TasNetworks Standard

Communications and Data Cabling Standard

R0001043989

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Tasmanian Networks Pty Ltd (ABN 24 167 357 299)

Authorisations

Action	Name and title	Date
Prepared by	John Gangemi Senior Asset Strategy Engineer, Secondary Systems, Asset Strategy Asset Strategy and Performance Strategic Asset Management	01/06/2018
Reviewed by	Robert Smith	26/06/2018
Authorised by	Robert Smith	26/06/2018
Review cycle	30 months	

Responsibilities

This document is the responsibility of the Asset Strategy and Performance, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

Please contact the Asset Strategy and Performance Leader with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

Minimum Requirements

The requirements set out in TasNetworks' documents are minimum requirements that must be complied with by all TasNetworks team members, contractors, and other consultants.

The end user is expected to implement any practices which may not be stated but which can be reasonably regarded as good practices relevant to the objective of this document.

Record of revisions

Section number	Details
All	Removed references to Transend Networks and Aurora
All	Converted legacy Transend standard to the TasNetworks' document template
All	Tables, Figures and Equations use the TasNetworks' document template numbering system
1.6	Updates references to current Australian Standards, Codes of Practice, and relevant legislation
1.7.1	Updated Acronyms and Definitions where applicable
3.1	Added the requirement of conductive support structures to be equipotentially bonded as well as earthed
4.1	Added the requirement of conductive support structures to be equipotentially bonded as well as earthed
3.1.1	Added note that cable armour is not to be considered as shielding for EMI and RFI
4.4	Changed from generic Wireless Access Points/Signals to IEEE 802.11 Wireless Access Points/Signals.

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1 General

1.1 Purpose

The purpose of this document is to define the requirements, specifications and application of all communications cabling and terminations to be installed on substation and telecommunications network sites owned and operated by, or under the responsibility of, Tasmanian Networks Pty Ltd (hereafter referred to as "TasNetworks"). This includes cabling used for communications to protection and control devices, data cabling and cabling used within the TasNetworks' telecommunications network.

1.2 Scope

This standard applies to all communications cabling carried out by TasNetworks' employees, contractors, or any other person or entity providing cabling in substations or telecommunications facilities under TasNetworks' responsibility.

1.3 Objective

The basic objectives of this standard are to:

- Protect the health and safety of any person who may operate; work on; use services supplied by means of; or be otherwise reasonably likely to be affected by the operation of; a telecommunications network, telecommunications facility, telecommunications facility, substation, asset or sites that are owned and operated by, or are under the responsibility of, TasNetworks;
- Protect the integrity and proper functioning of a telecommunications network, telecommunications facility, substation, asset or sites that are owned and operated by, or are under the responsibility of, TasNetworks; and
- To ensure that where practical a standard approach and philosophy is used to design, operate and maintain assets and sites that are owned and operated by, or are under the responsibility of TasNetworks.

1.1 Precedence

Any apparent conflict between the requirements of this standard and the law, mandatory requirements, industry standards, project specifications, non-statutory standards or guidelines, and any other associated documents should be brought to the immediate attention of TasNetworks' for resolution. No action must be taken that might result in a breach of law or mandatory standard.

Where there may be a conflict between the requirements of this standard and any:

- law, mandatory requirement, or industry standard, then: that law or statutory requirement will prevail over this standard; and
- non-mandatory standard or guideline, then: this standard will prevail over that standard or guideline; or
- project specification, then the contract documentation will prevail over this standard.

If other TasNetworks' cabling standards conflict with this telecommunications standard such as the TasNetworks' power cabling standards, this standard shall take precedence.

1.1 Deviations and/or variations to this Standard

Approval for a deviation to this standard may only be accorded if it does not reduce the quality of workmanship, pose a safety risk to personnel or equipment, and does not deviate from the intent of this standard. Deviations, if any, must be specifically requested and approved in writing by TasNetworks' Asset Strategy and Performance team leader.

1.2 References

As a component of the complete specification for a system, this standard is to be read in conjunction with other standards and documents as applicable. In particular, this includes the documents mentioned below.

