modules work on the insulation displacement connection (IDC) principle, which means that there is no need to strip the insulation from the copper conductor prior to making the connection.. Jumper wires are used between modules to provide a cross connection. Wires are inserted into the IDC contacts on the module using an appropriate insertion tool.

Care is needed when selecting the wiring scheme to be used in the installation since this will greatly affect the wiring density. For example, using a Volition four-pair cable per TO effectively reduces the potential density by 75% since only one of the four-pairs is used to carry voice. Whilst this has little affect at the TO. connecting all four-pairs at the DP will reduce the density at the DP by 75% since only one in four of the terminated conductors will be used for voice.
It is only required to connect all four pairs if a dual data/voice system is being installed.

28.1.1 Module installation for horizontal wiring at the DP

When a dual voice/data system is installed using Volition four-pair cable and eight pair modules, the following wiring scheme should be adopted at the module. Note that position one is on the left of the module when viewed from the front and that voice is usually carried over pair one.

Table 4.10 Wiring scheme for 4 pair cable

Module position	Pair no	Wire colour
1	1	White/blue
2	1	Blue
3	2	White/orange
4	2	Orange
5	3	White/green
6	3	Green
7	4	White/brown
8	4	Brown
9	1	White/blue
10	1	Blue
11	2	White/orange
12	2	Orange
13	3	White/green
14	3	Green
15	4	White/brown
16	4	Brown

28.1.2 RJ45 Giga jack installation in the horizontal at the DP and TO

When installing the RJ45 Giga jack in a patch panel at the DP or in an outlet at the TO the following wiring scheme should be adopted:

Table 4.11 RJ45 Giga jack wiring scheme

Jack position	Pair no	Wire colour
1	2	Orange/white
2	2	Orange
3	3	Green/white
4	1	Blue
5	1	Blue/white
6	3	Green
7	4	Brown/white
8	4	Brown

28.1.3 Module installation in the backbone at the DP and BD

When using higher pair count cables in the backbone then the wiring scheme to be followed will depend on the following:

1. Whether a dual data/voice scheme is being installed
2. Whether eight or ten pair modules are being used
3. The type and size of the backbone cable
4. The wire grouping in the cable

If a dual data/voice scheme is being installed and Volition four-pair cable is being used in the backbone, then the wiring scheme shown in Table 4.10 should be followed. If however the installation is for voice only and a large pair count cable with ten pair grouping is being used in the backbone, then the wiring scheme shown in Table 4.11 should be followed.

Table 4.12 Wiring scheme for cable in 10 pair groups

Module position		Pair	Colour
8 pair	10 pair		Blue
1	1	1	Blue/white
2	2	1	Blue
3	3	2	Orange/white
4	4	2	Orange
5	5	3	Green/white
6	6	3	Green
7	7	4	Brown/white
8	8	4	Brown
1	9	5	Slate/white
2	10	5	Slate
3	1	6	Blue/red
4	2	6	Blue
5	3	7	Orange/red
6	4	7	Orange
7	5	8	Green/red
8	6	8	Green
1	7	9	Brown/red
2	8	9	Brown
3	9	10	Slate/red
4	10	10	Slate

28.1.4 Patchcord and jumper installation at the DP and BD

Patchcords and jumpers are only installed once the installation is complete and after all testing has been finalised. Care should be taken when routing jumpers and patchcords between modules and patch panels. Sufficient patchcord management panels and horizontal and vertical jumper rings should be used to ensure a tidy installation and to facilitate tracing of circuits at a later date

29.0 Testing

Where data cable has been installed, the system must be tested in accordance with the requirements of paragraph 20. Where voice grade cable has been installed, it is only necessary to test that the correct wire mapping has been followed between each end of the links being tested.

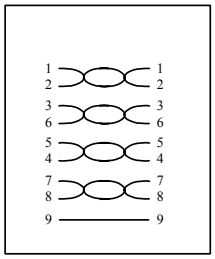
29.1 Testing procedure for voice grade cable

Testing shall be performed using either a manual tester or an automatic tester or scanner. The following parameter of the link shall be verified:

- wire map

A wire map test is intended to verify correct pin termination at each end of the link and to check for Incorrectly terminated wires. For each of the conductors in the cable, and the screen(s), if any, the conductor map indicates:

- continuity to the remote end
- shorts between any two or more conductors/screen(s)
- transposed pairs
- reversed pairs
- split pairs
- any other connection errors.



Correct pairing

A reversed pair occurs when the polarity of one wire pair is reversed at one end of the link. Note this is also sometimes referred to as a tip and ring reversal

A transposed pair occurs when the two conductors in a wire pair are connected to the position for a different pair at the remote connection. Note transposed pairs are sometimes referred to as crossed pairs.

Split pairs occur when pin-to-pin continuity is maintained but physical pairs are separated. Figure 4.6 gives an illustration of all three conditions.

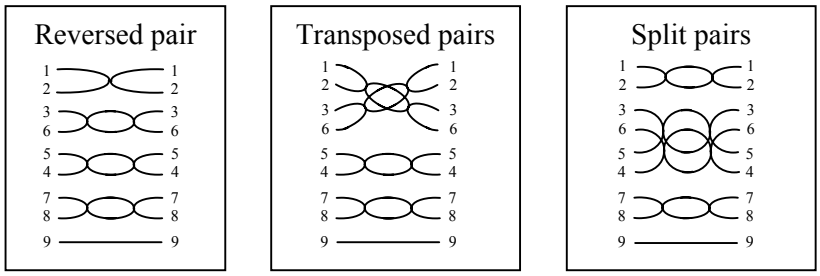


Figure 4.6 Incorrect pairing

29.2 Test report

Upon completion of the testing a fully documented test report must be produced. The contents of the test report shall include at least the following information:

- system location
- testing date
- name of person(s) performing test
- performance details of each link tested.

PART 5 – SYSTEM ADMINISTRATION AND SYSTEM WARRANTY

30.0 System administration

Administration is an essential aspect of the Volition Cabling System. The flexibility of the system can only be fully exploited if the installation is properly administered. This involves accurate identification of all the components, including pathways, closets and other places in which they are installed.

30.1 Labelling

Every element of the cabling system, including the pathways and spaces in which it is installed, shall be readily identifiable. A unique identifier shall be assigned to every cable, distributor and telecommunications outlet. Cables shall be marked at both ends and outlets shall be marked to reference circuit designation.

One possible colour scheme based on ANSI/TIA/EIA-606 is shown in Table 5.1. Typically, cables are labelled within 20cm of the termination field or outlet point.

Table 5.1 ANSI/TIA/EIA 606 colour scheme

Function	Colour
Auxiliary and miscellaneous	Yellow
Common Equipment	Purple
Customer side of the network interface	Green
First level backbone	White
Horizontal cable to work area	Blue
Key telephone equipment	Red
Network side of network interface	Orange
Second level backbone	Grey

30.2 Records

Detailed records of the original installation shall be kept and all subsequent changes documented as and when they are carried out. A computer-based scheme is highly recommended.

31.0 Warranty

31.1 Summary

3M warrant that the Volition System will perform for 20 years to the channel specifications in industry standards at the time of installation. 3M extend the system warranty to the end user by way of the certified Volition Integration Professional (VIP) or Certified Volition Installer (CVI). The VIP or CVI has responsibility for proper installation of the system.

The warranty covers the end-to-end link from the wall outlet at the workstation to the patch panel in the equipment room. Patchcords and electronic equipment are excluded from the 20-year system warranty.

The VIP (or CVI) has responsibility for the installation and final testing. Changes to the system are covered by the warranty, provided the changes are made and tested to current channel specifications and warranty requirements at the time of the change.

If the installation does not perform to specifications, the labour to repair or replace defective components will be provided by the VIP (or CVI). The cost of the labour and parts is resolved between 3M and the VIP or CVI according to the terms in the VIP Agreement or CVI Agreement.

A precise description of the warranty coverage and conditions is given on the warranty certificate.

31.2 Warranty application procedure

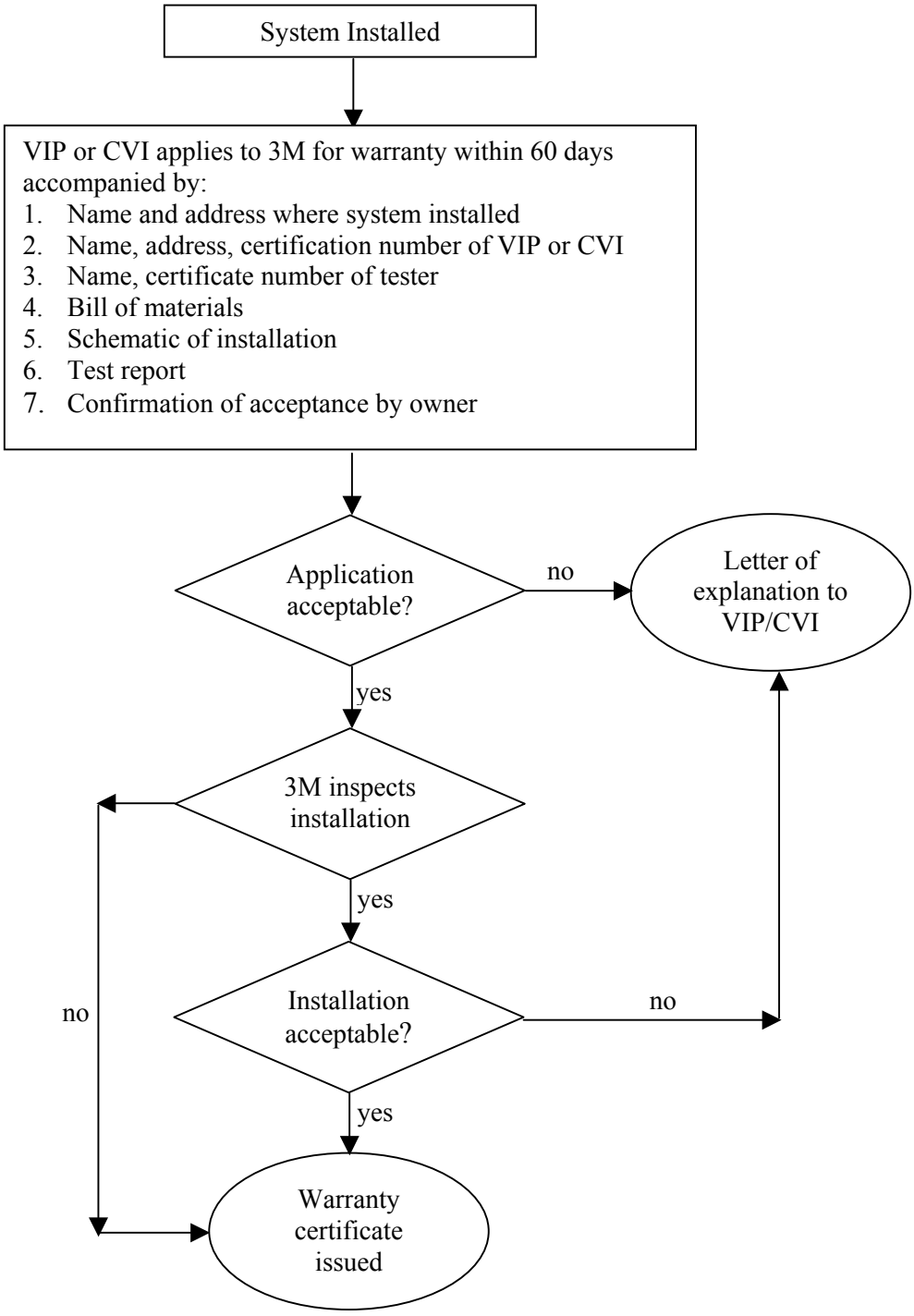


Figure 5.1 Warranty application procedure

31.3 Warranty deviation

Changes to the procedure as outlined above will be necessary if a product that has not been supplied by 3M and has not been approved by 3M is used in the installation. In such a case a special application must be made to 3M prior to the installation taking place.

3M Technical Service will review the product substitution(s) to determine if channel performance is likely to be compromised. Subject to technical approval, the final decision on whether to grant a warranty will be made by the appropriate 3M business manager.

PART 6 - SYSTEM COMPONENTS AND GLOSSARY

32.0 Volition fibre system components

32.1 The VF-45™ small form factor (SFF) connector

The VF-45™ is a two-part connector, with a plug/socket configuration. The socket is simple and quick to terminate in the field, thus cutting the cost of installations. The plug comes pre-terminated on the patchcord. The VF-45™ is tested in accordance with a combination of TIA, IEC and 3M specifications the results of which are shown in Table 6.1.

Table 6.1 VF-45™ specification

Test	Test condition/requirements (multimode)	Test condition/requirements (singlemode)
Attenuation (dB)	≤0,75dB	≤0,75dB
Return Loss (dB)	≥20dB	≥26dB
Mating Durability	500 cycles, ≤0,75dB	500 cycles, ≤0,75dB
Strength of Coupling	33N, ≤0,75dB	33N, ≤0,75dB
Plug Cable Retention	66N, ≤0,75dB	66N, ≤0,75dB
Plug Static side load	6,6N, ≤0,75dB	6,6N, ≤0,75dB
Plug Cable Flexing	100 cycles ± 90°, 0,5kg, ≤0,75dB	100 cycles ± 90°, 0,5kg, ≤0,75dB
Plug Cable Twist	10 cycles ± 2,5 revs, 15N, ≤0,75dB	10 cycles ± 2,5 revs, 15N, ≤0,75dB
Cold	-10C, 96 Hours, <0,3dB change	-10C, 96 Hours, <0,3dB change
Dry Heat	+60C 14 days, <0,3dB change	+60C 14 days, <0,3dB change
Change of Temperature	5 cycles -10C to +60C, <0,3dB change	5 cycles -10C to +60C, <0,3dB change
Vibration	10-55Hz, 30min/axis, <0,3dB change	10-55Hz, 30min/axis, <0,3dB change

32.2 Tooling

A range of special hand tooling is available for installing and maintaining the VF-45™ connector.

32.2.1 VF 45 Quick install kit

The VF-45™ Quick Install Kit contains everything required to quickly and easily install the VF-45™ socket. Cable and fibre strippers, polishing and socket assembly fixtures and inspection viewer - all contained in a pouch that can be conveniently clipped to the installer's belt. Consumables sufficient for the first 500 terminations are included in the kit.

32.2.2 VF-45 Maintenance cleaning kit

The VF-45 Maintenance Cleaning System keeps the VF-45™ interconnect at the "just installed" level of optical performance. The system comprises a spray bottle containing Volition HFE-based cleaning fluid and separate attachments designed to interface with the VF-45™ plug and socket. HFE -based cleaning fluid is non-flammable and non-conductive making the maintenance cleaning kit a convenient, quick and effective way of cleaning the fibre end faces.

Table 6.2 Quick install and maintenance cleaning kits and components

Model Number	Description
VOL-0562	VF-45™ quick install kit
VOL-0570	VF-45™ maintenance cleaning kit
VOL-0570A	VF-45™ cleaning fluid, 473 ml bottle
VOL-0560A	Jacket stripper
VOL-0560B	Scissors
VOL-0560C	Micro module stripper
VOL-0560D	Fibre stripper, 250µm coating
VOL-0560F	Polishing puck assembly
VOL-0560G	Polishing puck face
VOL-0560L	Fibre view scope with adapter base
VOL-0560N	Cotton buds
VOL-0560P	Lint free wipes
VOL-0560R	Bottle, alcohol, empty
VOL-0560W	Cleaning wires 100µm diameter
VOL-0562C	Adapter base, view scope
VOL-0562H	Polishing station sub-assembly
VOL-0562J	Replacement cleave blade
VOL-0562K	Polishing paper – 5 sheets
VOL-0562L	Penlight
VOL-0562M	Tool pouch
VOL-0562S	Tool case
VOL-0562V	Base station door
VOL-0562X	View scope assembly (base, scope, penlight)

32.3 Housings

32.3.1 Rack mount patch panels

The Volition system patch panels are designed to take maximum advantage of the small form factor of the VF-45™ connector. They are available in 24, 48 and 72 port formats. A separate patchcord management panel is also available.

Table 6.3 Rack mount patch panels

Model number	Number of ports	No of patch cable management rings	Mounting arrangement	Vertical rack space	Colour
VOL-0430-ES	24	-	19”(IEC 297)	1U	Cream
VOL-0432-ES	48	-	19”(IEC 297)	2U	Cream
VOL-0434-ES	72	-	19”(IEC 297)	3U	Cream
VOL-0499E	0	4	19”(IEC 297)	1U see note 1	Cream

Notes:
1. Patch Cable management panel only.

32.3.2 Wall Mount patch panels

Volition wall mount patch panels are manufactured in powder coated sheet metal and can be fixed easily and quickly to the wall.

A hinged door on the front of the panel provides access to the VF-45™ sockets, which can be locked using a padlock (not supplied) for extra security. Wall mount patch panels are available in 6, 12 and 24 port formats.

Table 6.4 Wall mount patch panels

Model number	Number of ports	Dimensions (mm) (W x H x D)	Colour
VOL-0406	6	198 x 163 x 54	Cream
VOL-0412	12	198 x 255 x 54	Cream
VOL-0414	24	198 x 439 x 54	Cream

32.3.3 Wall mount splice boxes

Volition wall mount splice boxes serve as a division point for multi–fibre cables and to accommodate splices in centralised cabling. The low profile structure eliminates the need for equipment rooms on each floor.

Table 6.5 Wall mount splice boxes and accessories

Model number	Number of fibres	Dimensions (mm) (W x H x D)	Colour
VOL-0450	48 – 96	300 x 300 x 85	Grey (RAL 7035)
VOL-0451	144 – 288	225 x 600 x 210	Grey (RAL 7035)
VOL-0452	288 – 576	425 x 600 x 210	Grey (RAL 7035)
VOL-0453	288 – 864	650 x 600 x 210	Grey (RAL 7035)
VOL-0454	576 – 1172	875 x 600 x 210	Grey (RAL 7035)
	Accessory		
VOL-450	Adhesive cable guide, 20mm		
VOL-450	Protective brush for cable entry		
VOL-450	PG entry plate		
VOL-450	Splice cassette holder for 4 cassettes		
VOL-0450-4	Adaptor board for cassette holder		
VOL-0450-4	DIN splice cassette with lid		
VOL-451-4	Clip-on cable guide, 55mm		
VOL-451-4	Protective brush for cable entry		
VOL-451-4	PG entry plate		
VOL-451-4	Splice cassette holder for 12 cassettes		
VOL-451-4	Splice cassette holder for 12 cassettes		

32.4 Outlet products

32.4.1 Wall mount outlets

Volition wall-mounted outlets accommodate VF-45™ sockets and include cable strain relief and fibre storage facilities. The VOL-0250A and 0250B outlets can house up to two VF-45™ sockets and are used in conjunction with VOL-0700 faceplates to additionally accommodate 0, 2 or 4 RJ45 sockets. The VOL-0255 and 0256 outlets can house up to two VF-45™ sockets; one VF-45™ socket and one RJ45 jack or two RJ45 jacks (RJ45 jacks must employ keystone latching and be size compatible with the outlet).

32.4.2 Flush mount outlets

The VOL-0257 outlet is used in conjunction with separately supplied mounting and facia plates. Typically used in pillar or trunking applications, it can house up to two VF-45™ sockets.

32.4.3 Furniture outlets

Volition modular furniture outlets house a maximum of two VF-45™ sockets. To save space, the VF-45™ plug lays parallel to the furniture partition. They are available in a number of colours.