1.2.1 Legislation

Parliament of Australia, Telecommunications Act 1997

Parliament of Australia, Radiocommunications Act 1992

1.2.2 TasNetworks' Standards

Table 1 - TasNetworks' Standards

Record Number	TasNetworks' Standard
R0000759837	Distribution Standard - Cables and Conductors
R0000565986	EHV Cable System Standard
R0000248806	Fibre Optic Overhead Ground Wire (OPGW) Standard
R0000684808	TasNetworks Nomenclature Standard
R0000590630	HV and LV Cable Systems Standard
R0000522692	Substation Lightning Protection and Earthing Standard
R0000780788	Transmission Line and Cable Name and Number Standard
R0000517370	Site Names and Abbreviations Standard
R0000565984	AC Distribution System Standard
R0000522693	DC Distribution System Standard

1.2.3 Australian Standards and Codes of Practice

Table 2 - Australian Standards and Codes of Practice

Record Number	Document Name	Organisation	Date Published
ACMA Labelling Notices	The Telecommunications (Labelling Notice for Customer Equipment and Customer Cabling) Instrument	Australian Government under the Telecommunications Act 1997	2015

Record Number	Document Name	Organisation	Date Published
ACMA Labelling Notices	Radiocommunications (Compliance Labelling – Devices) Notice	Australian Government under the Telecommunications Act 1997 Radiocommunications Act 1992	2014
ACMA Labelling Notices	Radiocommunications Labelling (Electromagnetic Compatibility) Notice	Australian Government under the Telecommunications Act 1997 Radiocommunications Act 1992	2017
ACMA Labelling Notices	Radiocommunications (Compliance Labelling - Electromagnetic Radiation) Notice	Australian Government under the Telecommunications Act 1997 Radiocommunications Act 1992	2014
AS 2067:2016	Substations and high voltage installations exceeding 1 kV a.c.	Standards Australia	2016
AS/CA S008:2010	Requirements for customer cabling products	Communications Alliance Ltd	2010
AS/CA S009:2013	Installation requirements for customer cabling (Wiring rules)	Communications Alliance Ltd	2013
AS/NZS 1367:2016	Coaxial cable and optical fibre systems for the RF distribution of digital television, radio and in-house analog television signals in single and multiple dwelling installations	Standards Australia	2016
AS/NZS 2967:2014	Optical fibre communication cabling systems safety	Standards Australia	2014
AS/NZS 3000	Australian/New Zealand Wiring Rules	Standards Australia	2018
AS/NZS 3015 (obsolescent not withdrawn)	Extra-Low Voltage DC Power Supplies and Service Earthing Within Public Telecommunications Networks	Standards Australia	2004
AS/NZS 3080:2013	Information technology—Generic cabling for customer premises (ISO/IEC 11801:2011, MOD)	Standards Australia	2013
AS/NZS 3835.1	Earth Potential Rise – Protection of Telecommunications Network Users, Personnel and Plant; Part 1: Code of Practice	Standards Australia	2006

Record Number	Document Name	Organisation	Date Published
AS/NZS 3835.2	Earth Potential Rise – Protection of Telecommunications Network Users, Personnel and Plant; Part 2: Application Guide	Standards Australia	2006
AS/NZS 60950.1:2015	Information technology equipment - Safety - Part 1: General requirements (IEC 60950-1, Ed. 2.2 (2013), MOD)	Standards Australia	2015
AS/NZS IEC 60825.1:2014	Safety of laser products Part 1: Equipment classification and requirements	Standards Australia	2014
AS/NZS IEC 60825.2:2011	Safety of laser products Part 2: Safety of optical fibre communication systems (OFCS)	Standards Australia	2011
AS/NZS ISO/IEC 24702:2007	Telecommunications installations — Generic cabling — Industrial premises	Standards Australia	2007
AS/NZS ISO/IEC 24764:2012	Generic cabling systems for data centres	Standards Australia	2012
CA C524:2013	External Telecommunication Cable Networks Industry Code	Communications Alliance Ltd	2013
HB 101-1997 (CJC 5)	Coordination of power and telecommunications - Low Frequency Induction (LFI): Code of practice for the mitigation of hazardous voltages induced into telecommunications lines	Standards Australia	1997
HB 101-1997 (CJC 5) Amdt 1-1998	Coordination of power and telecommunications - Low Frequency Induction (LFI): Code of practice for the mitigation of hazardous voltages induced into telecommunications lines	Standards Australia	1998

1.2.4 International Standards and Codes of Practice

Table 3 - International Standards and Codes of Practice

Record Number	Document Name	Organisation
ANSI/TIA 598-C	Optical Fiber Cable Color Coding	ANSI/TIA
ANSI/EIA 359-A	Colors for Color Identification and Coding	ANSI/EIA
TIA/EIA 568B	Termination of an 8P8C Plug	TIA/EIA

1.3 Acronyms and Definitions

1.3.1 Acronyms

8P8C	8 Position 8 Contact (commonly known as RJ45)
AC (or "ac")	Alternating Current (defined as the root mean square value unless stated otherwise)
ACMA	Australian Communications and Media Authority
ADSS	All-Dielectric, Self-Supporting (referring to fibre optic cables)
AS	Australian Standard
AWG	American Wire Gauge
BERT	Bit Error Rate Test
CA	Communications Alliance
CAE	Customer Access Equipment
CES	Communications Earth System
CET	Communications Earth Terminal
dB	Decibels
DC (or "dc")	Direct Current
DDF	Data Distribution Frame
EHV	Extra-High Voltage
ELV	Extra-Low Voltage
EMI	Electromagnetic Interference
EPR	Earth Potential Rise
EWIS	Emergency Warning and Intercommunication System
FOBOT	Fibre Optic Break Out Tray
HV	High Voltage
IED	Intelligent Electronic Device
ISO	International Organisation for Standardisation
ITU-T	International Telecommunication Union – Telecommunications Standardisation Sector
LAN	Local Area Network
LC	Little Connector (sometimes Lucent Connector)
LFI	Low Frequency Induction
LV	Low Voltage
MDF	Main Distribution Frame
MIMS	Mineral Insulated Metal Sheath
MIPP	Modular Industrial Patch Panel
NTD	Network Termination Device
OPGW	Optical Ground-Wire
OPUC	Optical Underground Cable

PABX	Private Automatic Branch Exchange
PoE	Power over Ethernet
RFI	Radiofrequency Interference
RJ45	Registered Jack 45
RMS	Root Mean Square
RTU	Remote Terminal Unit
SC/APC	Square Connector / Angled Physical Connection
SELV	Safety Extra-Low Voltage
SFP	Small Form-factor Pluggable
ST	Stab-Twist
SWA	Steel Wire Armouring
SWER	Single Wire Earth Return
TNV	Telecommunications Network Voltage
TO	Telecommunications Outlet
TRC	Telecommunications Reference Conductor
UV	Ultraviolet (radiation/light), e.g. direct sunlight
WAN	Wide Area Network

1.3.2 Definitions

The majority of the following definitions are taken from AS/CA S009 where relevant in order to minimise cross referencing.

1.3.2.1 Cabling

Cable or cables and any associated works or parts, e.g. pits, poles, conduits, trays, connecting devices, jumpers, etc.

1.3.2.2 Cabling provider

A person who performs or supervises cabling work.

1.3.2.3 Communications Earth System (CES)

A system of earthing using common elements to provide for earthing of electrical and communications equipment within a premise.

Note: A CES may be used for protective and functional earthing for telecommunications purposes

1.3.2.4 Communications Earth Terminal (CET)

A terminal provided for the purpose of equipotential bonding of the CES or the TRC to the main earthing bar, main earthing conduit, or sub-main earthing conductor of the electrical installation.

Note: the CET provides a demarcation between the electrical earthing system and the telecommunications earthing system and was formerly known as a "bonding terminal".

1.3.2.5 Cross-connection

A method of providing for flexible interconnection of cables or cable elements, by means of jumpers or patch cords.

1.3.2.6 Customer

A legal person, including a natural person, a corporation or an organisation, that subscribes to (pays for) the supply of a carriage service.