Table 6.6 Outlet products

Model number	Number of VF 45 ports	Number of RJ 45 ports	Dimensions (mm)	Mounting centres (mm)	Colour
VOL-0250A	2	0	121 x 75	90 - 60	Ivory
VOL-0250B	2	0	121 x 75	90 - 60	White
VOL-0700	0	0	121 x 75	83,3(1)	Office White
VOL-0700B	0	0	121 x 75	83,3(1)	Bright White
VOL-0701	0	1	121 x 75	83,3(1)	Office White
VOL-0701B	0	1	121 x 75	83,3(1)	Bright White
VOL-0702	0	2	121 x 75	83,3(1)	Office White
VOL-0702B	0	2	121 x 75	83,3(1)	Bright White
VOL-0703	0	4	121 x 75	83,3(1)	Office White
VOL-0703B	0	4	121 x 75	83,3(1)	Bright White
VOL-0255W	2	0	80 x 80	60	White
VOL-0255C	2	0	80 x 80	60	Cream
VOL-0256W	2	0	80 x 80	60	White
VOL-0257W	2	0	45 x 90	n/a	White
VOL-0350B	2	0	120 x 75	n/a	Bright White
VOL-0350G	2	0	120 x 75	n/a	Grey
VOL-0350BK	2	0	120 x 75	n/a	Black

Notes:
1. The VOL-0700 range of faceplates is used with model VOL-0250 only. It provides mounting for up to 4 RJ45 UTP jacks that use keystone latch panel mounting. If no RJ45 mounting is required, the VOL-0700 blanking plate must always be used.
2. The VOL-0257 is based on the 45mm x 45mm module standard. It clips into a mounting grid having an aperture of 45mm x 90mm with a matching face plate e.g. Legrand part no. 303 97 mounted in Legrand 100mm x 50mm trunking part no.300 38 refer. The minimum depth requirement for trunking or pillar is 50mm.

32.4.4 Blanking plugs for outlets and patch panels

Table 6.7 Blanking plugs

Model number	Colour
VOL-0300	Office white
VOL-0300B	Bright white
VOL-0300G	Grey
VOL-0300BK	Black

32.4.5 Floor box inserts

These inserts are designed for use with suspended floor applications where it is required to locate the VF-45™ socket in a box at floor level. They are available in powder coated sheet steel or plastic.

Table 6.8 Floor box inserts

Model number	Number of VF 45 ports	Number of RJ 45 ports	Type
VOL-0258A	2	2 x 3M	Steel, powder coat, black
VOL-0258B	2	2 x Panduit	Steel, powder coat, black
VOL-0258C	3	3 x Panduit	Steel, powder coat, black
VOL-0258D	2	2 x T&B	Steel, powder coat, black
VOL-0258E	3	3 x T&B	Steel, powder coat, black
VOL-0259A	2	2 x 3M	Plastic
VOL-0259B	2	2 x Panduit	Plastic
VOL-0259C	3	3 x Panduit	Plastic
VOL-0259D	2	2 x T&B	Plastic
VOL-0259E	3	3 x T&B	Plastic

32.5 Cable and patchcords

Unless otherwise stated, all Volition fibre cables are supplied with a low smoke zero halogen sheath. The specification for the fibre used in Volition horizontal and backbone cable is given in Table 6.9

Table 6.9 Fibre specification

Fibre Size (μm)	Parameter	Performance			
		850nm		1300nm	
		Indoor	Indoor/outdoor	Indoor	Indoor/outdoor
62,5/125	Attenuation	≤3,5dB/km	≤3,2dB/km	≤1,0dB/km	≤1,0dB/km
62,5/125	Bandwidth	>200MHz.km	>200MHz.km	500MHz.km	> 600 MHz-km
50/125	Attenuation	≤3,5dB/km	≤2,7dB/km	≤1,0dB/km	≤0,8 dB/km
50/125	Bandwidth	>500MHz.km	>500MHz.km	>500MHz.km	> 800 MHz-km
9/125	Attenuation	-	-	≤0,7dB/km	≤0,4dB/km

32.5.1 Horizontal cable

Volition horizontal cable is available in two-fibre and four-fibre format. The unique two fibre modular construction of the cable simplifies cable installation and facilitates the installation of the VF-45™ socket.

Operating temperature range -10°C to 60°C.
62,5/125 µm cables meet ISO/IEC 11801 specifications.
50/125 µm and 62,5/125 µm cables meet TIA/EIA specifications.

Table 6.10 Horizontal cable specification

Model No.	Description	Bend radius (mm) (short/long term(1))	Cable outer diameter (mm)	Weight of cable (kg/km)	Max load(2) (N)	Fire loading (MJ/m)
VOL-H52LX	50/125 µm, 2-fibre	50/30(3)	2,8	7,4	440	0,11
VOL-H54LX	50/125 µm, 4-fibre	50/30(3)	3,25	9,8	440	0,15
VOL-H62LX	62,5/125 µm, 2-fibre	50/30(3)	2,8	7,4	440	0,11
VOL-H64LX	62,5/125 µm, 4-fibre	50/30(3)	3,25	9,8	440	0,15
VOL-H92LX	9/125 µm, 2-fibre	38/30(3)	2,5	7,4	440	0,11
VOL-H94LX	9/125 µm, 4-fibre	47/30(3)	3,1	9,5	440	0,15

Notes:
1. The short term bend radius is under installation conditions.
2. Applied to the cable strength member(s)
3. 25mm in the termination area where the sheath has been removed.
4. X denotes the cable length. Cable can be ordered in 1km and 2km lengths for 50/125µm, 1km lengths for 62,5/125µm and 9/125µm fibre.
5. Cable colour is blue for 50/125µm and 62,5/125µm cable and green for 9/125µm cable.

32.5.2 Indoor backbone cable

The backbone cable provides the physical link between the floor distributor and the building distributor. Backbone cable is available in counts of 6-, 12-, 24-, 48-, 72- and 96- fibres. As with the horizontal cable, each pair of 250 µm coated fibres is contained within a separate buffer tube.

Specification:

Operation and Installation Temperature	-10°C to +70°C
Flame Propagation	IEC 332-3C
Smoke Density	IEC 61034
Toxic Emission	CENELEC HD 605
Corrosive Gas	IEC 60754-1, 60754-2
Material	CENELEC HD 624-7

Table 6.11 Backbone cable specification(1)

Model number	Description	Bend radius (short/long term(2)) (mm)	Cable outer diameter (mm)	Weight of cable (kg/km)	Max load(3) (N)
VOL-B56LX	50/125µm 6-fibre	75/50(4)	4,5	25,0	660
VOL-B512LX	50/125µm 12-fibre	75/50(4)	5,0	30,0	660
VOL-B524LX	50/125µm 24-fibre	90/60(4)	6,0	40,0	1320
VOL-B548LX	50/125µm 48-fibre	190/120(4)	12,0	110,0	5618
VOL-B572LX	50/125µm 72-fibre	250/150(4)	15,0	170,0	5618
VOL-B596LX	50/125µm 96-fibre	275/190(4)	19,0	300,0	5618
VOL-B66LX	62,5/125µm 6-fibre	75/50(4)	4,5	25,0	660
VOL-B612LX	62,5/125µm 12-fibre	75/50(4)	5,0	30,0	660
VOL-B624LX	62,5/125µm 24-fibre	90/60(4)	6,0	40,0	1320
VOL-B648LX	62,5/125µm 48-fibre	190/120(4)	12,0	110,0	5618
VOL-B672LX	62,5/125µm 72-fibre	250/150(4)	15,0	170,0	5618
VOL-B696LX	62,5/125µm 96-fibre	275/190(4)	19,0	300,0	5618
VOL-B96LX	9/125um 6-fibre	75/50(4)	4,5	25,0	660
VOL-B912LX	9/125um 12-fibre	75/50(4)	5,0	30,0	660
VOL-B924LX	9/125um 24-fibre	90/60(4)	6,0	40,0	1320
VOL-B948LX	9/125um 48-fibre	190/120(4)	12,0	110,0	5618
VOL-B972LX	9/125um 72-fibre	250/150(4)	15,0	170,0	5618
VOL-B996LX	9/125um 96-fibre	275/190(4)	19,0	300,0	5618

Notes:
1. All dimensions and weights are nominal values
2. The short term bend radius is under installation conditions.
3. Applied to the cable strength member(s)
4. 25 mm in the termination area where the sheath has been removed
5. X denotes the cable length. Cable can be ordered in 0.5km, 1.0km, 1.5km and 2km lengths.
6. Cable colour is blue for multimode, green for single mode.
7. 50/125µm and 9/125µm fibre cables of 12 fibre count and above, and 62,5/125µm fibre cables of 48 fibre count and above, have a central strength member.
8. Cables of 48 fibres and above are constructed from sub-units similar to the 12 fibre cable. Each sub-unit contains six 2-fibre tubes

32.5.3 Indoor/outdoor backbone cable

Available with 50/125µm and 62,5/125µm multimode, or 9/125µm singlemode fibre. All variants have good resistance against water. The cable core is water blocked using a combination of swellable tape and gel filling inside the tubes. The colour of multimode cable sheath is blue, single mode cable sheath is green. Additional construction variations are also available on request.

Specification:

Operation and Installation Temperature	-30°C to +60°C (2-24 fibres) -40°C to +60°C (48-72 fibres)
Flame Propagation	IEC 332-1
Smoke Density	IEC 61034
Toxic Emission	CENELEC HD 605
Corrosive Gas	IEC 60754-1, 60754-2
Material	CENELEC HD 624-7

- **Indoor/outdoor backbone cable with aramid yarn for tensile strength**

  Cable construction fully dielectric for immunity against lightning
  All tubes containing fibres are gel filled for protection against water
  The cable core is protected against water ingress by a swellable tape
  UV stabilised sheath makes the cable suited for outdoor use

Table 6.12 shows the details for 50/125µm/62,5/125µm/9/125µm aramid yarn indoor/outdoor cable.

Table 6.12 Specification for indoor/outdoor backbone cable with aramid yarn

Model number	Description	Bend radius (mm)	Outer diameter (mm)	Weight (kg/km)	Max. short term load (N)	Fire loading (MJ/m)
VOL-IOA52/62/9	2 fibre Unitube	100	7	30	1000	0,9
VOL-IOA54/64/94	4 fibre Unitube	100	7	30	1000	0,9
VOL-IOA56/66/96	6 fibre Unitube	100	7	30	1000	0,9
VOL-IOA58/68/98	8 fibre Unitube	100	7	30	1000	0,9
VOL-IOA512/612/912	12 fibre Unitube	100	7	30	1000	0,9
VOL-IOA524/624/924	24 fibre Unitube	100	8	35	1000	1,0
VOL-IOA548/648/948(1)	48 fibre Loose tube	210	10,5	90	1800	2,4
VOL-IOA572/672/972(1)	72 fibre Loose tube	210	10,5	90	1800	2,3

Notes:
1. Cables with 48 and 72 fibres have a non-metallic central strength member.

- **Indoor/outdoor backbone cable with glass yarn for rodent protection**

  Glass yarn acts as rodent protection, effective in most cases
  Cable construction fully dielectric for immunity against lightning
  All tubes containing fibres are gel filled for protection against water
  The cable core is protected against water ingress by a swellable tape
  UV stabilised sheath makes the cable suited for outdoor use

Table 6.13 shows the details for 50/125µm/62,5/125µm/9/125µm glass yarn indoor/outdoor cable.

Table 6.13 Specification for indoor/outdoor backbone cable with glass yarn

Model	Description	Bend radius (mm)	Outer diameter (mm)	Weight (kg/km)	Max. short term load (N)	Fire loading (MJ/m)
VOL-IOG54/64/94	4 fibre Unitube	100	11	140	2000	2,5
VOL-IOG56/66/96	6 fibre Unitube	100	11	140	2000	2,5
VOL-IOG58/68/98	8 fibre Unitube	100	11	140	2000	2,5
VOL-IOG512/612/912	12 fibre Unitube	100	11	140	3000	2,5
VOL-IOG524/624/924	24 fibre Unitube	100	11	145	3000	2,6
VOL-IOG548/648/948(1)	48 fibre Loose tube	300	13,5	230	8000	2,8
VOL-IOG572/672/972(1)	72 fibre Loose tube	300	13,5	230	8000	2,7

Notes:
1. Cables with 48 and 72 fibres have a non-metallic central strength member.

- **Indoor/outdoor backbone cable with corrugated steel tape armouring for guaranteed rodent protection**

  Corrugated steel tape armouring for added robustness and guaranteed rodent protection
  For direct burial under difficult laying conditions (48, 72 fibre cables)
  All tubes containing fibres are gel filled for protection against water
  The cable core is protected against water ingress by a swellable tape
  UV stabilised sheath makes the cable suited for outdoor use

Table 6.14 Specification for indoor/outdoor backbone cable with steel armouring

Model	Description	Bend radius (mm)	Outer diameter (mm)	Weight (kg/km)	Max. short term load (N)	Fire loading (MJ/m)
VOL-IOS92	2 fibre Unitube,	55	8,5	75	1000	1,3
VOL-IOS54/64/94	4 fibre Unitube,	55	8,5	75	1000	1,3
VOL-IOS56/66/96	6 fibre Unitube,	55	8,5	75	1000	1,3
VOL-IOS58/68/98	8 fibre Unitube	55	8,5	75	1000	1,3
VOL-IOS512/612/912	12 fibre Unitube	55	8,5	75	1000	1,3
VOL-IOS524/624/924	24 fibre Unitube	55	9,5	85	1000	1,3
VOL-IOS548/648/948	48 fibre Loose tube	290	14,5	285	1800	4,5
VOL-IOS572/672/972	72 fibre Loose tube	290	14,5	285	1800	4,4

Notes
1. Cables with 48 and 72 fibres have a non-metallic central strength member.

32.5.3 Patchcords

Available in a variety of standard lengths, 3M may also be able to supply pre-terminated patch cables to meet specific requirements.

Table 6.15 Patchcords

Model number				Description
VF-45™ – VF-45	VF-45 – ST	VF-45 – SC	VF-45 – MT-RJ	
VOL-V9L1	VOL-T9L1	VOL-C9L1	VOL-M9L1	9/125µm, 1m
VOL-V9L1,5	VOL-T9L1,5	VOL-C9L1,5	-	9/125µm, 1,5m
VOL-V9L2	VOL-T9L2	VOL-C9L2	VOL-M9L2	9/125µm, 2m
VOL-V9L3	VOL-T9L3	VOL-C9L3	VOL-M9L3	9/125µm, 3m
VOL-V9L5	VOL-T9L5	VOL-C9L5	VOL-M9L5	9/125µm, 5m
VOL-V9L6	VOL-T9L6	VOL-C9L6	-	9/125µm, 6m
VOL-V9L8	VOL-T9L8	VOL-C9L8	VOL-M9L8	9/125µm, 8m
-	-	-	VOL-M9L10	9/125µm, 10m
VOL-V9L15	VOL-T9L15	VOL-C9L15	-	9/125µm, 15m
VOL-V9L30	VOL-T9L30	VOL-C9L30	-	9/125µm, 30m
VOL-V5L1	VOL-T5L1	VOL-C5L1	VOL-M5L1	50/125µm, 1m
VOL-V5L1,5	VOL-T5L1,5	VOL-C5L1,5		50/125µm, 1,5m
VOL-V5L2	VOL-T5L2	VOL-C5L2	VOL-M5L2	50/125µm, 2m

Table 6.15 Patchcords (continued)

Model number				Description
VF-45™ – VF-45	VF-45 – ST	VF-45 – SC	VF-45 – MT-RJ	
VOL-V5L3	VOL-T5L3	VOL-C5L3	VOL-M5L3	50/125µm, 3m
VOL-V5L5	VOL-T5L5	VOL-C5L5	VOL-M5L5	50/125µm, 5m
VOL-V5L6	VOL-T5L6	VOL-C5L6	-	50/125µm, 6m
VOL-V5L8	VOL-T5L8	VOL-C5L8	VOL-M5L8	50/125µm, 8m
-	-	-	VOL-M5L10	50/125µm, 10m
VOL-V5L15	VOL-T5L15	VOL-C5L15	-	50/125µm, 15m
VOL-V5L30	VOL-T5L30	VOL-C5L30	-	50/125µm, 30m
VOL-V6L1	VOL-T6L1	VOL-C6L1	VOL-M6L1	62,5/125µm, 1m
VOL-V6L1,5	VOL-T6L1,5	VOL-C6L1,5	-	62,5/125µm, 1,5m
VOL-V6L2	VOL-T6L2	VOL-C6L2	VOL-M6L2	62,5/125µm, 2m
VOL-V6L3	VOL-T6L3	VOL-C6L3	VOL-M6L3	62,5/125µm, 3m
VOL-V6L5	VOL-T6L5	VOL-C6L5	VOL-M6L5	62,5/125µm, 5m
VOL-V6L6	VOL-T6L6	VOL-C6L6	-	62,5/125µm, 6m
VOL-V6L8	VOL-T6L8	VOL-C6L8	VOL-M6L8	62,5/125µm, 8m
-	-	-	VOL-M6L10	62,5/125µm, 10m
VOL-V6L15	VOL-T6L15	VOL-C6L15	-	62,5/125µm, 15m
VOL-V6L30	VOL-T6L30	VOL-C6L30	-	62,5/125µm, 30m

32.5.4 Reference patchcord sets and OTDR launch leads

The reference patchcord set comprises a VF-45™ to ST™ or SC hybrid patchcord, a VF-45™ to VF-45™ socket patchcord and a VF-45™ to VF-45™ patchcord. It is essential to use the reference patchcord set for referencing the power level prior to taking link attenuation measurements with a power meter and light source.

The OTDR launch leads are required when making OTDR measurements

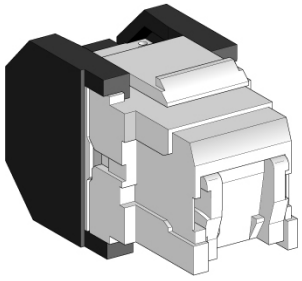
Table 6.16 Patchcord sets and OTDR launch leads

Model number	Description
GEN-REF-062-ST	Reference patchcord set 62,5/125µm, with ST connectors
GEN-REF-062-SC	Reference patchcord set 62,5/125µm, with SC connectors
GEN-REF-050-ST	Reference patchcord set 50/125µm, with ST connectors
GEN-REF-050-SC	Reference patchcord set 50/125µm, with SC connectors
GEN-REF-SM-ST	Reference patchcord set 9/125µm, with ST connectors
GEN-REF-SM-SC	Reference patchcord set 9/125µm, with SC connectors
GEN-REF-SM-FC	Reference patchcord set 9/125µm, with FC connectors
VOL-C6L100	OTDR launch lead, 62,5/125µm, with SC connector, 100m
VOL-C5L100	OTDR launch lead, 50/125µm, with SC connector, 100m

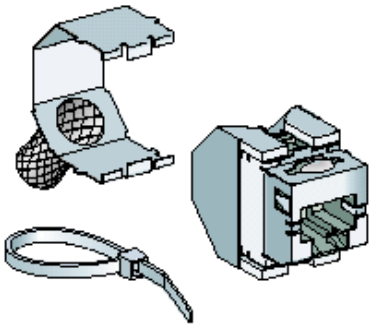
33.0 Volition copper system components

33.1 RJ45 Giga , K5E and K6 RJ45 Jacks

All jacks offer tool-free termination in record time, all 8 conductors and the drain wire can be wired in a single operation. The compact size facilitates the mounting of the connector in a variety of locations without compromising the minimum bend radius requirements of the cable. In the shielded version all jacks have a metallic shield extending over all the outer surfaces of the connector. The rear metal cover is reversible allowing the cable to route away from the connector in two directions.