Note: for most purposes of this standard, TasNetworks' Protection and Control can be considered as a customer of the TasNetworks' Telecommunications Operations team.

1.3.2.7 Customer access equipment (CAE)

Customer equipment with multiple ports (local or network) that provides access (gateway functions) to a telecommunications network and is capable of switching, storage, processing, conversion, integration, line isolation/coupling or multiplexing of analogue or digital voice or voice equivalent communication.

Note 1: examples of CAE include, but are not limited to, PABX or key systems, line isolators, ISDN terminal adapters, echo cancellers, interactive voice response systems, voice/packet gateway, integrated access devices, voice messaging systems, protection relays and remote terminal units (RTUs).

Note 2: CAE is a type of customer equipment but, for the purposes of this standard, is not considered to be "terminal equipment". An operator console, telephone handset or any other peripheral device connected to CAE that may be regularly handled by an end-user is "terminal equipment".

Note 3: CAE was formerly referred to as CSS (Customer Switching System)

1.3.2.8 Customer cabling and equipment

Any line (cabling) or equipment, apparatus, tower, mast, antenna, or other structure, or system (software based or otherwise) that is used, installed ready for use, or intended for use on the customer side of the boundary of a telecommunications network.

1.3.2.9 Distributor

A collection of components used to terminate cables which provides for cross-connection of cables or cable elements, e.g. a fibre-optic patch panel or a Krone frame.

Note: Any cable termination equipment used to connect two or more cables or cable elements together without cross-connection (e.g. a cable joint) is not regarded as a distributor for the purposes of this standard.

1.3.2.10 Earth Potential Rise (EPR)

A rise in voltage of an earthing system and the surrounding soil with respect to a distant earth. EPR is caused primarily when an earth fault on an HV or EHV power system produces a current flow through the earthing system of an HV or EHV site.

1.3.2.11 End-user

The customer or any other person that may use a carriage service, e.g. an employee of the customer.

1.3.2.12 Extra-High Voltage (EHV)

Refer to section 1.7.3: Voltage Classifications.

1.3.2.13 Extra-Low Voltage (ELV)

Refer to section 1.7.3: Voltage Classifications.

1.3.2.14 Functional earth

The earthing of a point in equipment or in a system which is necessary for a purpose other than safety, e.g. as a reference voltage for a telecommunications circuit.

1.3.2.15 High Voltage (HV)

Refer to section 1.7.3: Voltage Classifications.

1.3.2.16 Indoor cabling

Customer cabling that is installed inside a building but not underground or exposed to the elements.

Note: cabling installed within a sheltered structure between buildings such as a service tunnel, covered walkway or above-ground trunking system, is treated as indoor cabling for certain requirements of this standard (e.g. cable properties and separation from other services).

1.3.2.17 Isolation device

A device that isolates each of the conductors of a telecommunications service to prevent the transfer of hazardous voltages but allows the service to operate normally. For example an optical isolator.

1.3.2.18 Jumper

A cable unit or cable element without connectors, typically one to four twisted pairs, either unsheathed or sheathed, used to make a cross-connection within a distributor.

1.3.2.19 Low Frequency Induction (LFI)

The generation of currents in a telecommunications line due to inductive coupling with a power line carrying large unbalanced currents e.g. during a fault condition on the HV or EHV power system.

1.3.2.20 Low Voltage (LV)

Refer to section 1.7.3: Voltage Classifications.

1.3.2.21 Main distribution frame (MDF)

A distributor that provides, or is intended to provide, an electrical termination point for a communications service provider's twisted pair lead-in cabling.

Note: for the purpose of this standard, the TasNetworks' Telecommunications Operations team can be considered as a communication service provider providing services to customers including TasNetworks' Protection and Control amongst others.

1.3.2.22 Network boundary

Refer to Section 2.8: Network Boundary.

1.3.2.23 Outdoor cabling

Customer cabling that is installed external to a building, either underground or exposed to the elements.

Note: cabling installed within a sheltered structure between buildings such as a service tunnel, covered walkway or above-ground trunking system, is treated as indoor cabling for certain requirements of this standard (e.g. separation from other services).

1.3.2.24 Patch panel

A distributor (see section 1.7.2.9) designed to accommodate the use of patch cords.

1.3.2.25 Protective earth

The earthing of a point in equipment or in a system which is necessary for safety purposes.

1.3.2.26 Sub-duct

A conduit installed within a larger conduit, duct, or trunking.

Note: sub-ducting is used to provide physical or electrical separation between a cable installed within the sub-duct and any service installed within the larger conduit, duct, or trunking.

1.3.2.27 Telecommunications Network Voltage (TNV)

See section 1.7.3: Voltage Classifications.

1.3.2.28 Telecommunications Outlet (TO)

A fixed connecting device to which an end-user may connect terminal equipment to telecommunications cabling.

Note: the use of "end-user" in this definition (as opposed to "customer") implies that the person connecting to TO may or may not have any technical skills or background.

1.3.2.29 Telecommunications Reference Conductor (TRC)

A low noise earthing system providing a zero voltage reference point for telecommunications signalling and other functional purposes which may include equipment reliability.

1.3.2.30 Terminal equipment

Peripheral equipment operated by the end-user to access a telecommunications service.

Note 1: an example of terminal equipment is a telephone instrument, headset, fax machine, modem, or other equipment that may be handled by the customer.

Note 2: terminal equipment is a type of customer equipment. Equipment such as a distributor or CAE is also customer equipment but is not terminal equipment

1.3.2.31 Underground cabling

Cabling that is installed below ground level external to a building.

Note: cabling installed within an underground structure such as a service tunnel is treated as indoor cabling for certain requirements of this standard (e.g. separation from other services).

1.3.2.32 User

See section 1.7.2.6: Customer.

1.3.3 Voltage Classifications

The voltage classifications referred to in this standard are defined as follows. For a summary of the voltage classifications used in this standard, refer to Figure 1.

1.3.3.1 Extra-Low Voltage (ELV)

A voltage not exceeding 42.4 V_{ac} peak or 60 V_{dc}.

Note 1: This definition (taken from AS/CA S009) differs from the ELV definition contained in AS/NZS 3000, which is more closely aligned to the TNV limits described in section 1.7.3.2.

1.3.3.2 Telecommunications Network Voltage (TNV)

A voltage not exceeding 71 V_{ac} peak or 120 V_{dc} if telephone ringing signals are not present and only AC or DC voltage is present in the signal. If telephone ringing signals are present – voltages such that the signal complies with the criteria of either Clause M.2 or Clause M.3 of AS/NZS 60950.1 (the signal is required to be current limited and cadenced). If a combination of AC voltage and DC voltage is present in the signal – voltages such that the following formula is satisfied:

Equation 1

1.3.3.3 Low Voltage (LV)

A voltage exceeding ELV Limits, but not exceeding 1000 Vac peak or 1500 V_{dc}.

1.3.3.4 High Voltage (HV)

A voltage exceeding LV limits, but less than 110 kV_{ac}.

1.3.3.5 Extra-High Voltage (EHV)

For the purpose of this standard (as applicable to TasNetworks), a voltage equal to or exceeding 110 kV_{ac}.