K6 UTP Jack



RJ45 Giga STP jack

The RJ45 Giga jacks are available in 8 point, 9 point and shielded versions and will mount directly into the BCC or Qmax ranges of patch panel while the K5E and K6 RJ45 jacks with their keystone mounting will mount directly into the Classic and Double Plate ranges of patch panels.

Modules incorporating the jack are also available and these can have the front face orientated vertically or at 30 degrees to the vertical. Modules can accommodate a visual and mechanical polarity key and come complete with dust cover and label (telephone or computer)

Highlights

- Meets ISO 8877 requirements
- Meets Category 5E and Category 6 standards as appropriate
- Available in 8 point, 9 point and shielded versions
- No tools required to terminate conductors.
- Comprehensive range of accessories

Table 6.17 RJ45 Giga and K6 RJ45 jack specifications

Technical data	RJ45 Giga			K6		
Overall dimensions 8 point (W x H x D) (mm)	19 x 28 x33			18 x 23 x 35		
Overall dimensions 9 point (W x H x D) (mm)	19 x 28 x 33			18 x 23 x 35		
Overall dimensions shielded (W x H x D) (mm)	19 x 45 x51			18 x 23 x 51		
Wire diameter –solid (mm)	0,5 – 0,65			0,5 – 0,65		
Overall diameter (over insulation) (mm)	≤1,6			≤1,6		
Housing material	PBT			PBT		
Flame protection	UL 94 V0			UL 94 V0		
Insulation resistance (MΩ)	$>10^4$					
Contact resistance Rc (mΩ)	17> Rc < 20			17> Rc < 20		
	100MHz	200MHz	250MHz	100MHz	200MHz	250MHz
Attenuation (dB)	< 0,2	< 0,2	< 0,3	< 0,2	< 0,2	< 0,3
Return Loss (dB)	24	18,5	16	24	18,5	16
NEXT (pair to pair) (dB)	-49	-40	-36	-58	-50	-47,5

Table 6.18 RJ45 Giga jacks and modules

Model number	Description
P28770AA	Volition RJ45 Giga jack Cat 5e, UTP, light grey
P28753AB	Volition RJ45 Giga jack 8 pin, vertical front face, 22.5 x 45, Cat 5e UTP
P28756AB	Volition RJ45 Giga jack 8 pin, vertical front face, 45 x 45 Cat 5e UTP
P28759AB	Volition RJ45 Giga jack 8 pin, vertical front face, 25 x 50 Cat 5e UTP
P28762AB8	Volition RJ45 Giga jack 8 pin, vertical front face, 50 x 50 Cat 5e UTP
P28750A	Volition RJ45 Giga jack 8 pin, angled front face 30º, down 22.5 x 45 Cat 5e UTP
P28771AA	Volition RJ45 Giga jack Cat 5e, FTP, light grey
P28754AB	Volition RJ45 Giga jack 9 pin, vertical front face, 22.5 x 45 Cat 5e FTP
P28757AB	Volition RJ45 Giga jack 9 pin, vertical front face, 45 x 45 Cat 5e FTP
P28760AB	Volition RJ45 Giga jack 9 pin, vertical front face, 25 x 50 Cat 5e FTP
P28763AB	Volition RJ45 Giga jack 9 pin, vertical front face, 50 x 50 Cat 5e FTP
P28751AB	Volition RJ45 Giga jack 8 pin, angled front face 30º down, 22.5 x 45 Cat 5e FTP
P28772AA	Volition RJ45 Giga jack Cat 5e, STP, light grey and metallic shield
P28755AB	Volition RJ45 Giga jack, vertical front face, 22.5 x 45 Cat 5e STP
P28758AB	Volition RJ45 Giga jack, vertical front face, 45 x 45 Cat 5e STP
P28761AB	Volition RJ45 Giga jack, vertical front face, 25 x 50 Cat 5e STP
P28764AB	Volition RJ45 Giga jack, vertical front face, 50 x 50 Cat 5e STP
P28752AB	Volition RJ45 Giga jack 8 pin, angled front face 30º down, 22.5 x 45 Cat 5e STP

Table 6.19 K6 RJ45 jacks

Model number	Description	Size (mm)
VOL-0CK6-U	Volition RJ45 K6 jack Cat 6 UTP, white	
VOL-0CK6-F	Volition RJ45 K6 jack Cat 6 FTP, white	
VOL-0CK6-S	Volition RJ45 K6 jack Cat 6 STP, white and metallic shield	

Table 6.20 Plug in face plates for K5E and K6 RJ45 jacks

Model number	Description	Colour
VOL-FP2M-F1K	Volition 22,5 x 45 Faceplate, 1 port keystone,white	22.5 x 45
VOL-FP4M-F1K	Volition 45 x 45 Faceplate, 1 port keystone,white	45 x 45
VOL-FP2M-F2K	Volition 22,5 x 45 Faceplate, 2 ports keystone,white	22.5 x 45

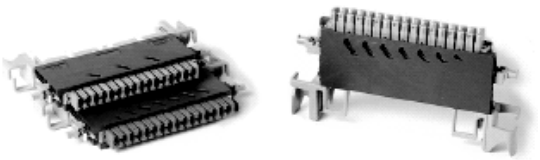
Table 6.21 Inserts for face plates for K5E and K6 RJ45 jacks

Model number	Description	Colour
VOL-0790-BL	Reversible icon for Volition 22,5 x 45 and 45 x 45 faceplates	Blue
VOL-0790-YL	Reversible icon for Volition 22,5 x 45 and 45 x 45 faceplates	Yellow
VOL-0790-RD	Reversible icon for Volition 22,5 x 45 and 45 x 45 faceplates	Red
VOL-0790-GR	Reversible icon for Volition 22,5 x 45 and 45 x 45 faceplates	Green

33.2 Connection modules

33.2.1 RCP2000

The RCP 2000 module family is the latest in the evolution of the RCP range of connection modules. This module is available in a shielded or unshielded version and offers Category 5 transmission performance as a standard. It gives very good protection against electromagnetic radiations up to 155MHz. As a result the module can be used in any modern network and is fully compatible with a wide range of applications (including xDSL, pair-gain. etc.).



Compatible with RIBE, CIPE and European E8 profile backmount frames, termination is easy and cables and jumpers can either be managed from the rear or from the side of the module. An added feature is that the IDC contacts accept both solid and multi-stranded conductors.

Modules are available in blue (for horizontal distribution) green (for vertical distribution) yellow (for resources) orange (for private voice) ivory (for digital) and red (for security).
The RCP 2000 Corel range was specifically designed for and approved by France Telecom.

Highlights

- Category 5 as a standard
- Unshielded 8 pair connection and disconnection modules (rear and side cable)
- Unshielded 16 pair connection and disconnection module (rear cable only)

- High density (14 mm pitch)
- 0,4 - 0,8 mm wire handling range
- 2 wires can be accommodated in the same slot
- Optional contacts for stranded wires
- Colour coded modules to aid circuit identification
- Multiple re-terminations
- Comprehensive range of protection circuits and accessories

Table 6.22 RCP 2000 specification

Technical data	RCP 2000	RCP 2000 - Corel
Connection modules	yes	yes
Disconnection modules	yes	yes
16 pair modules	yes	-
10 pair modules	no	no
8 pair modules	yes	yes
Vertical pitch (mm)	16	16
Wire diameter -solid (mm)	0,4 - 0,70	0,4 - 0,80
Wire diameter -stranded (mm)	7 x 0,15 - 0,20	7 x 0,15 - 0,20
Overall diameter (over insulation) (mm)	≤ 1,50 ?	≤ 1,50 ?
Number of re-terminations (0,8Ø wire)*		
Contact material		
Contact surface (tin-lead plated) (µm)		
Housing material	PBT	PBT
Flame protection		UL 94 V0
Insulation resistance (MΩ)	$>10^4$	$>10^4$
Volume resistance (MΩ)	< 20	< 20
Dielectric strength	$4,5kV_{eff}/50Hz$	$4,5kV_{eff}/50Hz$

RCP 2000 Shielded (against conducted and radiated electromagnetic interference)

Single wire and multi wire cables can be connected to either the upper or lower contacts. Equipped with a bonding comb, bonding strip and channelled wire guide in the lower part. Requires shielded cords.

Table 6.23 RCP 2000 module shielded against conducted and radiated interference

Model number	Description	Colour
P45920DH	Shielded 8 pair disconnection module	Blue
P45839DH	Shielded 8 pair disconnection module	Green
P45840DH	Shielded 8 pair disconnection module	Yellow
P45734DH	Shielded 8 pair disconnection module	Ivory
P45809DH	Shielded 8 pair disconnection module	Red
P45920DK	Shielded 16 pair disconnection module	Blue
P45840DK	Shielded 16 pair disconnection module	Yellow
P45839DK	Shielded 16 pair disconnection module	Green

RCP 2000 shielded (against conducted electromagnetic interference)

Single wire and multi wire cables can be connected to either the upper or lower contacts. Equipped with a bonding comb, a bonding strip, and a channelled wire guide in the lower part. Requires shielded cords.

Table 6.24 RCP 2000 module shielded against conducted and interference

Model number	Description	Colour
P45920DF	Shielded 8 pair disconnection module	Blue
P45839DF	Shielded 8 pair disconnection module	Green
P45840DF	Shielded 8 pair disconnection module	Yellow
P45734DF	Shielded 8 pair disconnection module	Ivory
P45809DF	Shielded 8 pair disconnection module	Red

Table 6.25 RCP 2000 backplane bonding kit

Model number	Description	Colour
P44520AA	Backbone bonding kit	-

RCP 2000 Unshielded rear cable entry modules

Single wire and multi wire cables can be connected to either the upper or lower contacts. No channelled wire guide in the upper part. Requires unshielded cords.

Table 6.26 RCP 2000 Unshielded rear cable entry modules

Model number	Description	Colour
P45920DA	Unshielded 8 pair disconnection module	Blue
P45839DA	Unshielded 8 pair disconnection module	Green
P45840DA	Unshielded 8 pair disconnection module	Yellow
P45734DA	Unshielded 8 pair disconnection module	Ivory
P45809DA	Unshielded 8 pair disconnection module	Red
P45921DA	Unshielded 8 pair connection module	Orange
P45920DD	Unshielded 16 pair disconnection module	Blue
P45839DD	Unshielded 16 pair disconnection module	Green
P45840DD	Unshielded 16 pair disconnection module	Yellow

RCP 2000 Unshielded side cable entry modules

Single wire and multi wire cables can be connected to either the upper or lower contacts. Bonding springs for the drain only provided on the blue and green modules. Equipped with 2 channelled wire guides. Requires unshielded cords.

Table 6.27 RCP 2000 Unshielded side cable entry modules

Model number	Description	Colour
P45920CE	Unshielded 8 pair disconnection module	Blue
P45839CE	Unshielded 8 pair disconnection module	Green
P45840CE	Unshielded 8 pair disconnection module	Yellow
P45734CE	Unshielded 8 pair disconnection module	Ivory
P45809CE	Unshielded 8 pair disconnection module	Red
P45921CE	Unshielded 8 pair connection module	Orange

RCP 2000 Corel modules

Approved by France Telecom in accordance with CSE S 32-20. Single wire and multi wire cables can be connected to either the upper or lower contacts. Equipped with 2 bonding combs, 2 springs for bonding drains, quad channelled wire guide above and by pairs below. Requires screened cords.

Table 6.28 RCP 2000 Corel modules

Model number	Description	Colour
P45022FT	Shielded 8 pair disconnection module	Green
P45024FT	Shielded 8 pair disconnection module	Yellow
P45021FT	Shielded 8 pair disconnection module (with shielded pair screen connection)	Yellow
P45010FT	Shielded 8 pair connection module	Blue
P45012FT	Shielded 8 pair connection module	Green
P45011FT	Shielded 8 pair connection module	Yellow
P23S10453	Shielded 8 pair NEW	Blue
P23S10339	Shielded 8 pair NEW	Green
P23S10800	Shielded 8 pair NEW	Yellow
P23S10347	Shielded 8 pair NEW	Red
P23S10834	Shielded 8 pair NEW	Ivory

33.2.2 STG 2000

The STG 2000 module family is the latest in the evolution of the STG range of connection modules. This module offers Category 5 transmission performance as a standard. As a result this module can be used in any modern network and is fully compatible with a wide range of applications (including xDSL, pair-gain. etc.). Termination is easy and cables and jumpers can either be managed from the rear or from the side of the module.

Highlights

- Category 5 as a standard
- High density (14 mm pitch)
- 0,4 - 0,8 mm wire handling range
- 2 wires can be accommodated in the same slot

- Optional contacts for stranded wires
- Specific module with rear cable termination
- Multiple re-terminations
- Comprehensive range of protection circuits and accessories

Table 6.29 STG 2000 Specification

Technical data	STG 2000 - U	STG 2000 - C	STG 2000 - O
Connection modules	yes		
Disconnection modules		yes	
Switching modules			yes
10 pair modules	yes	yes	yes
8 pair modules	yes	yes	yes
Vertical pitch (mm)	14	14	14
Wire diameter (mm)	0,4 - 0,80	0,4 - 0,80	0,4 - 0,80
Overall diameter (over insulation) (mm)	≤ 1,80	≤ 1,80	≤ 1,80
Number of re-terminations (0,65Ø wire)	≤ 100	≤ 100	≤ 100
Number of re-terminations (0,8Ø wire)*	≤ 10	≤ 10	≤ 10
Contact material	bronze	bronze	bronze
Housing material	PBT		PBT
Flame protection	UL 94 V0		UL 94 V0
Insulation resistance (MΩ)	$>10^{12}$	$>10^{12}$	$>10^{12}$
Volume resistance (MΩ)	< 10	< 10	< 10
Dielectric strength	$4,5kV_{eff}$/50Hz	$4,5kV_{eff}$/50Hz	$4,5kV_{eff}$/50Hz

Table 6.30 STG 2000 for Euro 8 and Euro 10 back-mount frames

Model number	Marking	Description	Colour
C252824A	STG2 U2 10	Connection module (10 pair)	Grey
C252806A	STG2 U2 8	Connection module (8 pair)	Grey
C252818A	STG2 C2 10	Disconnection module (10 pair)	White/grey
C252800A	STG2 C2 8	Disconnection module (8 pair)	White/grey
C252830A	STG2 O2 10	Switching module (10 pair)	Blue/grey
C252812A	STG2 O2 8	Switching module (8 pair)	Blue/grey
C252825A	STG2 U2 10 P	Connection module (10 pair) w/multi pair protection	Grey/grey
C252807A	STG2 U2 8 P	Connection module (8 pair) w/multi pair protection	Grey/grey
C252819A	STG2 C2 10 P	Disconnection module (10 pair) w/multi pair protection	White/grey
C252801A	STG2 C2 8 P	Disconnection module (8 pair) w/multi pair protection	White/grey
C252831A	STG2 O2 10 P	Switching module (10 pair) w/multi pair protection	Blue/grey
C252813A	STG2 O2 8 P	Switching module (8 pair) w/multi pair protection	Blue/grey
C252826A	STG2 U2 10 PU	Connection module (10 pair) w/single pair protection	Grey/grey
C252808A	STG2 U2 8 PU	Connection module (8 pair) w/single pair protection	Grey/grey
C252820A	STG2 C2 10 PU	Disconnection module (10 pair) w/single pair protection	White/grey
C252802A	STG2 C2 8 PU	Disconnection module (8 pair) w/single pair protection	White/grey
C252832A	STG2 O2 10 PU	Switching module (10 pair) w/single pair protection	Blue/grey
C252814A	STG2 O2 8 PU	Switching module (8 pair) w/single pair protection	Blue/grey

Table 6.31 STG 2000 for Euro 8 and Euro 10 back mount frames

Model number	Marking	Description	Colour
C252827A	STG2 U2 K10	Connection module (10 pair)	Grey
C252809A	STG2 U2 K8	Connection module (8 pair)	Grey
C252821A	STG2 C2 K10	Disconnection module (10 pair)	White/grey
C252803A	STG2 C2 K8	Disconnection module (8 pair)	White/grey
C252833A	STG2 O2 K10	Switching module (10 pair)	Blue/grey
C252815A	STG2 O2 K8	Switching module (8 pair)	Blue/grey
C252828A	STG2 U2 K10 P	Connection module (10 pair) w/multi pair protection	Grey/grey
C252810A	STG2 U2 K8 P	Connection module (8 pair) w/multi pair protection	Grey/grey
C252822A	STG2 C2 10 P	Disconnection module (10 pair) w/multi pair protection	White/grey
C252804A	STG2 C2 K8 P	Disconnection module (8 pair) w/multi pair protection	White/grey
C252834A	STG2 O2 K10 P	Switching module (10 pair) w/multi pair protection	Blue/grey
C252816A	STG2 O2 K8 P	Switching module (8 pair) w/multi pair protection	Blue/grey
C252829A	STG2 U2 K10 PU	Connection module (10 pair) w/single pair protection	Grey/grey
C252811A	STG2 U2 K8 PU	Connection module (8 pair) w/single pair protection	Grey/grey
C252823A	STG2 C2 K10 PU	Disconnection module (10 pair) w/single pair protection	White/grey
C252805A	STG2 C2 K8 PU	Disconnection module (8 pair) w/single pair protection	White/grey
C252835A	STG2 O2 K10 PU	Switching module (10 pair) w/single pair protection	Blue/grey
C252817A	STG2 O2 K8 PU	Switching module (8 pair) w/single pair protection	Blue/grey

Table 6.32 STG 2000 accessories

Model number	Description	Colour
C220674B	10 pair numbered label holder (clips onto backmount frame)	
C220673B	8 pair numbered label holder (clips onto backmount frame)	
C222903A	Blank label holder (bag of 100) clips onto side of module (3 digits)	
C222918A	Numbered label holder (bag of 100) clips to side of module (0-100)	
C222951A	10 pair numbered label holder (swivelling)	
C222950A	8 pair numbered label holder (swivelling)	
C222916B	Numbered marking caps (bag of 100)	Black
C222920A	Marking caps (bag of 100)	Black
C222921A	Marking caps (bag of 100)	Grey
C222922A	Marking caps (bag of 100)	Red
C222923A	Marking caps (bag of 100)	Yellow
C222924A	Marking caps (bag of 100)	Blue
C222925A	Marking caps (bag of 100)	Green
C222917A	Numbered ID tabs (bag of 100) mounted on side of module	Black
C222956A	Dust cover, 10 pair modules or blocks, length 2m	
C222955A	Dust cover, 8 pair modules or blocks, length 2m	
C222961A	Dust cover, 10 pair modules in a 50 pair block	
C222963A	Dust cover, 10 pair modules in a 100 pair block	
C223765A	8 pair module wire guide (bag of 20) clipped to sides of module)	
C234030A	Punch down tool for STG and RCP system	
C234037A	Punch down tool for QSA/LSA+ and Siemens system	
C234043A	Spare blades (10) for STG and RCP system	
MPA078BA	Punch down base support (10 pair)	
MPA078BA	Punch down base support (8 pair)	
C222053A	Combined insertion/extraction tool for protection magazine	

Table 6.33 Test leads for STG 2000 modules

Model number	Description	Length (m)
C222048B	Parallel test lead (banana plugs to PCB) 2 way	3
C222014B	Serial test lead (banana plugs to PCB) 4 way	3
MPA025DB	Serial test lead (terminals to PCB) 4 way	1,5
MPA025EB	Test lead 4 way unterminated	1,5
MPA0255A	Test lead 4 way unterminated	0,5
C222025B	Test lead (PCB to PCB) 2 way	3
C222024B	Test lead (PCB to PCB) 4 way	3
C242612A	Test lead (PCB to open end) 2 way	2
C242611A	Test lead (PCB to open end) 2 way	1
MPA0781A	Parallel test plug for RJ 11 connector	
C222059A	10 pair test plug	
C222058A	8 pair test plug	
MPA0781A	Disconnection plugs (bag of 100)	
C242628A	Serial display plug/1 network line	
C242629A	Display plug/1 PABX line	

Protection magazines (for STG modules with protection facility)

Table 6.34 STG 2000 protection magazines

Model number	Description
C233725B	10 pair magazine without arresters
C233726B	8 pair magazine without arresters
C233740B	10 pair magazine equipped with 250 V arresters w/fail safe
C233736B	8 pair magazine equipped with 250 V arresters w/fail safe
C233741B	10 pair magazine equipped with 350 V arresters w/fail safe
C233737B	8 pair magazine equipped with 350 V arresters w/fail safe

Protection magazines with 0,3 m earthing cord (for STG modules without protection facility)

Table 6.35 STG 2000 protection magazines with earthing cord

Model number	Description
C233728B	10 pair magazine without arresters
C233727C	8 pair magazine without arresters
C233748B	10 pair magazine equipped with 250 V arresters w/fail safe
C233744B	8 pair magazine equipped with 250 V arresters w/fail safe
C233749B	10 pair magazine equipped with 350 V arresters w/fail safe
C233745B	8 pair magazine equipped with 350 V arresters w/fail safe

Surge arresters and protection plugs

Table 6.36 STG 2000 single pair protection plugs

Model number	Description
C231039A	3-pole arrester with fail safe (250V)
C231040A	3-pole arrester with fail safe (350V)
C233796A	Over voltage (250V) protection (grey)
C233797A	Over voltage (250V) and current protection (orange)
C233798A	5 pole (varistors) over voltage (250V) and current protection (yellow)
C233799A	5 pole (diodes) over voltage (250V) and current protection (brown)
C222037A	Current protection (fuses, 1,25A/250V)

33.2.3 QSA Series 1 and 2

Available in 10 and 20 pair versions this system is compatible with the Krone LSA+ system. The Series 1 modules can be screw fixed into small distribution units. The fixing dimensions for the 10 and 20 pair modules are 96 or 170 mm respectively according to DIN 47608 (parts 1 and 2). Earthing modules for 44 or 84 wires complete the product range. The Series 2 modules are available in connection and disconnection formats for mounting on back mount frames.