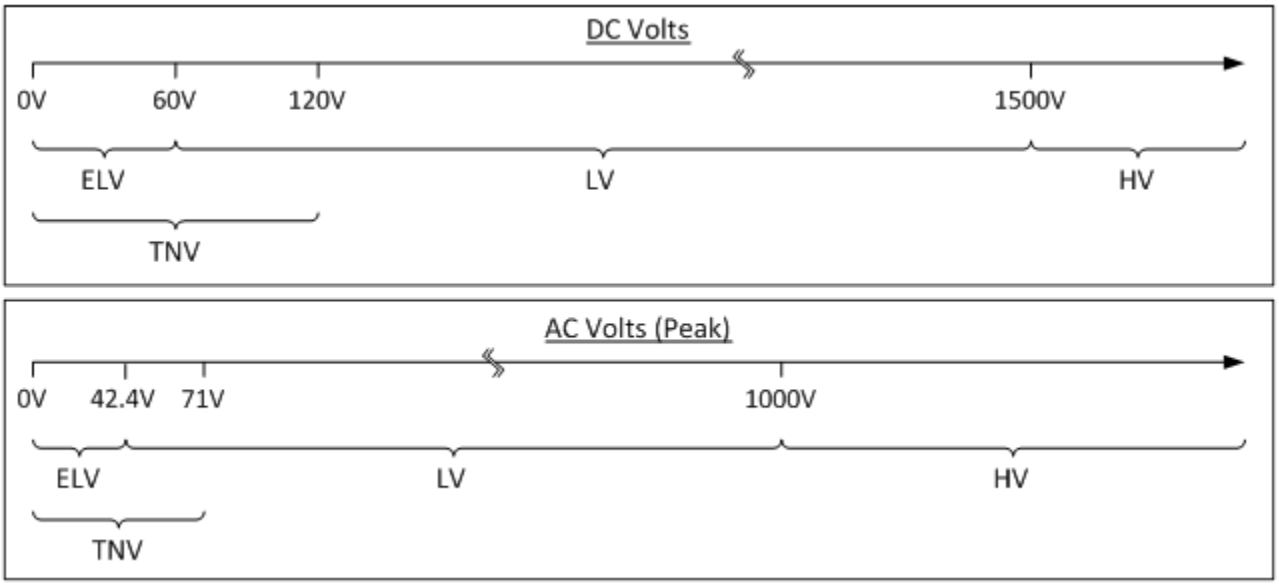


Figure 1 - Voltage classifications used in this standard

2 General requirements

2.1 Manufacturer's Instructions

Cable and equipment installed for connection to TasNetworks' telecommunications network or within a TasNetworks' site shall be installed in accordance with:

- The manufacturer's instructions, including (in the case of cable) such things as cable bend radius, tension, cable tie pressure, colour code, etc.; and
- The instructions provided by the manufacturer or supplier of any equipment to which the cable or equipment is to be connected.

2.1.1 Conflicts with this standard

Any conflict between the manufacturer's instructions and the requirements of this standard should be brought to the attention of TasNetworks for resolution. The requirements of this standard shall take precedence over the manufacturer's instructions.

2.2 Compliance Labelling

Any customer cabling or customer equipment that is subject to a standard under the *Telecommunications Act 1997* and installed by a cabling provider shall be labelled in accordance with the *Telecommunications Labelling Notice*.

Note that earthing and telecommunications power distribution components are not required to comply with the Telecommunications Labelling Notice. These components include (but are not limited to) earthing/power conductors, earthing bars, busbars, earthing/power terminals, line tap devices, earth electrodes and associated fittings, batteries, fuses, and circuit breakers.

2.3 Protection against Damage

All parts of an installation shall be adequately protected against damage which might reasonably be expected to result from:

- mechanical forces;
- exposure to weather;
- water or excessive moisture;
- corrosive substances;
- accumulation of dust;
- steam;
- oil and grease;
- high temperature; or
- Any other circumstance to which they will be exposed under the conditions of their use.

2.1 Proper Use

A cabling product installed at a TasNetworks' site shall be fit for purpose for its intended use. In addition to the requirements of this standard, customer cabling should be installed in accordance with the following standards where relevant:

Table 4 - Types of Cabling

Type of cabling	Applicable standards	Description
Generic cabling for commercial premises	AS/NZS 3080	Generic Cabling – Commercial Premises
Generic cabling for industrial premises	AS/NZS ISO/IEC 24702	Generic Cabling – Industrial Premises
Generic cabling for data centres	AS/NZS ISO/IEC 24764	Generic Cabling Systems for Data Centres
Optical fibre cabling	AS/NZS 60825.1	Safety of Laser Products Part 1: Equipment Classification and Requirements
	AS/NZS 60825.2	Safety of Laser Products Part 2: Safety of Optical Fibre Communication Systems
	AS/NZS 3080	Generic Cabling – Commercial Premises
Coaxial cabling	AS/NZS 1367	Coaxial Cable and Optical Fibre Systems

2.2 Earth Potential Rise (EPR)

All cabling and/or cabling infrastructure at TasNetworks' sites shall be installed with consideration for the hazards associated with Earth Potential Rise. In particular, an engineered solution must be considered in the following scenarios where the cabling may cross the boundary of the site earth mat:

- Cabling which crosses the boundary of any building on the site;
- Cabling which crosses the boundary of any electrical infrastructure region (e.g. the substation fence); or
- Cable which is external to the building where the earth potential rise for that site exceeds 430V.