Table 6.37 QSA Series 1 and 2 specification

Technical data	QSA 1	QSA 2
Connection modules	yes	yes
Disconnection modules		yes
Earthing modules	yes	yes
10 pair modules	yes	yes
20 pair modules	yes	
Wire diameter (mm)	0,40 - 0,80	0,40 - 0,80
Overall diameter (over insulation) (mm)	0,70 - 1,50	0,70 - 1,50
Number of re-terminations (0,65Ø wire)	> 50	> 50
Number of re-terminations (0,8Ø wire)*	≤ 50	≤ 50
Contact material	special brass	special brass
Contact surface (silver plated) (µm)	3 - 5	3 - 5
Housing material	PBT	PBT
Flame protection	UL 94 V0	UL 94 V0
Insulation resistance (MΩ)	5×10^4	5×10^4
Volume resistance (MΩ)	< 10	< 10
Dielectric strength	$2kV_{eff}$/50Hz	$2kV_{eff}$/50Hz

Table 6.38 QSA series 1 modules

Model number	Part	Dimensions (mm) (W x H x D)	Colour
79101-517 40	Connection module (10pr)	105 x 26 21,5	Grey
79101-518 40	Connection module (20pr)	178 x 26 x 25,5	Grey
79101-533 40	Earthing module (44 wires)	105 x 26 x 21.5	Red
79101-534 40	Earthing module (84 wires)	178 x 26 x 25.5	Red

Table 6.39 QSA series 2 modules

Model number	Description	Dimensions (mm) (W x H x D)	Colour
79101-510 40	Connection module (10pr)	123 x 18 x 39	Grey
79103-510 40	Disconnection module (10pr)	123 x 18 x 39	White
79101-516 40	Earthing module (38 wires)	123 x 18 x 39	Red

Table 6.40 QSA series 1 and 2 accessories

Model number	Description	Colour
79156-505 40	QSA 1 Labelling frame (10 pairs)	
79156-506 40	QSA 1 Labelling frame (20 pairs)	
79156-501 40	QSA 2 Labelling frame (10 pairs)	
79156-503 40	QSA 2 Labelling frame (10 pairs) hinged	
79170-507 40	Label for labelling frame	
79004-500 40	Single pair marker cap	Red
79004-500 65	Single pair marker cap	Yellow
79004-500 67	Single pair marker cap	Green
79004-500 69	Single pair marker cap	Black
79004-500 70	Single pair marker cap	Brown
79004-500 71	Single pair marker cap	Blue
79397-500-40	QSA punch down tool	

Table 6.41 QSA series 1 and 2 test leads

Model number	Description	Length (m)
79054-555 40	Test leads w/banana plug jack 1 way	
79054-501 40	Test leads w/banana plug jacks 2 way	
79054-524 40	Test leads w/banana plug jacks 4 way	
79096-500 40	Test plug kit connection 2 way	
79096-501 40	Test plug kit disconnection 4 way	
79054-503 40	Test lead, connection , one side open 2 way	1
79054-503 66	Test lead, connection one side open 2 way	2
79054-503 68	Test lead, connection one side open 2 way	4
79054-505 40	Test lead, disconnection one side open 4 way	1
79054-505 66	Test lead, disconnection one side open 4 way	2
79054-505 68	Test lead, disconnection one side open 4 way	4
79054-502 40	Test lead, connection , both ends terminated 2 way	1
79054-502 66	Test lead, connection, both ends terminated 2 way	2
79054-502 68	Test lead, connection, both ends terminated 2 way	4
79054-504 40	Test lead, disconnection , both ends terminated 4 way	1
79054-504 66	Test lead, disconnection, both ends terminated 4 way	2
79054-504 68	Test lead, disconnection, both ends terminated 4 way	4

Table 6.42 QSA series 1 and 2 disconnection plugs

Model number	Description	Colour
79122-500 40	Single pair for line disconnection	Red
79122-500 65	Single pair for line disconnection	White
79122-500 66	Single pair for line disconnection	Green
79122-500 67	Single pair for line disconnection	Yellow
79122-500 69	Single pair for line disconnection	Black
79122-500 70	Single pair for line disconnection	Brown
79122-500 71	Single pair for line disconnection	Blue
79122-505 40	Ten pair for line disconnection	-
79072-500 40	Single pair dummy plug to prevent line disconnection	-

Table 6.43 QSA series 1 and protection magazines

Model number	Description	Dimensions (mm) L x W x D
38126-500 40	Ten pair, 2 pole shape F for connection and disconnection	112 x 22 x 43
39081-701 26	Arrestor 2 pole shape F	-
38126-501 65	Ten pair, 2 pole shape G/H for connection and disconnection	112 x 22 x 41
39081-730 00	Arrestor 2 pole shape G	-
39081-727 00	Arrestor 2 pole shape H	-
38126-502 40	Ten pair, 3 pole for connection and disconnection	112 x 22 x 43
39081-728 00	Arrestor 3 pole	-
38104-506 71	Ten pair, Fine protection for disconnection 5V/7,1V*	112 x 24 x 61
38104-506 65	Ten pair, Fine protection for disconnection 12V/17,1V*	112 x 24 x 61
38104-506 75	Ten pair, Fine protection for disconnection 18V/21V*	112 x 24 x 61
38104-506 40	Ten pair, Fine protection for disconnection 24V/34V*	112 x 24 x 61
38104-506 67	Ten pair, Fine protection for disconnection 48V/64V*	112 x 24 x 61
38104-506 66	Ten pair, Fine protection for disconnection 60V/95V*	112 x 24 x 61
38104-506 72	Ten pair, Fine protection for disconnection 120V/143V*	112 x 24 x 61

* operating voltage/breakdown voltage

33.2.4 SID - C and SID - CT

Offering a significantly higher density than the QSA module, the SID-C module has insulation displacement contacts enclosed in a plastic housing. This improves the insulation performance and helps to provide a safe working practice.

The SID-C product family includes 8 and 10 pair connection and disconnection modules. The individual mounting systems provide improved handling. Backmount frames or profile rails are available as required. In addition, FlexiRail is an individual mounting system for targeted applications.

The SID-CT product family also includes 8 and 10 pair connection and disconnection modules but has the advantage that it is suitable for mounting on LSA+ and QSA 2 back mount frames (in which case it offers a lower density than SID - C) The module also mounts on standard SID back mount frames.

A wide range of accessories and a over voltage protection system complete the product family.

Highlights

- High density
- Compatible with LSA+ and QSA backmount frames (SID - CT)
- One wire per slot 0.32 - 0.80 mm
- Optimised cable conductor guide
- Long-life tools
- Flexible mounting systems
- Removal without a special tool
- Comprehensive over voltage protection system

Table 6.44 SID – C and SID –CT specification

Technical data	SID -C	SID-CT
Connection modules	yes	Yes
Disconnection modules	yes	Yes
Earthing modules	yes	Yes
10 pair modules	yes	Yes
Vertical pitch (mm)	17,5	17,5 or 22,5
Wire diameter (mm)	0,32 - 0,80	0,32 - 0,80
Overall diameter (over insulation) (mm)	0,50 - 1,60	0,50 - 1,60
Number of re-terminations (0,65Ø wire)	> 100	> 100
Number of re-terminations (0,8Ø wire)*	≤ 30	≤ 30
Contact material	Special brass	Special brass
Contact surface (silver plated) (µm)	3 - 5	3 - 5
Housing material	PBT	PBT
Flame protection	UL 94 V0	UL 94 V0
Insulation resistance (MΩ)	5×10^4	5×10^4
Volume resistance (MΩ)	< 10	< 10
Dielectric strength	$2kV_{eff}$/50Hz	$2kV_{eff}$/50Hz

Table 6.45 SID – C modules

Model number	Description	Dimensions (mm) (W x H x D)	Colour
79101-553 00	Connection module (10 pair)	112 x 17,3 x 37	Grey/black*
79101-553 35	Connection module (10 pair) gel filled	112 x 17,3 x 37	Grey/black*
79101-561 00	Connection module (8 pair)	112 x 17,3 x 37	Grey/black*
79101-564 00	ABS connection module 3 pole	112 x 17,3 x 37	Grey/black*
79103-534 00	Disconnection module (10 pair)	112 x 17,3 x 37	Grey/green*
79103-534 35	Disconnection module (10 pair) gel filled	112 x 17,3 x 37	Grey/green*
79103-540 00	Disconnection module (8 pair)	112 x 17,3 x 37	Grey/green*
79103-543 00	ABS disconnection module 3 pole	112 x 17,3 x 37	Grey/green*
.79101-567 00	Earthing module (40 wires)	112 x 17,3 x 37	Grey/red
79105-500 00	Switching module (10 pair)	112 x 17,3 x 37	Brown/white*
79105-501 00	Switching module (8 pair)	112 x 17,3 x 37	Brown/white*

* First colour refers to module, second colour refers to printing

Table 6.46 SID – CT modules

Model number	Description	Dimensions (mm) (W x H x D)	Colour
79101-589 00	Connection module (10 pair)	112 x 17,3 x 37	Grey/black*
79101-553 35	Connection module (10 pair) gel filled	112 x 17,3 x 37	Grey/black*
79101-588 00	Connection module (8 pair)	112 x 17,3 x 37	Grey/black*
79101-590 00	ABS connection module 3 pole	112 x 17,3 x 37	Grey/black*
79103-557 00	Disconnection module (10 pair)	112 x 17,3 x 37	Grey/green*
79103-534 35	Disconnection module (10 pair) gel filled	112 x 17,3 x 37	Grey/green*
79103-564 00	Disconnection module (8 pair)	112 x 17,3 x 37	Grey/green*
79103-565 00	ABS disconnection module 3 pole	112 x 17,3 x 37	Grey/green*
79101-591 00	Earthing module (40 wires)	112 x 17,3 x 37	Grey/red
79105-503 00	Switching module (10 pair)	112 x 17,3 x 37	Brown/white*
79105-502 00	Switching module (8 pair)	112 x 17,3 x 37	Brown/white*

* First colour refers to module, second colour refers to printing

Table 6.47 SID - C and SID – CT accessories

Model number	Description	Colour
79156-516 00	Labelling frame (10 pairs)	
79397-512 00	SID punch down tool	Red
03-991-00900	SID punch down tool - heavy duty	Red
03-991-01000	SID bit for punch down tool	
62397-502 00	Pliers	
15014-502 00	Dust cover pitch 17,5 mm, 50 pairs	
15014-505 00	Dust cover , pitch 17,5mm 100 pairs	
15014-500 00	Dust cover, pitch 22,5 mm 50 pairs	
79058-502 00	Switching adaptor for 1 pair	
79058-503 00	Switching adaptor for 10 pairs	
79169-513 28	Cover strips for 10 pair connection modules (1-100)	Grey
79169-513 26	Cover strips for 10 pair disconnection modules (1-100)	Green

Table 6.48 SID - C and SID – CT test leads

Model number	Description	Length (m)
79054-552 00	Test leads w/banana plug jacks 2 way	
79054-553 00	Test leads w/banana plug jacks 4 way	
79054-567 00	Test leads flex w/banana plug jacks 4 way	
79096-533 00	Test plug kit 4 way	
79054-556 00	Test lead, one side open 4 way	1
79054-556 26	Test lead, one side open 4 way	2
79054-556 28	Test lead, one side open 4 way	4
79054-556 29	Test lead, one side open 4 way	5
79054-561 00	Test lead, both ends terminated 4 way	1
79054-561 25	Test lead, both ends terminated 4 way	2
79054-561 26	Test lead, both ends terminated 4 way	4

Table 6.49 SID - C and SID – CT disconnection plugs and marker caps

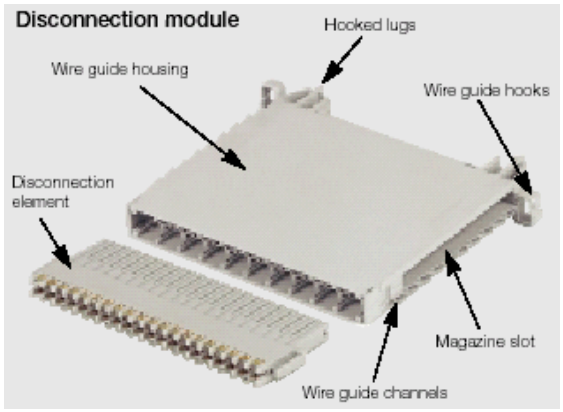
Model number	Description	Colour
79122-544 40	Single pair for line disconnection	Red
79122-544 26	Single pair for line disconnection	Green
79122-544 29	Single pair for line disconnection	Black
79122-545 00	Five pair for line disconnection	Red
79122-543 00	Single pair dummy plug to prevent line disconnection	Red
79122-543 26	Single pair dummy plug to prevent line disconnection	Green
79122-543 29	Single pair dummy plug to prevent line disconnection	Black
79004-506 00	Single pair marker cap	Red
79004-506 26	Single pair marker cap	Green
79004-506 29	Single pair marker cap	Black
79169-510 00	Ten pair marker cap allowing testing and disconnection	Red
79169-510 26	Ten pair marker cap allowing testing and disconnection	Green
79169-510 28	Ten pair marker cap allowing testing and disconnection	Grey
79169-510 29	Ten pair marker cap allowing testing and disconnection	Black

Table 6.50 SID - C and SID – CT protection magazines and plugs

Model number	Description	Dimensions (mm) L x W x D
79126-504 00	8/10 pair, 2 pole shape H for connection and disconnection	99 x 16,5 x 31
39081-727 40	Arrestor, 2 pole, shape H 230 V - 5 A / 5kA	-
39081-727 00	Arrestor, 2 pole, shape H 230 V - 10 A / 10kA	-
79126-510 00	8/10 pr, 3 pole shape H connection/disconnection (SID - C)	98 x 17,3 x 31,5
79126-512 00	8/10 pr, 3 pole shape H connection/disconnection (SID - CT)	98 x 17,3 x 31,5
39081-728 00	Arrestor, 3 pole, w/o fail safe 230 V - 5 A / 5kA	-
05-661-02400	Arrestor, 3 pole, with fail safe 230 V - 5 A / 5kA {n (100 °C) ts = 10 s}	-
79104-503 00	1 pair, over voltage with fail-safe and optical detection alarm.	-
79104-502 00	1 pair, over voltage and over current with fail-safe and optical detection alarm.	-
79104-504 00	1 pair, ultra fast over voltage and over current with fail-safe and optical detection alarm.	-
79114-542 00	8/10 pair SID-SPP earthing rails	-
79397-515 00	Extraction tool for over voltage protection magazines	-

33.2.5 ID 3000

The ID 3000 disconnection block is available as a modular design for horizontal or vertical mounting in existing distributor frames e.g., HVt 55/71 DTAG or in the ID 3000 frame. Disconnection blocks comprise several disconnection modules located onto a back mount frame that has mounting points on the rear. Each block comprises:



- **disconnection modules (8 pair or 10 pair):** comprising disconnection elements and wire guide housing
- **back mount frame:** with rear panel mounting points (M4 threaded bolts, 10 mm long) for mounting on conventional frames
- **cable cover:** for covering and protecting conductors on the cable and system-side of the disconnection blocks
- **covering strips:** for the covering and identification of the touch-protected insulation displacement contacts of the disconnection element
- **labelling strips:** identifies the jumper-side wire guide channels in the wire guide housing
- **covering strips:** for mounting of the lateral labelling strips
- **labelling module:** for optical differentiation of dissimilar disconnection module and insertion of the labelling strips
- **labelling strips:** for strip holders for marking of the ID 3000 disconnection modules (inscription field 11 x 85 mm)
- **mounting material:** M4 nuts and toothed washers for mounting the disconnection blocks on existing (conventional) distribution frames, e.g., HVt 55/71 DTAG.

Highlights

- high density
- 0.32 - 0.8 mm wire diameter
- new compact MDF-structure: - exchangeable modules (no tool required)
    - 8 and 10 pair modules
    - blocks fit same mounting rail
    - compatible with existing MDF-frames
- cost savings through: - simple configuration of the frame
    - pre-jumpering possible
    - short jumpering distances resulting in cable savings
    - reduced installation time
- double contacts for T-connection protected by module housing
- significant decrease in weight
- available as block or individual module
- cable guide accepts twisted pair and one pair shielded cable
- extensive range of accessories and over voltage protection
- 8 or 10 pair protection magazine

Table 6.51 ID 3000 disconnection blocks - Technical data

Technical data	ID 3000 disconnection module
Contact material	CuZn23 Al3Co
Surface treatment	AG (Silver) min. 5 µm
Wire configuration	Solid conductors with a diameter of 0.32 – 0.64 mm, PE- or PVC-insulated (solid PE)
Flame protection	UL 94 V0
Max overall diameter (mm)	1.1
Service life	≥ 200 connections
Module body	Polycarbonate, colour: RAL 7035, grey
Contact resistance (mΩ)	≤ 3
Dielectric strength	2 kVeff / 50 Hz
Current carrying capacity (A at 20°C)	≥ 2.5 (acc. to DIN 41 640 part 8)
Insulation resistance (Ω)acc. to DIN 40 040	≥ 1012 (in new condition, indoor conditions) ≥ 1010 (after damp heat)
Coupling capacitance (pF)	< 2.5
Surge voltage acc. to VDE 0433, table 3 (kV)	≥ 1.8 (surge wave 10/700)
Surge current / pulse form 8/20 µs (kA)	≥ 2.5
Transmission rates (near end cross talk): Ethernet according to IEEE 802.3 at 10 MHz Token Ring according to IEEE 802.5 at 4 MHz	 > 45 dB > 62 dB (at 10 MHz > 50 dB)
Material of the back mount frames	Stainless steel 1.5 mm

Table 6.52 IDC 3000 blocks

Part Number	ID 3000 frame	Existing frame	Description
15-600-02000	yes	—	Disconnection block
15-600-02025	yes	—	Disconnection block
15-628-02000	yes	—	Disconnection blocks
15-564-02100	yes	—	Disconnection block with abc modules
15-600-02100	yes	—	Disconnection block with abc modules
15-600-00000	—	yes	Disconnection block
15-600-00025	—	yes	Disconnection block
15-600-00026	—	yes	Disconnection block
15-604-00000	—	yes	Disconnection block
15-628-00000	—	yes	Disconnection block
15-628-00026	—	yes	Disconnection block
15-700-00000	—	yes	Disconnection block
15-700-10000	—	yes	Disconnection block
15-512-00000	—	yes	Disconnection block
15-512-00025	—	yes	Disconnection block
15-564-00100	—	yes	Disconnection block with abc modules
15-564-00326	—	yes	Disconnection block with abc modules
15-600-00100	—	yes	Disconnection block with abc modules

33.3 Module supports

33.3.1 Main distribution frames

FAE frame for RCP (8 and 10 pair) modules

The FAE range of frames is available in heights of 1,44m and 2,3m (78 and 248 modules). Cable entry is at the rear of the module. The 2,3m frame has a telescopic base making its overall height adjustable between 2,0 and 2,3 m. Suitable for 8 pair and 10 pair modules, each frame can be mounted independently and spaced according to the room available. Cable jumper rings and a PVC cable channel facilitate wire management on the frame. For greater density in larger installation, frames can be mounted back to back. Each frame is equipped as follows: -

Table 6.53 FAE frames

Model number	P6810AAB	P6800AAB	P6820AAB
No of levels	4	6	6
No of modules	78	124	248
Overall height (mm)	1440	2300	2300
Effective height (mm)	1248	1984	1984
Overall depth excluding horizontal flow ring (mm)	250	250	590
High capacity aluminium E8 profile (150mm x 120mm)	1	1	2
Reversible aluminium profile cover	Y	Y	2
Red horizontal flow ring.	Y	Y	2
Black vertical guide rings	4	6	12
Earth braid	Y	Y	Y
Omega brackets for wall mounting.	2	2	2
ID label holder	Y	Y	2
Telescopic base	-	Y	Y
Removable lower cable panel.	-	Y	Y
Floor anchoring lugs	-	Y	Y
Extension partitions (300mm spacing).	-	-	Y

Table 6.54 Accessories for FAE frames

Model number	Description	Size (mm)	Colour
P26548AA	Vertical guide ring, V0 plastic inc. fixing screws	112 x 65	Black
P26549AA	Horizontal guide ring, metal inc. fixing screws	185 x 130	Red

British Telecom Type 105 and 106 frames for QSA 2, SID – C and SID-CT 10 pair modules

These are free standing, double sided frames for QSA 2, SID – C or SID-CT 10 pair connection modules. Any number of frames can be mounted side-by-side to create a strong, compact and durable installation. The following features are offered within the frame construction:

- Durable, rigid frame, factory assembled from heavy gauge steel
- Integral stainless steel back mount
- Hard wearing coated steel jumper rings for efficient cable management
- Integral bonded earth bar and kicking strips
- Ample mounting holes for 'plug-in' type cable ties
- Steel front and rear panels available as accessories

Table 6.55 British Telecom Type 105 and 106 frames

Model number	Description	Capacity (pairs)	Size (mm) (H x W x D)
1230	MDF 105D (QSA)	2760 in 4 columns	2010 x 500 x 300
2015	MDF 105D (SID-C)	3520 in 4 columns	2010 x 500 x 300
1309	MDF 106D (QSA)	1380 in 2 columns	1980 x 500 x 295
2016	MDF 106D (SIC-C)	1760 in 2 columns	1980 x 500 x 295

Table 6.56 Accessories for Type 105 and 106 frames

Model number	Description
1097	Front Cover Assembly – MDF 105
1098	Side Cover Assembly – MDF 105
1014	Front Cover Assembly – MDF 106
1012	Side Cover Assembly – MDF 106

British Telecom Type 108 frame for QSA 2 and SID-CT (10 pair) modules

The Type 108 is a modular distribution frame, which can either be wall-mounted or installed back-to-back for free standing applications. The frame is available in single (model number 1470) and double column (model number 1390) versions. The following features are offered within the frame construction: -

- Durable, rigid frame, factory assembled from coated steel
- Back mount frames manufactured from stainless steel
- Hard wearing, coated steel jumper rings, wire guides and fanning strips for efficient cable management – frame design allows easy access to top jumper rings
- Fully earth bonded, meeting IEC regulations. Earth bar and clip supplied
- Adjustable feet which can be removed to reduce height from 2000mm to 1850mm
- Steel front and rear panels available as accessories (for model numbers 1390 and 1441 only)

Table 6.57 British Telecom Type 108 frame

Model number	Description	Capacity (pairs)	Size (mm) (H x W x D)
1390	MDF 108E (QSA)	1400 in 2 columns	2000 x 570 x 150
2018	MDF 108E (SID-C)	1800 in 2 columns	2000 x 570 x 150
1441	MDF 108E City (QSA)	1600 in 2 columns	2080 x 570 x 150
2019	MDF 108E City (SID-C)	2040 in 2 columns	2080 x 570 x 150
1470	MDF 108E (QSA)	700 in 1 column	2000 x 285 x 150
2020	MDF 108E (SIC-C)	900 in 1 column	2000 x 285 x 150

Table 6.58 Accessories for Type 108 frame

Model number	Description
1434	Front Cover Assembly – MDF 108
1436	Side Cover Assembly – MDF 108

British Telecom Type 205 frame for QSA 2 and SID-CT (10 pair) modules

The Type 205 is a wall-mounted, single sided frame designed to accommodate up to 276 QSA 2 or SID-CT 10 pair connection modules. Any number of frames can be mounted side-by-side.

The following features are offered within the frame construction: -

- Durable, rigid frame, factory assembled from coated steel
- Back mount frames manufactured from stainless steel
- Hard wearing, coated steel jumper rings, wire guides and fanning strips for efficient cable management – frame design allows easy access to top jumper rings
- Fully earth bonded, meeting IEC regulations. Earth bar and clip supplied
- Adjustable feet which can be removed to reduce height from 2000mm to 1850mm
- Steel front and rear panels available as accessories (for model numbers 1390 and 1441 only)

Table 6.59 British Telecom Type 205 frame

Model number	Description	Capacity (pairs)	Size (mm) (H x W x D)
1310	MDF 205D (QSA)	2760 in 4 columns	1980 x 1000 x 295
2017	MDF 205D (SID-C)	3520 in 4 columns	1980 x 1000 x 295

Table 6.60 Accessories for Type 205 frame

Model number	Description
1015	Front Cover Assembly – MDF 205
1434	Front Cover Assembly – two column versions only
1012	Side Cover Assembly – MDF 106/205
1436	Side Cover Assembly – all versions

ID - Multi frames for SID - C, SID - CT and QSA (8 and 10 pair) modules

The ID - Multi frames can be free standing or wall-mounted. They are available in two heights, 2400mm or 2800mm and are suitable for medium to large installations. Available either as a basic frame or as an extension frame all versions are suitable for ID 3000, SID C and SID - CT modules. Each frame is supplied with a set of guard bars, a mounting rail, a set of cable shelves, a set of contact plates and an earthing kit.

Table 6.61 ID - multi frame

Model number	Description	Capacity (pairs) Using ID 3000 blocks	Size (mm) (H x W x D)
41-302-015 00	Basic frame free standing	2048 equipment side, 3200 line side in 8 columns	2400 x 710 x 850
41-302-016 00	Extension frame free standing	2048 equipment side, 3200 line side in 8 columns	2400 x 710 x 850
41-302-018 00	Basic frame free standing	3072 equipment side, 4800 line side in 8 columns	2400 x 710 x 850
41-302-019 00	Extension frame free standing	3072 equipment side, 4800 line side in 8 columns	2400 x 710 x 850
41-301-016 00	Basic frame wall mount	1024 equipment side, 1600 line side in 8 columns	2400 x 710 x 600
41-301-017 00	Extension frame wall mount	1024 equipment side, 1600 line side in 8 columns	2400 x 710 x 600
41-301-018 00	Basic frame wall mount	1536 equipment side, 2400 line side in 8 columns	2400 x 710 x 600
41-301-019 00	Extension frame wall mount	1536 equipment side, 2400 line side in 8 columns	2400 x 710 x 600

Table 6.62 Accessories for ID – multi frame

Model number	Description
41096-561 00	Set of cable channels
41027-557 00	Cable clamps for cable diameters 7,0 – 8,0 mm
41027-558 00	Cable clamps for cable diameters 8,5 - 9,5 mm
41027-559 00	Cable clamps for cable diameters 14,0 – 15,0 mm
79148-542 00	SID-C 128 Pairs - 16 x 8 pair
79148-532 00	SID-CT 100 Pairs - 10 x 10 pair
79148-574 00	SID-CT 128 Pairs - 16 x 8 pair
79148-564 00	QSA2 100 Pairs - 10 x 10 pair
79148-565 00	QSA2 128 Pairs - 16 x 8 pair

33.3.2 Small distribution frames

RIBE frames for RCP (8 pair) modules

Six heights of RIBE frames are available offering capacities ranging from 288 to 1984 pairs. All frames are for rear cable entry modules only. Made from aluminium with aluminium covers, they are specially designed for cables carrying frequencies up to 100MHz. The frame incorporate vertical wire management rings for cable management and allow flat symmetrical cabling, allowing for jumpering wires used for voice services.

Table 6.63 RIBE frames

Model number	Configuration (columns x pitches)	Capacity (pairs)	Size (mm) H x D	Cover model number
P6770AAB	2 x 18	288	310 x 185	NN374067 or NN374068
P6720AAB or P6609AAA*	2 x 28	448	460 x 185	NN374063 or NN374064
P6730AAB or P6610AAA*	2 x 41	656	660 x 185	NN374061VA or NN374065
P6740AAB or P6611AAA	2 x 65	1040	1060 x 185	NN374062VA or NN374066
P6790AAB	2 x 90	1440	1500 x 185	NN374075
P6700AAB	2 x 124	1984	2000 x 185	NN574003

* equipped with 100 x 100mm PVC duct.

CIPE frame for STG and RCP (8 and 10 pair) modules

The CIPE frame is designed to have the jumper wires routed across the back of the frame. Available in six sizes between 310mm and 2000mm in height, the wall-mounted aluminium frames can accommodate both STG (10 pair) and RCP (8 pair and 10 pair) modules. All frames are supplied in kit form complete with all hardware necessary to complete the installation. A range of cabinets is available in both steel and ABS plastic to improve appearance and provide security.

Table 6.64 CIPE frames

Model number	Description	Configuration (columns x pitches)	Capacity (pairs)	Size (mm) H x W x D
C232740A	CIPE 2 x 18 (8 pairs)	2 x 18	288	310 x 450 x 135
C232741A	CIPE 2 x 28 (8 pairs)	2 x 28	448	460 x 450 x 135
C232742A	CIPE 2 x 41 (8 pairs)	2 x 41	656	660 x 450 x 135
C232743A	CIPE 2 x 65 (8 pairs)	2 x 65	1040	1060 x 450 x 135
56312100	CIPE 2 x 90 (8 pairs)	2 x 90	1440	1500 x 450 x 135
463392VA	CIPE 2 x 124 (8 pairs)	2 x 124	1984	2000 x 450 x 135
C232750A	CIPE 2 x 18 (10 pairs)	2 x 18	360	310 x 450 x 135
C232751A	CIPE 2 x 28 (10 pairs)	2 x 28	560	460 x 450 x 135
C232752A	CIPE 2 x 41 (10 pairs)	2 x 41	820	660 x 450 x 135
C232753A	CIPE 2 x 65 (10 pairs)	2 x 65	1300	1060 x 450 x 135
56312200	CIPE 2 x 90 (10 pairs)	2 x 90	1800	1500 x 450 x 135
463393VA	CIPE 2 x 124 (10 pairs)	2 x 124	2480	2000 x 450 x 135

Table 6.65 Steel cabinets for CIPE frames

Model number	Description	Colour	Size (mm) H x W x D
374 067 00	Steel cabinet, lockable steel door for CIPE 2 x 18	Beige	330 x 450 x 300
374 067 00	Smoked glass door		330 x 450
374 063 00	Steel cabinet, lockable steel door for CIPE 2 x 28	Beige	480 x 450 x 300
374 064 00	Smoked glass door		480 x 450
374 061 VA	Steel cabinet, lockable steel door for CIPE 2 x 41	Beige	680 x 450 x 300
374 065 00	Smoked glass door		680 x 450
374 062 VA	Steel cabinet, lockable steel door for CIPE 2 x 65	Beige	1080 x 450 x 300
374 066 00	Smoked glass door		1080 x 450

Table 6.66 ABS cabinets for CIPE frames

Model number	Description	Colour	Size (mm) H x W x D
P6090 1AA	ABS cabinet, lockable door for CIPE 2 x 18	Beige	330 x 460 x 210
P6190 AAA	Smoked glass door		330 x 460
P6090 2AA	ABS cabinet, lockable door for CIPE 2 x 28	Beige	480 x 460 x 210
P6290 AAA	Smoked glass door		480 x 460
P6090 3AA	ABS cabinet, lockable door for CIPE 2 x 41	Beige	680 x 460 x 210
P6090 4AA	ABS cabinet, lockable door for CIPE 2 x 65	Beige	1080 x 460 x 210

Table 6 67 CIPE accessories

Model number	Description	Length (mm)
C232280A	Europe E8 profile, 16mm pitch, 55mm depth, STG 8 pair	2000
C232281A	Europe E8 profile, 16mm pitch, 55mm depth STG 10 pair	2000
P6008AAA	Wall mounting, single profile	-
P24940AA	Wall mounting, two profiles	-
P24940AA	Set of 5 vertical jumper rings 50 x 55 mm	-
P26665AA	Horizontal jumper rings for back mount frame 38 x 50	-
P26675AA	Horizontal jumper rings for back mount frame 50 x 70	-

QVG wall-mounted frame for SID C 10 pair modules

Three distribution frames, QVG 700, QVG 1000 and QVG 1600, with differing capacities, are available. The QVG frame can be used for medium to large installations and is constructed and extended modularly using the QRS mounting rail set and wall mounting set.

QRS mounting set

This set contains the mounting rails wire guides for 1000 pairs at the horizontal jumper level, a wire guide rail and wire guide rings for the vertical jumper level, and all system related mounting material. The mounting rail is available in three sizes - 700, 1000 and 1600 mm. The wire guide ring for 1000 pairs is attached to the mounting rail. It is possible to add another jumper level by attaching a second ring to the first. The design of the distribution frame separates the incoming and outgoing cables from the wire jumpers.

Wall mounting rail set

Available in 550 mm and 750 mm lengths, the wall mounting rail set is required for fixing the QRS to the wall, the set contains two mounting rails with four tail pieces plus mounting material. The tail pieces are used to fix the mounting rails to the wall and reduce the amount of bridging pieces required. The space between the mounting rails can be adjusted by using slide nuts. Cables are clamped using cable ties or hoop clamps (aperture width 16 mm).

The QVG 700 frame is constructed from the following parts:

Table 6.68 QVG 700 frame

Model number	Description	Size (mm)
41096-565 00	QRS 700 mounting rail kit	-
41096-568 25	2 column mounting rail kit	550
41096-569 25	3 column mounting rail kit	750
41096-562 00	Wire guide rail kit 700	700
41036-526 25	Cable channel kit 552	552
79096-569 25	FlexiRail QRS for SID C (34 modules) and SID CT (26 modules)	

The QVG 1000 frame is constructed from the following parts:

Table 6.69 QVG 1000 frame

Model number	Description	Size (mm)
41096-566 00	QRS 1000 mounting rail kit	-
41096-568 25	2 column mounting rail kit	550
41096-569 25	3 column mounting rail kit	750
41096-563 00	Wire guide rail kit 1000	1000
41036-536 25	Cable channel kit 850	850
79096-570 25	FlexiRail QRS for SID C (46 modules) and SID CT (36 modules)	

The QVG 1600 frame is constructed from the following parts:

Table 6.70 QVG 1600 frame

Model number	Description	Size (mm)
41096-567 00	QRS 1600 mounting rail kit	-
41096-568 25	2 column mounting rail kit	550
41096-569 25	3 column mounting rail kit	750
41096-564 00	Wire guide rail kit 1600	1000
41036-535 25	Cable channel kit 1500	850
79096-562 25	FlexiRail QRS for SID C (90 modules) and SID CT (70 modules)	

33.3.3 Wall-mounted and floor standing enclosures

British Telecom Type 500 series enclosure (including backmount frame)

Available in six sizes, these wall-mounted enclosures are used with 10 pair QSA 2, SID C and CT modules on customer premises.

Table 6.71 British Telecom Type 500 series closure

Model Number		Description	Capacity (pairs QSA)	Capacity (pairs SID-C)	Size (mm) H x W x D
QSA 2	SID-C				
1884	2009	BT Type 505 Enclosure	240	300	350 x 500 x 138
1911	2010	BT Type 510 Enclosure	340	440	1000 x 300 x 138
1883	2011	BT Type 515 Enclosure	440	560	630 x 500 x 138
1912	2012	BT Type 520 Enclosure	680	880	1000 x 500 x 138
1913	2013	BT Type 530 Enclosure	1020	1320	1000 x 750 x 138
1517	2014	BT Type 540 Enclosure	1360	1760	1000 x 1000 x 138

QVSN 2000 range of floor standing cabinets

QVSN 2000, multipurpose distribution cabinets are 400mm in depth and are used in conjunction with the QVG 1600 frame.
The cabinet features a strong welded steel frame. The inside of the front and rear frame profiles, have a continuous pattern of holes (spacing: 25 mm, in accordance with DIN 43356). The flush mounted side panels allow the cabinets to be mounted side by side to conserve space. The roof and floor have multiple entrance points for incoming and outgoing cables and the door, which has an opening angle of 180°; a 3-point bar lock, and twist handle can be hinged on the left or the right (changeable on site).
The cabinet is rated to IP 54 and finished with an electrostatic powder coating in grey (RAL 7032 and RAL 7022).