Any engineered solution shall be certified by a qualified electrical engineer as complying with the principles of AS/NZS 3835.1, as well as satisfying the Manager of TasNetworks' Telecommunications Operations. The cabling provider shall contact TasNetworks' in order to ascertain the extent of the EPR hazard zone before commencing work.

2.1 Earthing

Any earthing cabling or infrastructure shall be installed as per the following standards and codes of practice:

- TasNetworks' Substation Lighting Protection and Earthing Standard; the Installation Requirements for Customer Cabling (Wiring Rules), AS/CA S009; and
- The Extra-Low Voltage DC Power Supplies and Service Earthing within Public Telecommunications Networks standard, AS/NZS 3015:2004 as appropriate.

Satisfying these standards will require the consideration of an engineered solution.

2.1 Low Frequency Induction (LFI)

Any cabling and/or cabling infrastructure which contains electrically conductive elements shall not be installed in a location where proximity to HV or EHV lines may cause 50 Hz induced voltages under a phase-to-earth fault in excess of 430 V_{ac}, except as part of an engineered solution. Any engineered solution shall be certified by a qualified electrical engineer as complying with the principles of HB 101 and HB 102.

2.2 Network Boundary

A clearly defined separation point has been designated in the Telecommunications Act 1997 as the network boundary for the telecommunications network. For all installations the network boundary is defined as:

(a) If there is a main distribution frame in the building, and the line is connected to the frame – the side of the frame nearest to the end user;
(b) The cable terminations at the users equipment is the responsibility of the end-user;
(c) If subparagraph (a) does not apply, if the line is connected to a network termination device (such as optical patch panel) located in or within close proximity to the building – the side of the device nearest to the end-user;
(d) If neither sub-paragraphs (a) or (b) applies but the line is connected to one or more sockets in the building – the side nearest to the end-user of the first socket after the building entry point.

Everything on the telecommunications side of the network boundary including the boundary device itself is the responsibility of TasNetworks' telecommunications network staff, and all works on this side of the boundary shall be carried out by TasNetworks' telecommunications network staff unless explicit permission is granted by the TasNetworks' Telecommunications Operations.

All terminations (installation or removal) at the network boundary shall be made by TasNetworks' telecommunications network staff. User cabling installed by the user, or contractors acting on their user's behalf, shall be left unterminated at the network boundary with sufficient length to allow TasNetworks' telecommunications network staff to terminate.

2.1.1 Cable between Network Boundary and User Device

All telecommunications cables installed on the user side of the network boundary are owned by the user.

Works on the cables between user devices and the network boundary is to be arranged collaboratively between the user(s) and TasNetworks' telecommunications network staff, as follows:

- In the case of the users' capital works, the cable will be provided be the user, or contractors acting on the users' behalf, who will run the cable and provide a coil of spare cable sufficient for termination at the network boundary by TasNetworks' telecommunications network staff;
- The termination of cables on the users' equipment shall be provided as per the users' device

specification. In the case of protection IED signalling, the cable should be terminated directly to the user device and not through an intermediary termination block;

- In the case of operational maintenance on protection and control cables, once the users' equipment is proven, TasNetworks' telecommunications network staff will provide end-to-end testing and if required arrange for replacement of the cable. The user shall identify the appropriate rack and the equipment for TasNetworks' telecommunications network staff in all cases, either directly or by an appropriately authorised users' representative; and
- Testing of cables, as required, shall be carried out as part of end to end service testing and shall be carried out by TasNetworks' telecommunications network staff. The test shall be a bit error rate test, at the applicable service rate, using the service interface type.

2.1 Users' Media Converters

Where possible, a dedicated cabinet for the users' fibre to copper media converters should be provided. This should be situated as close to the communications cabinet(s) as possible. The cabinet location shall be negotiated with TasNetworks' telecommunications design staff, however installation within a dedicated site telecommunications room should be avoided.