Table 6.72 QVSN 2000 cabinet

Model number	Description	Size (mm) H x W x D
43-101-02100	Type 1 (2 columns)	2000 x 600 x 400
43-103-02100	Type 2 (3 columns)	2000 x 800 x 400
79096-562 25	FlexiRail for SID-C (90 modules) and SID-CT (70 modules)	

QWG Range of wall-mounted cabinets for SID – C and SID – CT modules (8 and 10 pair)

The QWG 150 cabinet features two Flexirail mounting profiles for mounting 8 or 10 pair SID-C modules. The rails are fastened directly to the rear panel of the cabinet via profile holders. This gives the cabinet a reduced depth. Generous cable guide elements are provided for optimal cable management. The removable side panels ease cable installations and jumpering between cabinets when cabinets are installed side by side. The location of the door hinge can be changed on site.
Supplied in grey powder coated sheet steel, the cabinets meet the requirements of Class IP 30 as standard but are also available to Class IP54 on request.

Table 6.73 QWG wall cabinet

Model number	Description	Size (mm) H x W x D
41-105-01200	QWG 150 (accommodates up to 92 modules (8 or 10 pair)	1100 x 600 x 150

The QWG 600 and QWG 800 cabinets utilise the QVG frame (see above) for module mounting. Constructed with a welded steel frame the cabinets are mounted on the wall via mounting rails (supplied as standard).

The inside of the frame profiles have a continuous pattern of holes (spacing: 25 mm, to DIN 43356) and cable clamps are provided on the rails in the area of the cable entry ports. The cabinet roof and floor are fabricated from one piece of sheet steel with pre-prepared cable entry ports having removable plastic blanking plugs and PG cable gland screw fittings. The 180° opening door is flush fitted, has a lockable twist handle and can easily be removed for access to the cabinet. Hinge location is left or right, changeable on site.
Supplied in grey powder coated sheet steel the cabinets meet the requirements of Class IP 30 as standard but are also available to Class IP54 on request.

Table 6.74 QWG 600 and QWG 800 cabinets

Model number	Description	Size (mm) H x W x D
41-106-01100	QWG 600 / empty	1100 x 600 x 350
41-106-01000	QWG 600 / 2 mounting rails (2 x QRS 1000) 92 modules max.	1100 x 600 x 350
41-108-01100	QWG 800 / empty	1100 x 800 x 350
41-108-01000	QWG 800 / 3 mounting rails (3 x QRS 1000) 138 modules max	1100 x 800 x 350

Table 6.75 Accessories for QWG 600 and QWG 800 cabinets

Model number	Description	Size (mm)
41096-570 00	Expansion kit	
43096-705 00	IP 54 upgrade kit	
43036-536 25	Cable channel	850
79096-570 25	FlexiRail (for 46 SID – C modules, 36 SID – CT modules)	

VKA wall-mounted cabinets

Available in four sizes, this range of wall-mounted cabinets accommodates from 60 to 640 pairs using SID modules. QSA modules can also be accommodated. A distinguishing feature of the VKA range is the rotating base plate - "FlexiBase". FlexiBase is available on VKA 4, VKA 8 and VKA 12 and allows different types of modules to be used in the same cabinet. For example SID-CD strips (DIN standard) can be mounted on one side and a back mount frame and FlexiRail for SID-C modules can be mounted on the other. The FlexiRail system itself allows for different module types to be used. Knockout cable entry ports are provided and all boxes are equipped as standard with snap locks. Safety locks can also be fitted retrofitting option.

Table 6.76 VKA wall-mounted cabinets

Model number	Description	Capacity	Size (mm)
52-300-00025	VKA 2 / DIN-SID-C	80	330 x 200 x 100
52-300-00100	VKA 4 / DIN-SID-C	160	330 x 330 x 125
52-300-00200	VKA 8 / DIN-SID-C	320	550 x 330 x 125
52-300-00300	VKA 12 / DIN-SID-C	640	550 x 665 x 125
52-301-00025	VKA 2 / QSA2	60	330 x 200 x 100
52-301-00100	VKA 4 / QSA2	100	330 x 330 x 125
52-301-00200	VKA 8 / QSA2	200	550 x 330 x 125
52-301-00300	VKA 12 / QSA2	400	550 x 665 x 125

Double 19” wall mounted cabinets

Used in small and medium installations. These cabinets are manufactured from sheet steel and finished in grey (RAL 7035). Each box consists of the following:

- A fixed back section, 100mm deep.
- An intermediate hinged mid section, 400mm deep.
- 2 off 19” uprights with adjustable depth.
- 4 off removable blanking plates for cable entry / obstruction.
- 1 front door with viewing area and lock.

Table 6.77 Double 19” wall mounted cabinet

Model number	Description	Size (mm) H x W x D
P20325AB	19” cabinet 6U high	316 x 600 x 500
P20324AB	19” cabinet 12U high	584 x 600 x 500
P20326AB	19” cabinet 15U high	717 x 600 x 500

Single 19” wall mounted cabinets

Used in small and medium installations. Each cabinet is equipped with a front door that can be hinged either from the left or right, a lock and a swivel frame. Finished in grey (RAL 7035)

Table 6.78 Single 19” wall mounted housings

Model number	Description	Size (mm) H x W x D
P20101AB	19” cabinet 5U	316 x 600 x 400
P20106AB	19” cabinet 14U	717 x 600 x 400

33.3.4 Floor standing 19” racks

BCCS Range

A range of 19” racks for general purpose use on customers’ premises. Uprights can be adjusted at the base. Finished in light grey (RAL 7035). The rack is supplied in kit form with all fittings. A full range of accessories is available. See separate catalogue for information. Features:

- Full rear door with lock and keys.
- Glass front door with lock and keys.
- Perforated top allowing for mounting 4 fans.
- 2 rear uprights to fix pre equipped boxes.
- 2x19” uprights with adjustable depth.
- 5 earth braids.
- 4 mounted lights.

Table 6.79 BCCS 19” rack

Model number	Description	Size (mm)
P20320AA	BCCS rack 36U high	600 x 600
P20330AA	BCCS rack 42U high	600 x 600
P20331AA	Extension 42U (complete with side panels)	600 x 600
P20334AA	BCCS rack 24U high (steel rear door, glass front door)	800 x 600
P20335AA	BCCS rack 42U high (steel rear door, glass front door)	800 x 600
P20336AA	Extension 42U (complete with side panels)	800 x 600
P20337AA	BCCS rack 42U high	800 x 600
P20345AA	BCCS rack 42U high	800 x 800
P20338AA	BCCS rack 42U high	800 x 800
P20339AA	BCCS rack 42U high	800 x 800

QVSL 2000 range

The QVSL 2000 range of floor standing 19" racks and cabinets offers a comprehensive solution to housing patch panels and through special adapter frames (sub-racks), SID (C and CT), STG 2000 and RCP 2000 modules. All versions are manufactured from sheet steel and finished in a grey (RAL 7032 and RAL 7022) powder coating. Lockable doors are provided front and back and the front door is attractively finished with a smoked glass viewing panel. The QVSL Basic rack is 2m (42U) high. For smaller installations, the QVSL Mini at just 1,1m (20U) high is available. If space is limited and neither of these options is acceptable, then there is also the QVSL Compact family of wall mountable cabinets to select from, with cabinets ranging in height from 6U to 15U. Complementing each range is a wide range of accessories that will facilitate the installation. Please consult the product catalogue for full details of the full range of accessories.

QVSL Mini

OVSL Basic

QVSL Compact

Table 6.80 QVSL 19” rack

Model number	QVSL 2000 Type	Height (U)	Size (mm) H x W x D	IP rating
43-104-01100	Basic Type 1 without mounting frame	42	2000 x 800 x 600	30 (54*)
43-104-03300	Basic Type 2 including 19” frame	42	2000x 800 x 600	30 (54*)
43-104-03400	Basic Type 3 including 19” swing frame	40	2000 x 800 x 600	30 (54*)
43-105-01100	Basic Type 4 without mounting frame	42	2000 x 800 x 800	30 (54*)
43-105-03600	Basic Type 5 including 19” frame	42	2000 x 800 x 800	30 (54*)
43-105-03630	Basic Type 5A including 19” frame +	40	2000 x 800 x 800	30 (54*)
43-105-03629	Basic Type 5B including 19” frame +	40	2000 x 800 x 800	30 (54*)
43-105-03700	Basic Type 6 including 19” swing frame	40	2000 x 800 x 800	30 (54*)
43-108-00100	Server	42	2000 x 600 x 900	20
43-109-00100	Server mini	20	1100 x 600 x 900	20
43-106-03300	Mini no 19”	20	1100 x 800 x 600	30 (54*)
43-106-01200	Mini w /glass door	20	1100 x 800 x 600	30 (54*)
43-115-01500	Compact 15	15	770 x 600 x 580	54
43-115-01200	Compact 12	12	645 x 600 x 580	54
43-115-00900	Compact 9	9	495 x 600 x 580	54
43-115-00600	Compact 6	6	370 x 600 x 580	54
43-116-00200	Pico 1	4	550 x 450 x 215	20
43-116-00400	Pico 3	6	550 x 450 x 315	20

* Using upgrade kit

33.4 Housings

33.4.1 BCC 19" patch panels

Available in black or brushed aluminium, these patch panels can easily be mounted in rack frames, wall boxes or cabinets having a 19" mounting format. In the shielded version the RJ 45 patch panels support a wide range of cable diameters and provide effective protection against electromagnetic interference due to 360° contact on cable braids using a single earthing plane.

The BCC/16, 24, 32, and 48 port patch panels support the RJ45 Giga connector and offer an advantage over integrated punch down patch panels since in the case of failure of one of the connectors, it can easily be replaced without having to remove the entire panel. A wide range of options is available including coloured identification plates to aid port identification and security.

The BCC/16, 24, 32 and 48 K6 patch panels support the K5E and K6 RJ45 jacks which feature keystone mounting. Two versions are available, the "Classic" which includes a cable support shelf and the "Economic" which does not have any support for the cable and must be used in conjunction with rack mounted cable management features.

Table 6.81 BCC 19" patch panels

Model number	Description	Height
P33255AA	BCC/16 RJ45 brushed aluminium (70mm depth)	1U
P33355AA	BCC/16 RJ45 black (70mm depth)	1U
P33275AA	BCC/24 RJ45 brushed aluminium (100mm depth)	1U
P33375AA	BCC/24 RJ45 black (100mm depth)	2U
P33265AA	BCC/32 RJ45 brushed aluminium (100mm depth)	3U
P33365AA	BCC/32 RJ45 black (100mm depth)	3U
P33285AA	BCC/48 MJP brushed aluminium (130mm depth)	4U
P33385AA	BCC/48 MJP black (130mm depth)	4U
VOL-PPCA-F16K	BCC/16 K6 Classic brushed aluminium	1U
VOL-PPCB-F16K	BCC/16 K6 Classic black	1U
VOL-PPCA-F24K	BCC/24 K6 Classic brushed aluminium	1U
VOL-PPCB-F24K	BCC/24 K6 Classic black	2U
VOL-PPCA-F32K	BCC/32 K6 Classic brushed aluminium	3U
VOL-PPCB-F32K	BCC/32 K6 Classic black	3U
VOL-PPCA-F48K	BCC/48 K6 Classic brushed aluminium	4U
VOL-PPCB-F48K	BCC/48 K6 Classic black	4U
VOL-PPCA-F16K	BCC/16 K6 Economic brushed aluminium	1U
VOL-PPCB-F16K	BCC/16 K6 Economic black	1U
VOL-PPCA-F24K	BCC/24 K6 Economic brushed aluminium	1U
VOL-PPCB-F24K	BCC/24 K6 Economic black	2U
VOL-PPCA-F32K	BCC/32 K6 Economic brushed aluminium	3U
VOL-PPCB-F32K	BCC/32 K6 Economic black	3U
VOL-PPCA-F48K	BCC/48 K6 Economic brushed aluminium	4U
VOL-PPCB-F48K	BCC/48 K6 Economic black	4U

Table 6.82 Accessories for BCC 19" patch panels

Model number	Description	Colour
P33240BE	Coloured faceplate (bag of 8)	Blue
P33240JA	Coloured faceplate (bag of 8)	Yellow
P33240RE	Coloured faceplate (bag of 8)	Red
P33240VE	Coloured faceplate (bag of 8)	Green
P33182AA	Blanking plug (bag of 16)	White
P33405AA	1U Cable management panel (plastic guides)	Beige
P33410AA	1U Cable management panel (plastic guides)	Black
P33070AA	1U Cable management panel (Velcro guides)	Beige
P33065AA	1U Cable management panel (Velcro guides)	Black
P33110AA	2U Cable management panel (metal guides)	Beige
P33105AA	2U Cable management panel (metal guides)	Black

Q_{max} range of 19" patch panels

A range of 16 and 24 port 1U patch panels for mounting individual RJ45 Giga jacks or with punch down IDC connection blocks mounted on a printed circuit board. The patch panels are variously rated up to 100MHz and 250 MHz, making them ideally suited to both voice and data applications. Manufactured in sheet steel and finished in grey (RAL 7032) powder coating.

Table 6.83 Volition 19" x 1U patch panels, equipped, Q_{max}

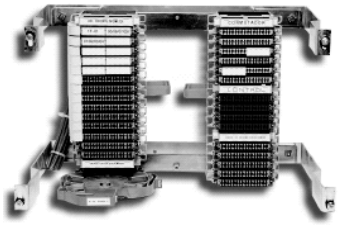
Model number	Description	Size (mm) H x W x D
43018 641 30	Volition 19" x 1U patch panel, 16 ports Q_{max} total shield	44 x 483 x 115
43018 642 30	Volition 19" x 1U patch panel, 24 ports Q_{max} total shield	44 x 483 x 115
43018 592 33	Volition 19" x 1U x 170mm idc patch panel, 24 ports shielded	44 x 483 x 166
43018 593 33	Volition 19" x 1U x 170mm idc patch panel, 16 ports shielded	44 x 483 x 166
43018 651 30	Volition 19" x 1U patch panel, 16 ports Q_{max} total shield	44 x 483 x 115
43018 652 30	Volition 19" x 1U patch panel, 24 ports Q_{max} total shield	44 x 483 x 115
43018 626 30	Volition 19" x 1U patch panel, 16 ports Q_{max}	44 x 483 x 115

Table 6.84 Accessories for 19" patch panels, Q_{max}

Model number	Description	Colour
05 636 04000	Volition face plate for punch down patch panel, Q_{max}	Green
05 636 04100	Volition face plate for punch down patch panel, Q_{max}	Red
05 636 04200	Volition face plate for punch down patch panel, Q_{max}	Yellow
05 636 04300	Volition face plate for punch down patch panel, Q_{max}	Blue
79397-519 00	SID Punch down tool	-

33.4.2 19" Sub-racks for RCP 2000, STG 2000 and SID/QSA modules

BCCE sub-rack for RCP 2000 modules

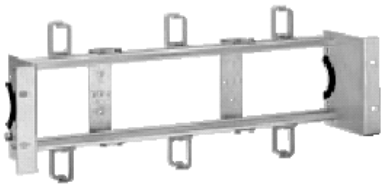


The BCCE range of sub-racks is designed to enable RCP 2000 modules to be fitted into a 19" rack or cabinet. Three sizes are available offering a 3U high sub-rack with single column of 26 modules, a 6U sub-rack offering a double column each of 14 modules or a 9U high sub-rack offering a double column of 20 modules each.

Table 6.85 BCCE sub-racks

Model number	Description	Height
P33040AA	BCCE E1 sub-rack, 1 Column, 26 Modules vertical.	3U
P33050AA	BCCE E2 sub-rack, 2 Column, 14 Modules horizontal	6U
P33060AA	BCCE E3 sub-rack, 2 Column, 20 Modules horizontal	9U

FlexiRail sub-rack for SID - C, SID - CT and QSA modules



The FlexiRail sub-rack is for SID – C, SID – CT and QSA modules and mounts in a 19" rack or cabinet. Two types are available offering a 3U high sub-rack with module mounting columns for SID or QSA modules. Cable jumper rings are located along the top and bottom edges of the sub-rack.

Model number	Description	Height
43026-507 00	19"-FlexiRail SID-C Capacity 240 pairs	3U
43026-508 00	19"-FlexiRail LSA-Plus Capacity 190 pairs	3U

Sub-rack for 10 pair STG 2000, SID – CT and QSA modules

Available in six sizes to accommodate a maximum of 21 modules, these sub-racks are either mounted back from the front face of the rack (recessed) or level with the front face of the rack (flush).

Table 6.86 Sub-racks for SID – CT and QSA modules

Model number	Description	Height
1951	3 columns, maximum of 4 modules (SID –C)/column recessed	2U
1952	3 columns, maximum of 4 modules (SID –C)/column flush	2U
1953	3 columns, maximum of 6 modules (SID –C)/column recessed	3U
1954	3 columns, maximum of 6 modules (SID –C)/column flush	3U
1955	3 columns, maximum of 8 modules (SID –C)/column recessed	4U
1956	3 columns, maximum of 8 modules (SID –C)/column flush	4U
1957	3 columns, maximum of 3 modules (QSA 2)/column recessed	2U
1958	3 columns, maximum of 3 modules (QSA 2)/column flush	2U
1959	3 columns, maximum of 5 modules (QSA 2)/column recessed	3U
1960	3 columns, maximum of 5 modules (QSA 2)/column flush	3U
1961	3 columns, maximum of 7 modules (QSA 2)/column recessed	4U
1962	3 columns, maximum of 7 modules (QSA 2)/column flush	4U

33.5 Wall and floor outlets

33.5.1 Wall outlets

RJ 45 faceplate incorporating shielded jack

A range of surface mounting and flush mounting faceplates that incorporate a shielded RJ45 Giga RJ 45 jack. Flush mount versions are supplied with a rear box manufactured from zamack and fixing screws. All versions have an integral dust cover over the jack aperture.

Table 6.87 Volition sockets and faceplates

Model number	Description
60-516-02000	Volition flush mounted socket, 2 ports, Q_{max} RAL1013
60-516-02025	Volition flush mounted socket, 2 ports, Q_{max} RAL1010
60-016-02000	Volition surface mounted socket, 2 ports, Q_{max} RAL1013
60-016-02025	Volition surface mounted socket, 2 ports, Q_{max} RAL1010
60-516-03000	Volition flush mounted single shielded socket, 2 ports, Q_{max} RAL1013
60-516-03025	Volition flush mounted single shielded socket, 2 ports, Q_{max} RAL1010
60-016-03000	Volition surface mounted single shielded socket, 2 ports, Q_{max} RAL1013
60-016-03025	Volition surface mounted single shielded socket, 2 ports, Q_{max} RAL1010
60-516-04000	Volition German flush mounted 50 x 50 faceplate, 2 ports Giga RAL 1013
60-516-04025	Volition German flush mounted 50 x 50 faceplate, 2 ports Giga RAL 1010
60-016-04000	Volition German surface mounted 50 x 50 faceplate 2 ports Giga RAL 1013
60-016-04025	Volition German surface mounted 50 x 50 faceplate 2 ports Giga RAL 1013
VOL-SGFB-F2K	Volition German flush mounted faceplate 2 ports keystone, beige
VOL-SGFW-F2K	Volition German flush mounted faceplate 2 ports keystone, white
VOL-SGSB-F2K	Volition German surface mounted faceplate 2 ports keystone, beige
VOL-SGSW-F2K	Volition German surface mounted faceplate 2 ports keystone, white

RJ 45 faceplate incorporating shielded RJ45 K6 jack

Table 6.88 Volition faceplates including RJ45 K6 jack

Model number	Description
VOL-SGFCB-W2K	Volition flush mounted socket with 2 x RJ45 K6 jacks, central fixing, beige
VOL-SGFCW-W2K	Volition flush mounted socket with 2 x RJ45 K6 jacks, central fixing, white
VOL-SGFB-W2K	Volition flush mounted socket with 2 x RJ45 K6 jacks, keystone, beige
VOL-SGFW-W2K	Volition flush mounted socket with 2 x RJ45 K6 jacks, keystone, white
VOL-SGSB-W2K	Volition surface mounted socket with 2 x RJ45 K6 jacks, keystone, beige
VOL-SGSW-W2K	Volition surface mounted socket with 2 x RJ45 K6 jacks, keystone, white
VOL-SGFCB-W1K	Volition flush mounted socket with 1 x RJ45 K6 jacks, central fixing, beige
VOL-SGFCW-W1K	Volition flush mounted socket with 1 x RJ45 K6 jacks, central fixing, white
VOL-SGFB-W1K	Volition flush mounted socket with 1 x RJ45 K6 jacks, keystone, beige
VOL-SGFW-W1K	Volition flush mounted socket with 1 x RJ45 K6 jacks, keystone, white
VOL-SGSB-W1K	Volition surface mounted socket with 1 x RJ45 K6 jacks, keystone, beige
VOL-SGSW-W1K	Volition surface mounted socket with 1 x RJ45 K6 jacks, keystone, white

Table 6.89 Volition faceplates for K6 RJ45 jack

Model number	Description
VOL-FP2M-F1K	Volition 22,5 x 45 faceplate, 1 port keystone, white
VOL-FP4M-F1K	Volition 45 x 45 faceplate, 1 port keystone, white
VOL-FP4M-F2K	Volition 45 x 45 faceplate, 2 ports keystone, white
VOL-0712B	Volition single gang faceplate, 2 ports keystone, bright white
VOL-0712	Volition single gang faceplate, 2 ports keystone, office white
VOL-0714B	Volition single gang faceplate, 4 ports keystone, bright white
VOL-0714	Volition single gang faceplate, 4 ports keystone, office white
VOL-FPUK-1K	Volition UK single gang faceplate, 1 ports keystone, white
VOL-FPUK-2K	Volition UK single gang faceplate, 2 ports keystone, white

33.5.2 Floor boxes

The single floor box is suitable for use in false floors. Unequipped, it is supplied with a tool for removing RJ45 jacks. The box contains six 45mm x45mm apertures, into which up to twelve 22,5mm x 45mm modules can be placed. Finished in grey (RAL 7011).

Table 6.90 Floor boxes

Model number	Description	Size (mm) L x W x D
P28491AA	Volition Single floor box	170 x 205 x 88
P28493AA	Volition Cover for Single Floor Box	160 x 153 x 5
P28494AA	Volition standard plate support for single floor box	170 x 132 x 16

33.6 Outlet Accessories

33.6.1 Surface mounting boxes

These boxes are moulded in white (RAL 9010) ABS

Table 6.91 Single gang surface mounting boxes

Model number	Description	Size (mm) H x W x D
P28400AA	Volition surface mounted single box RAL 9011	65 x 65 x 45
P28410AA	Volition surface mounted single box RAL 9011	65 x 65 x 48
P28420AA	Volition Single gang box (45mm x 45mm format)	65 x 65 x 48
P20470AA	Volition Box for 3 mounting plates	132 x 170 x 60
P20471AA	Volition Box for 4 mounting plates	132 x 225 x 60
P20472AA	Volition Box for 6 mounting plates	132 x 339 x 60
P28436AA	Volition 45 x 45 frame for two RJ45 modules	
P28435AA	Volition 50 x 50 frame for two RJ45 modules	
P20370AA	Volition cover plate	

Double and triple gang boxes are moulded in white (RAL 9010) ABS. An insulated partition allows for the separation of power and data cables within the box assembly. Boxes will accept both 45mm x 45mm and 22.5mm x 45mm modules. To enable a complete box assembly, one box, one faceplate, and two (double gang) or three (triple gang) support mechanisms are required.

Table 6.92 Double and triple gang surface mounting boxes

Model number	Description	Size (mm) H x W x D
P28690AA	Volition surface mounted box	80 x 150 x 42
P28691AA	Volition lid for surface mounted box	80 x 150 x 2
P28695AA	Volition surface mounted box	80 x 205 x 42
P28696AA	Volition lid for surface mounted box	80 x 205 x 2
P28692AA	Volition module support	64 x 75,5 x 10,5
P28693AA	Volition insulating partition (ABS)	72,5 x 39,5 x 2

Table 6.93 Anodised aluminium boxes

Model number	Description	Size (mm) H x W x D
P28452AA	Volition simple surface mounted box for 2 sockets	80 x 140 x 48
P28454AA	Volition simple surface mounted box for 4 sockets	80 x 230 x 48
P28457AA	Volition simple surface mounted box for 7 sockets	80 x 365 x 48
P28463AA	Volition double surface mounted box for 2 x 3 sockets	120 x 185 x 60
P28465AA	Volition double surface mounted box for 2 x 5 sockets	120 x 275 x 60
P28467AA	Volition double surface mounted box for 2 x 7 sockets	120 x 365 x 60
P28250AA	Volition 45mm x 45mm full cover	45 x 45
P28251AA	Volition 22,5mm x 45mm half cover	22,5 x 45
NN123915	Volition 50mm x 50mm full cover	50 x 50
P28033AA	Volition 25mm x 50mm half cover	25 x 50
P28405AA	Volition adapter, 50mm x 50mm to 45mm x 45mm	50 x 50

34.0 Cable and patchcords

34.1 Horizontal and backbone cable

34.1.1 Volition four-pair twisted Category 5E cable

Volition four-pair twisted Category 5E cable is available in three different constructions, unshielded (UTP) shielded with a foil (FTP) or screened and shielded with a foil (SFTP). All Category 5E cables meet or exceed the transmission requirements of ISO/IEC 11801, EN 50173, EIA/TIA 568 and EN 50167/8/9. They are available with either a low smoke zero halogen (LSZH) or plenum (riser?) grade sheath material.

Specification:

Operation temperature	-10°C to +60°C
Installation temperature	0°C to +50°C
Flame propagation*	IEC 332-3C
Smoke density*	IEC 61034
Toxic emission*	CENELEC HD 605
Corrosive gas*	IEC 60754-1,
Material*	CENELEC HD 624-7

* for LSZH cable only

Table 6.94 Category 5E UTP cable specification

Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	ACR (dB)	PS NEXT (dB)	ELFEXT (dB/100m)	PS ELFEXT (dB/km)	Return Loss (dB)
1	1,9	72,0	70,1	69	70	68	28,0
4	3,8	64,0	60,2	61	58	56	28,0
10	6,0	58,0	52,0	55	52	50	28,0
16	7,6	55,0	47,5	52	46	44	28,0
20	8,5	53,0	44,5	50	44	42	28,0
31,25	10,6	50,0	39,4	47	40	38	26,0
62,5	15,2	45,5	29,7	42	34	32	24,5
100	19,5	43,0	23,5	40	30	28	23,0
155	25,0	40,0	15,0	37	26	24	22,0
200	32,0	38,0	6,0	35	24	22	21,0

Table 6.95 UTP Category 5E FTP cable specification

Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	ACR (dB)	PS NEXT (dB)	ELFEXT (dB/100m)	PS ELFEXT (dB/km)	Return Loss (dB)
1	1,9	70	68,1	67	70	68	28,0
4	3,8	60	56,2	58	58	56	28,0
10	6,0	55	49,0	52	52	50	28,0
16	7,6	52	44,4	49	46	44	28,0
20	8,5	50	41,5	47	44	42	28,0
31,25	10,6	48	37,4	45	40	38	26,0
62,5	15,2	43	27,2	40	34	32	24,5
100	19,5	41	21,5	38	30	28	23,0
155	25,0	38	13,0	35	26	24	22,0
200	32,0	35	7,0	32	24	22	21,0

Table 6.96 Category 5E cable physical characteristics

Cable type	Minimum bend radius (mm) Short term/long term	Nominal cable diameter (mm)	Nominal cable weight (kg/km)	Maximum pulling load (N)
Cat 5E UTP	40/20	5,1	32	100
Cat 5E FTP	50/25	6,0	40	115
Cat 5E SFTP				

34.1.2 Volition four-pair twisted Category 6 cable

Volition four-pair twisted Category 5E cable is available in three different constructions, unshielded (UTP) shielded with a foil (FTP) or screened and shielded with a foil (SFTP). All Category 6 cables meet or exceed the transmission requirements of ISO/IEC 11801, EN 50173, EIA/TIA 568 and EN 50167/8/9. They are available with either a low smoke zero halogen (LSZH) or plenum (riser?) grade sheath material.

Specification:

Operation temperature	-10°C to +60°C
Installation temperature	0°C to +50°C
Flame propagation*	IEC 332-3C
Smoke density*	IEC 61034
Toxic emission*	CENELEC HD 605
Corrosive gas*	IEC 60754-1,
Material*	CENELEC HD 624-7

* for LSZH cable only

Table 6.97 Category 6 UTP cable specification

Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	ACR (dB)	PS NEXT (dB)	ELFEXT (dB/100m)	PS ELFEXT (dB/km)	Return Loss (dB)
1	1,9	72,0	70,1	69	70	68	28,0
4	3,8	64,0	60,2	61	58	56	28,0
10	6,0	58,0	52,0	55	52	50	28,0
16	7,6	55,0	47,5	52	46	44	28,0
20	8,5	53,0	44,5	50	44	42	28,0
31,25	10,6	50,0	39,4	47	40	38	26,0
62,5	15,2	45,5	29,7	42	34	32	24,5
100	19,5	43,0	23,5	40	30	28	23,0
155	25,0	40,0	15,0	37	26	24	22,0
200	32,0	38,0	6,0	35	24	22	21,0
250	36,0	36,0	<1,0	-	-	-	-

Table 6.98 Category 6 FTP cable specification

Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	ACR (dB)	PS NEXT (dB)	ELFEXT (dB/100m)	PS ELFEXT (dB/km)	Return Loss (dB)
1	1,9	72,0	70,1	69	70	68	28,0
4	3,8	64,0	60,2	61	58	56	28,0
10	6,0	58,0	52,0	55	52	50	28,0
16	7,6	55,0	47,5	52	46	44	28,0
20	8,5	53,0	44,5	50	44	42	28,0
31,25	10,6	50,0	39,4	47	40	38	26,0
62,5	15,2	45,5	29,7	42	34	32	24,5
100	19,5	43,0	23,5	40	30	28	23,0
155	25,0	40,0	15,0	37	26	24	22,0
200	32,0	38,0	6,0	35	24	22	21,0
250	36,0	36,0	<1,0	-	-	-	-

Table 6.99 Category 6 SFTP cable specification

Frequency (MHz)	Attenuation dB/100m	NEXT (dB)	ACR (dB)	PS NEXT (dB)	ELFEXT (dB/100m)	PS ELFEXT (dB/km)	Return Loss (dB)
1	1,9	72,0	70,1	69	70	68	28,0
4	3,8	64,0	60,2	61	58	56	28,0
10	6,0	58,0	52,0	55	52	50	28,0
16	7,6	55,0	47,5	52	46	44	28,0
20	8,5	53,0	44,5	50	44	42	28,0
31,25	10,6	50,0	39,4	47	40	38	26,0
62,5	15,2	45,5	29,7	42	34	32	24,5
100	19,5	43,0	23,5	40	30	28	23,0
155	25,0	40,0	15,0	37	26	24	22,0
200	32,0	38,0	6,0	35	24	22	21,0
250	36,0	36,0	<1,0	-	-	-	-

34.1.3 Twisted pair voice cable

This type of cable is designed to handle low frequency signals for short-range applications and can be terminated in insulation displacement connectors (IDC). It may also be soldered or wrapped. Containing solid annealed copper conductors, these cables can have a concentric layer construction or of a unit construction where the cable is bundled into 10 pair or 20 pair units. The pair colour scheme for the cables should comply with the International Electrotechnical Commission (IEC) recommendations Tables 6.100, 6.101 and 6.102 give details for a suitable voice grade cable for use in horizontal or backbone applications.

Table 6.100 Specification for suitable voice grade cable (0,4mm)

Number of pairs	Conductor diameter (mm)	Minimum insulation wall thickness (mm)	Maximum insulation diameter (mm)	Unit size/make up	Minimum sheath wall thickness (mm)	Maximum overall diameter (mm)	Resistance @ 20C (ohms/km)	Capacitance Unbalance (pF/500m)
1	0.4	0.15	0.85	Layer	0.4	3.3	153.0	300
3	0.4	0.15	0.85	Layer	0.5	5.3	153.0	300
6	0.4	0.15	0.85	Layer	0.6	6.8	153.0	300
10	0.4	0.15	0.85	Layer	0.6	8.3	153.0	300
12	0.4	0.15	0.85	Layer	0.7	8.9	153.0	300
16	0.4	0.15	0.85	Layer	0.7	9.8	153.0	300
20	0.4	0.15	0.85	Layer	0.7	10.4	153.0	300
25	0.4	0.15	0.85	Layer	0.8	11.1	153.0	200
40	0.4	0.15	0.85	Layer	0.9	13.8	153.0	300
50	0.4	0.15	0.85	Layer	0.9	14.1	153.0	200
60	0.4	0.15	0.85	Layer	1.0	15.8	153.0	300
72	0.4	0.15	0.85	Layer	1.1	17.3	153.0	300
100	0.4	0.15	0.85	Layer	1.2	20.1	153.0	200

Table 6.101 Specification for suitable voice grade cable (0,5mm)

Number of pairs	Conductor diameter (mm)	Minimum insulation wall thickness (mm)	Maximum insulation diameter (mm)	Unit size/make up	Minimum sheath wall thickness (mm)	Maximum overall diameter (mm)	Resistance @ 20C (ohms/km)	Capacitance Unbalance (pF/500m)
1	0.5	0.15	0.95	Layer	0.4	2.2	97.8	500
2	0.5	0.15	0.95	Layer	0.4	4.0	97.8	500
3	0.5	0.15	0.95	Layer	0.5	5.3	97.8	500
4	0.5	0.15	0.95	Layer	0.5	5.8	97.8	500
6	0.5	0.15	0.95	Layer	0.6	6.8	97.8	500
8	0.5	0.15	0.95	Layer	0.6	7.6	97.8	500
10	0.5	0.15	0.95	Layer	0.6	8.3	97.8	500
12	0.5	0.15	0.95	Layer	0.7	9.1	97.8	500
15	0.5	0.15	0.95	Layer	0.7	9.8	97.8	500
16	0.5	0.15	0.95	Layer	0.7	10.0	97.8	500
20	0.5	0.15	0.95	Layer	0.7	10.7	97.8	500
20	0.5	0.15	0.95	Unit	0.7	10.7	97.8	500
24	0.5	0.15	0.95	Layer	0.8	11.3	97.8	500
25	0.5	0.15	0.95	Layer	0.8	11.4	97.8	500
28	0.5	0.15	0.95	Layer	0.8	11.5	97.8	500
30	0.5	0.15	0.95	Layer	0.8	12.2	97.8	500
40	0.5	0.15	0.95	Layer	0.9	14.2	97.8	500
42	0.5	0.15	0.95	Layer	1.0	14.5	97.8	500
50	0.5	0.15	0.95	Layer	1.0	15.7	97.8	500
53	0.5	0.15	0.95	Layer	1.0	15.9	97.8	500
60	0.5	0.15	0.95	Layer	1.0	16.3	97.8	500
75	0.5	0.15	0.95	Layer	1.1	17.8	97.8	500
80	0.5	0.15	0.95	Layer	1.2	21.8	97.8	500
80	0.5	0.15	0.95	Unit	1.2	21.8	97.8	500
100	0.5	0.15	0.95	Layer	1.4	22.6	97.8	500
120	0.5	0.15	0.95	Layer	1.5	25.2	97.8	500
160	0.5	0.15	0.95	Unit	1.7	29.8	97.8	500
320	0.5	0.15	0.95	Unit	2.2	39.1	97.8	500

Table 6.102 Colour code for suitable voice grade cable

Pair number	A - wire	B - wire	Pair number	A - wire	B - wire
1	WHITE	BLUE	31	BLUE-Black	BLUE
2	WHITE	ORANGE	32	BLUE-Black	ORANGE
3	WHITE	GREEN	33	BLUE-Black	GREEN
4	WHITE	BROWN	34	BLUE-Black	BROWN
5	WHITE	GREY	35	BLUE-Black	GREY
6	RED	BLUE	36	YELLOW-Blue	BLUE
7	RED	ORANGE	37	YELLOW-Blue	ORANGE
8	RED	GREEN	38	YELLOW-Blue	GREEN
9	RED	BROWN	39	YELLOW-Blue	BROWN
10	RED	GREY	40	YELLOW-Blue	GREY
11	BLACK	BLUE	41	WHITE-Orange	BLUE
12	BLACK	ORANGE	42	WHITE-Orange	ORANGE
13	BLACK	GREEN	43	WHITE-Orange	GREEN
14	BLACK	BROWN	44	WHITE-Orange	BROWN
15	BLACK	GREY	45	WHITE-Orange	GREY
16	YELLOW	BLUE	46	ORANGE-Red	BLUE
17	YELLOW	ORANGE	47	ORANGE-Red	ORANGE
18	YELLOW	GREEN	48	ORANGE-Red	GREEN
19	YELLOW	BROWN	49	ORANGE-Red	BROWN
20	YELLOW	GREY	50	ORANGE-Red	GREY
21	WHITE-Blue	BLUE	51	ORANGE-Black	BLUE
22	WHITE-Blue	ORANGE	52	ORANGE-Black	ORANGE
23	WHITE-Blue	GREEN	53	ORANGE-Black	GREEN
24	WHITE-Blue	BROWN	54	ORANGE-Black	BROWN
25	WHITE-Blue	GREY	55	ORANGE-Black	GREY
26	RED-Blue	BLUE	56	YELLOW-Orange	BLUE
27	RED-Blue	ORANGE	57	YELLOW-Orange	ORANGE
28	RED-Blue	GREEN	58	YELLOW-Orange	GREEN
29	RED-Blue	BROWN	59	YELLOW-Orange	BROWN
30	RED-Blue	GREY	60	YELLOW-Orange	GREY
61	WHITE-Green	BLUE	91	BROWN-Black	BLUE
62	WHITE-Green	ORANGE	92	BROWN-Black	ORANGE
63	WHITE-Green	GREEN	93	BROWN-Black	GREEN
64	WHITE-Green	BROWN	94	BROWN-Black	BROWN
65	WHITE-Green	GREY	95	BROWN-Black	GREY
66	GREEN-Red	BLUE	96	YELLOW-Brown	BLUE
67	GREEN-Red	ORANGE	97	YELLOW-Brown	ORANGE
68	GREEN-Red	GREEN	98	YELLOW-Brown	GREEN
69	GREEN-Red	BROWN	99	YELLOW-Brown	BROWN
70	GREEN-Red	GREY	100	YELLOW-Brown	GREY
71	GREEN-Black	BLUE	101	WHITE-Grey	BLUE
72	GREEN-Black	ORANGE	102	WHITE-Grey	ORANGE
73	GREEN-Black	GREEN	103	WHITE-Grey	GREEN

Table 6.102 Colour code for suitable voice grade cable (continued)

Pair number	A - wire	B - wire	Pair number	A - wire	B - wire
74	GREEN-Black	BROWN	104	WHITE-Grey	BROWN
75	GREEN-Black	GREY	105	WHITE-Grey	GREY
76	YELLOW-Green	BLUE	106	GREY-Red	BLUE
77	YELLOW-Green	ORANGE	107	GREY-Red	ORANGE
78	YELLOW-Green	GREEN	108	GREY-Red	GREEN
79	YELLOW-Green	BROWN	109	GREY-Red	BROWN
80	YELLOW-Green	GREY	110	GREY-Red	GREY
81	WHITE-Brown	BLUE	111	GREY-Black	BLUE
82	WHITE-Brown	ORANGE	112	GREY-Black	ORANGE
83	WHITE-Brown	GREEN	113	GREY-Black	GREEN
84	WHITE-Brown	BROWN	114	GREY-Black	BROWN
85	WHITE-Brown	GREY	115	GREY-Black	GREY
86	RED-Brown	BLUE	116	YELLOW-Grey	BLUE
87	RED-Brown	ORANGE	117	YELLOW-Grey	ORANGE
88	RED-Brown	GREEN	118	YELLOW-Grey	GREEN
89	RED-Brown	BROWN	119	YELLOW-Grey	BROWN
90	RED-Brown	GREY	120	YELLOW-Grey	GREY

Note:

Uppercase letters indicate the base colour of insulation, lower case indicates bands applied to the base

34.2 Patchcords

34.2.1 RJ45 to RJ45 (100Ω)

Table 6.103 Volition Category 5e RJ45 to RJ45 LSOH patch cables

Model number UTP Category 5E, LSOH	Model number FTP Category 5E, LSOH	Model number SFTP Category 5E LSOH	Length (m)
VOL-5EUL-L0.5	VOL-5EFL-L0.5	VOL-5ESFL-L0.5	0,5
VOL-5EUL-L1	VOL-5EFL-L1	VOL-5ESFL-L1	1,0
VOL-5EUL-L2	VOL-5EFL-L2	VOL-5ESFL-L2	2,0
VOL-5EUL-L3	VOL-5EFL-L3	VOL-5ESFL-L3	3,0
VOL-5EUL-L5	VOL-5EFL-L5	VOL-5ESFL-L5	4,0

Table 6.104 Volition Category 5e RJ45 to RJ45 PVC patch cables

Model Number UTP Category 5E PVC			Length (m)
VOL-5EUP-L0.5			0,5
VOL-5EUP-L1			1,0
VOL-5EUP-L2			2,0
VOL-5EUP-L3			3,0
VOL-5EUP-L5			5,0

Table 6.105 Volition Category 6 RJ45 to RJ45 LSOH patch cables

Model number UTP Category 5E, LSOH	Model number FTP Category 5E, LSOH		Length (m)
VOL-6UL-L0.5	VOL-6FFL-L0.5		0,5
VOL-6UL-L1	VOL-6FFL-L1		1,0
VOL-6UL-L2	VOL-6FFL-L2		2,0
VOL-6UL-L3	VOL-6FFL-L3		3,0
VOL-6UL-L5	VOL-6FFL-L5		4,0

Table 6.106 Volition RJ45 to RJ45 PVC patch cables

Model Number UTP Category 5E PVC			Length (m)
VOL-6UP-L0.5			0,5
VOL-6UP-L1			1,0
VOL-6UP-L2			2,0
VOL-6UP-L3			3,0
VOL-6UP-L5			5,0

34.2.2 CBE to CBE (for use with RCP 2000 modules)

Table 6.107 LSZH CBE to CBE patchcords

Model cumber 1 pair LSZH	Model number 2 pair LSZH	Model number 3 pair LSZH	Length (m)
P39125D5	P39116A5	P39128D5	0,5
P39125A5	P39126A5	P39128A5	1,0
P39135A5	P39136A5	P39138A5	2,0
P39135J5	P39146A5	P39148A5	3,0
P39135L5	P39146L5	P39148L5	4,0
P39135M5	P39146M5	P39148M5	5,0

35.0 Glossary

The following glossary may be useful to the reader.

access floor: A system consisting of completely removable and interchangeable floor panels that are supported on adjustable pedestals or stringers (or both) to allow access to the area beneath.

administration: The method for labelling, identification, documentation and usage needed to implement moves, additions and changes of a cabling infrastructure.

alien crosstalk: Crosstalk between separate (copper) cables

attenuation: The decrease in signal power between two points. It is usually expressed as a ratio of the power output to the power input and measured in decibels (dB)

attenuation to crosstalk ratio (ACR): The ratio of the power of the received signal, attenuated by the media to the power of the near end crosstalk (NEXT) from the local transmitter, expressed in decibels.

backbone: The part of a network that carries the heaviest traffic.

backbone cable: See **backbone**.

balanced cable: A cable comprising one or more metallic symmetrical cable elements (twisted pairs or quads)

bridge: A device that connects two or more networks and forwards packets between them.

building backbone cable: A cable that connects the building distributor to a floor distributor. Intra-building backbone cables may also connect floor distributors in the same building.

building distributor (BD): A distributor in which the building backbone cable(s) terminate(s) and at which connections to campus or other incoming cables can be made.

building entrance facility: A facility that provides all necessary mechanical and electrical services, complying with all relevant regulations, for the entry of telecommunications cables into a building.

cabinet (telecommunications): An enclosure used for terminating telecommunications cables, wiring and connection devices with a hinged cover.

cable element: The smallest construction unit (e.g. copper pair, copper quad, or single fibre) in a cable.

cable run: A length of installed media which may include other components along its path.

cabling: A combination of all cables, wire, cord, fibre and connecting hardware.

campus: A premises containing one or more buildings.

campus backbone cable: A cable that connects the campus distributor to the building distributor(s). Campus backbone cables may also connect building distributors directly.

campus distributor (CD): The distributor from which the campus backbone cabling emanates.

ceiling distribution system: A distribution system that utilises the space between a suspended or false ceiling and the structural surface above.

centralised cabling: A cabling configuration from the TO in the work area to a centralised building distributor (BD) without the use of a floor distributor (FD).

channel: The end-to-end transmission path connecting any two pieces of application-specific equipment. The equipment and work area cables are included as part of the channel.

closed shaft: A series of vertically aligned closets, one on each floor. Cables run up through the floors - using sleeves, pipes, conduits or slots. Each closet typically contains additional fixtures to support the cabling and a method for fire-stopping the aperture.

closet (telecommunications): An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling, that is the recognised location of the cross-connect between the backbone and horizontal facilities. See also wiring closet.

collapsed backbone: See **centralised cabling**.

consolidation point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

CP cable: A cable connecting the consolidation point to the telecommunications outlet (TO).

CP link: The part of the permanent link between the floor distributor (FD) and the consolidation point (CP).

cross-connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

cross-connection: A connection scheme between cabling runs, subsystems, and equipment using patchcords or jumpers that attach to connecting hardware on each end.

crosstalk: The mechanism by which a signal travelling in one wire is coupled into an adjacent wire without any physical connection existing between the two wires. The strength of the coupled signal relates to the physical positioning of the wires, the electromagnetic shielding between them and the transmission technique being used.

customer premises: Building(s), grounds and appurtenances (belongings) under the control of the customer.

customer premises equipment (CPE): Telecommunications equipment located on the customer's premises.

DC loop resistance: the DC resistance of the loop created by connecting the transmit and receive wires together at the far end of a link.

distribution duct: A raceway of rectangular cross-section placed within or just below the finished floor and used to extend the wires or cables to a specific work area.

distribution frame: A structure with terminations for connecting the cabling of a facility in such a manner that interconnection or cross-connections may be readily made.

(1) **main**: When the structure is located at the entrance facility or main cross-connect and serving the building or campus.

(2) **intermediate**: When the structure is located between the main cross-connect and the telecommunications closet.

distributor: The term used for the functions of a collection of components (e.g., patch panels, patchcords) used to connect cables.

draw box: Space in the pathway system that allows the routeing of cables during the cable installation process such that the bending and pulling requirements of the cable are met.

duct: (1) A single enclosed raceway for conductors or cables. See also **conduit, raceway**. (2) A single enclosed raceway for wires or cables usually used in soil or concrete.

earth ground: A connection to earth obtained by a grounding electrode.

end user: The owner or user of the premises cabling system.

equal level far end crosstalk (ELFEXT): Pair to pair ELFEXT is expressed in decibels as the ratio between the measured FEXT and the attenuation of the disturbed pair.

equipment cable; cord: A cable or cable assembly used to connect telecommunications equipment to horizontal or backbone cabling.

equipment room (telecommunications): A centralised space for telecommunications equipment that serves the occupants of the building.

Note - An equipment room is considered distinct from a telecommunications closet because of the nature or complexity of the equipment.

external network interface: A point of demarcation between the public network and a private network. In many cases the external network interface is at the point of connection of the network provider's cable and the customer's cabling

far end crosstalk (FEXT): FEXT is a measure of the signal coupling from a transmitter at the near end into another pair measured at the far end, expressed as a ratio in decibels.

file server: a device used in a data network to store and distribute files of information to terminals, using the network.

fire break: A material, device, or assembly of parts installed along a cable, other than at a cable penetration of a fire barrier, to prevent the spread of fire along a cable.

fire shield: A material, device, or assembly of parts between cables to prevent propagation of flames from one cable to an adjacent cable.

fire stop: A material, device, or assembly of parts installed in a cable pathway at a fire-rated wall or floor to prevent passage of flame, smoke or gases through the rated barrier, (e.g., between cubicles or separated rooms or spaces).

floor distributor (FD): The distributor used to connect between the horizontal cable and other cabling subsystems or equipment. (See **telecommunications closet**).

ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

horizontal cable: A cable connecting the floor distributor (FD) to the telecommunications outlet(s) (TO).

horizontal cross-connect: A cross-connect of horizontal cabling to other cabling, e.g., horizontal, backbone, equipment.

host: A large computer used to handle most of the tasks within a data network.

identifier: An item of information that links a specific element of the telecommunications infrastructure with its corresponding record.

infrastructure (telecommunications): A collection of those telecommunications components, excluding equipment, that together provides the basic support for the distribution of all information within a building or campus.

inner duct: A non-metallic raceway, usually circular, placed within a larger raceway.

intermediate cross-connect: A cross-connect between first level and second level backbone cabling.

interface: A point at which connections are made to the generic cabling

intermediate distribution frame: See **distribution frame**.

jumper: A cable unit or cable element without connectors, used to make a connection at a cross connect

keying: The mechanical feature of a connector system that guarantees correct orientation of a connection, or prevents the connection to a jack, or to an optical fibre adapter of the same type intended for another purpose.

latency: The time it takes to get information through a network. Latency can be caused in several ways:-
(1) by propagation delay- the time it takes for the signal to travel the length of the line
(2) by transmission delay - the time it takes to send the packet the length of the line
(3) by processing delay - the time required to set up the path, attach addresses and execute other switching tasks etc.
(4) by rotation delay - the delay in accessing data arising from the need for the disk to rotate to the c

link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables.

main cross-connect: A cross-connect for first level backbone cables, entrance cables, and equipment cables.

main distribution frame: See **distribution frame**.

multi-user telecommunications outlet assembly: A grouping in one location of several telecommunications outlets/connectors.

near end crosstalk (NEXT): Pair to pair NEXT is a measure of the signal coupling from one pair to another within the link. A balanced input signal is applied to the disturbing pair at the near end of a link whilst the induced signal on the disturbed pair is measured at the near end. NEXT is expressed as the ratio between the two signals expressed in decibels.

open shaft: Usually an open space extending from a building's basement to its roof without any floor separations, such as ventilation or elevator shafts. Present codes do not allow any additions to existing open shafts.

optical fibre cable: A cable consisting of one or more optical fibres.

optical power meter: A device for measuring the link loss in an optical fibre network.

OTDR: Optical Time Domain Reflectometer. A device for measuring reflections and link loss in an optical fibre network.

outlet box (telecommunications): A metallic or non-metallic box mounted within a wall, floor, or ceiling and used to hold telecommunications outlets/connectors or transition devices.

outlet/connector (telecommunications): A connecting device in the work area on which horizontal cable terminates. (See **telecommunications outlet**).

pair: The two conductors of a balanced transmission line. Generally refers to a twisted pair or one side circuit two diametrically facing conductors in a quad).

patch cable (cord): A length of flexible cable with connectors on one or both ends used to establish connections.

patch panel: A cross-connect system of mateable connectors that facilitates administration.

pathway: A facility for the placement of telecommunications cable.

permanent link: The transmission path between two mated interfaces of generic cabling, excluding equipment cords, work area cords and cross-connections, but including the connecting hardware at each end.

phase delay: The circuit characteristic which result in certain transmitted frequencies arriving ahead of others, even though they were transmitted at the same time.

Power sum near end crosstalk (PS NEXT): PS NEXT takes into account the combined crosstalk (statistical) on a receive pair from all the near-end disturbing pairs operating simultaneously.

Power sum attenuation to crosstalk ratio (PS ACR): PS ACR is the ratio of the power of the received signal, attenuated by the media to the combined power (statistical) of the near end crosstalk (NEXT) from the local transmitter, expressed in decibels.

power sum equal level far end crosstalk (PS ELFEXT): PS ELFEXT takes into account the combined far end crosstalk (statistical) on a the attenuated receiver pair from all the far end disturbing pairs operating simultaneously.

power sum far end crosstalk (PS FEXT): PS FEXT takes into account the combined far end crosstalk (statistical) on a receiver pair from all the far end disturbing pairs operating simultaneously.

propagation delay: Propagation delay is the time taken for the signal to travel along the transmission medium.

pull cord: A cord or wire placed within a raceway and used to pull wire and cable through the raceway.

pull strength: See **pulling load**.

pulling load: The pulling force that can be applied to the strength member(s) of a cable without affecting specified characteristics for the cable.

quad: A cable element comprising four insulated conductors twisted together. Two diametrically facing conductors form a transmission pair.

rearrangement: An action taken to replace, add, adapt or remove existing premises wiring system components.

record: A collection of detailed information related to a specific element of the telecommunications infrastructure.

record drawing (as built): A plan, on paper, that graphically documents and illustrates the installed telecommunications infrastructure in a building, or portion thereof.

report: A presentation of a collection of information from the various records.

return loss (RL): Return loss is a measure of the reflected energy. It is usually expressed as a ratio in decibels to the energy being transmitted. Return loss in fibres is normally caused by changes in the refractive index of the material through which the signal is passing (e.g. at the glass/air boundary at a connector). In copper, return loss is normally caused by impedance variations within the system.

ring topology: A topology in which network cables are distributed in the form of a ring.

router: An electronic device which routes data from one terminal in a LAN to another terminal in a second LAN.

screen: See **shield**.

screened balanced cable: A balanced cable with an overall screen and/or screens for the individual elements.

server: An electronic device which distributes information to terminals in a data network.

shield (screen): A metallic layer placed around a conductor or group of conductors.

NOTE - The shield may be the metallic sheath of the cable or the metallic layer inside a non-metallic sheath.

skew: Skew is a measurement of the difference in signalling delay between the fastest pair to the slowest.

sleeve: An opening, usually circular, through the wall, ceiling, or floor to allow the passage of cables.

small form factor connector: An optical fibre connector designed to accommodate two or more optical fibres with at least the same mounting density as the connector used for balanced cabling.

splice: A joining of transmission media, copper or fibre, generally meant to be permanent, generally from separate sheaths.

splice box: A box, located in a pathway run, intended to house a cable splice.

star topology: A topology in which network cables are distributed from a central point.

telecommunications closet: See **closet (telecommunications)**.

telecommunications equipment room: See **equipment room (telecommunications)**.

telecommunications outlet: A fixed connecting device where the horizontal cable terminates. The telecommunications outlet provides the interface to the work area cabling.

terminal: (1) A point at which information may enter or leave a communications network. (2) The input-output associated equipment.

topology: The physical or logical arrangement of a network.

transition point: A location in the horizontal cabling where a change of cable type takes place; for example, backbone cable connects to horizontal cable.

twisted pair: A cable element comprising two insulated conductors twisted together to form a balanced transmission line.

uninterruptible power supply: A buffer between utility power or other power source and a load that requires continuous precise power.

unscreened balanced cable: A balanced cable without any screens.

wiring closet: the area, usually a room in which building cable is terminated and interconnected. See also closet (telecommunications).

work area (work station): A building space where the occupants interact with telecommunications terminal equipment.

work area cable (cord): A cable connecting the telecommunications outlet to the terminal equipment (sometimes referred to as a patchcord).

35.1 Acronyms and Abbreviations

ACR	attenuation to crosstalk ratio
ANSI	American National Standards Institute
APC	angled physical contact
ASTM	American Society for Testing and Materials
ATM	asynchronous transfer mode
BD	building distributor
BER	bit error rate
BICSI	Building Industry Consulting Service International
B-ISDN	broadband ISDN
CD	campus distributor
CISPR	International Special Committee on Radio Interference
CP	consolidation point
CPE	customer premises equipment
CSMA/CD	carrier sense multiple access with collision detection
DUT	device under test
EIA	Electronic Industries Association
ELFEXT	equal level far end cross talk
EMC	electromagnetic compatibility
EMI	electromagnetic interference
FD	floor distributor
FDDI	fibre distributed data interface
FEXT	far end crosstalk
FOTP	fibre optic test procedure
FTP	foiled twisted pair
IDC	insulation displacement connection
IDF	intermediate distribution frame
IEC	International Electrotechnical Commission
IEEE	The Institute of Electrical and Electronics Engineers
IL	insertion loss
ISDN	integrated services digital network
ISO	International Organisation for Standardisation
ITU-R	International Telecommunication Union - Radio sector
ITU-T	International Telecommunication Union - Telecommunication sector
LAN	local area network
LED	light emitting diode
MAU	media attachment unit
Mbps	megabits per second
MDF	main distribution frame
MUTO	multi user telecommunications outlet
NEXT	near end crosstalk
NIST	National Institute for Standards and Technologies
PBX	private branch exchange
PC	physical contact
PS NEXT	power sum NEXT
PS ACR	power sum ACR
PS ELFEXT	power sum ELFEXT

PS FEXT	power sum FEXT
PVC	polyvinyl chloride
RF	radio frequency
ScTP	screened twisted pair
SFF	small form factor connector
SFTP	shielded foiled twisted pair
SSTP	shielded shielded twisted pair
STP	shielded twisted pair
TIA	Telecommunications Industry Association
TO	telecommunications outlet
TP	transition point
TSB	Telecommunications System Bulletin
UL	Underwriters Laboratories Inc
UPS	uninterruptible power supply
UTP	unshielded twisted pair

35.2 Units of Measurement

A	ampere
mA	milliampere
C	degrees Celsius
dB	decibel
g	acceleration due to gravity
gm	gram
kg	kilogram
Hz	hertz
kHz	kilohertz
kPa	kilopascal
m	metre
km	kilometre
mm	millimetre
µm	micrometre
nm	nanometre
MHz	megahertz
N	Newton
kN	kilonewton
s	second
ms	millisecond
µs	microsecond
ns	nanosecond
V	Volt
mV	millivolt
µV	microvolt
Ω	ohm
mΩ	milliohm

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If any goods supplied or processed by or on behalf of 3M prove on inspection to be defective in material or workmanship, 3M will (at its option) replace the same or refund to the Buyer the price of the goods or services.

Except as set out above, all warranties and conditions, whether expressed or implied, statutory or otherwise are excluded to the fullest extent permissible at law.

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