This cabinet and all of its contents shall be the responsibility of the user(s) and as such all installations and maintenance in the cabinet shall be performed by the user(s) or contractor(s) acting on their behalf.

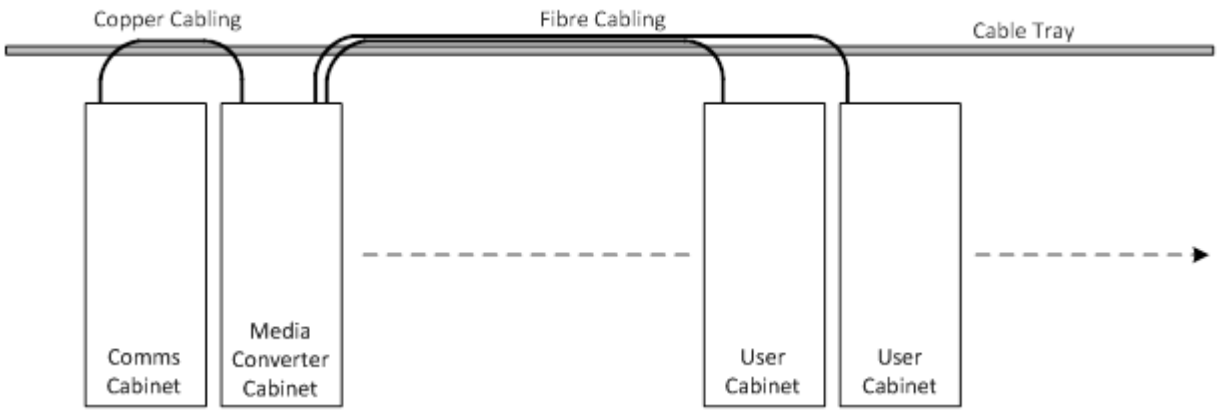


Figure 2 - Ideal user media converter cabinet location

3 Detailed Requirements for User Communications and Data Cabling in Substations

3.1 Cable Support Systems

Any electrically conductive support system for cables shall be connected to the site's protective earth and equipotentially bonded. This includes metallic cable trays, conduits, trunking systems, distribution frames, mounts, enclosures, racks, cabinets, or catenary supports.

Note the distinction between the protective earth system and the telecommunications reference conductor (TRC). The TRC shall not be used as a protective earth.

3.1.1 Cable Ducting

In all new equipment areas (new buildings, building extensions, or newly established areas in existing buildings) where data cabling (fibre optic or electrical) is run over a distance that is greater than between two adjacent racks, it shall be run in dedicated ducting. The ducting shall be fibre optic cable duct, and shall be orange in colour. In TasNetworks' electricity infrastructure sites, these orange duct systems shall be for the sole purpose of housing fibre optic cables carrying substation LAN and protection data. No cable, duct, or conduit of any other type may be laid in, fixed to, or otherwise restrict access to the fibre optic cable duct and its contents. Conversely, fibre optic cable duct shall not be installed in such a way that it impedes access to any other cabling or cabling infrastructure.

Fibre optic cable duct shall be labelled at appropriate intervals with a suitable warning that it may contain hazardous light sources.

3.1.1.1 Further Recommendations for User Communications Cabling within TasNetworks' Electrical Infrastructure Sites

In all new installations for substation LAN and protection cabling, 4" (100 mm x 100 mm) orange fibre optic cable duct should be installed in such a way that lengths of the tray pass above each new cabinet, and interconnect at regular intervals. Above each cabinet, a fixed exit with convoluted tube section of cable tray should be installed, and a 35mm section of convoluted tube run down into the cabinet. This tube should then be interfaced to a section of 50 mm flexible ducting which can be installed in the cabinet in such a way that appropriately distributes communications cabling around the cabinet.

The particular products used are at the discretion of the installer, providing they fulfil the requirements listed above and are easily and appropriately interfaced with any existing infrastructure. Examples of fibre optic cable management and preferred products are shown in the following figure and table.

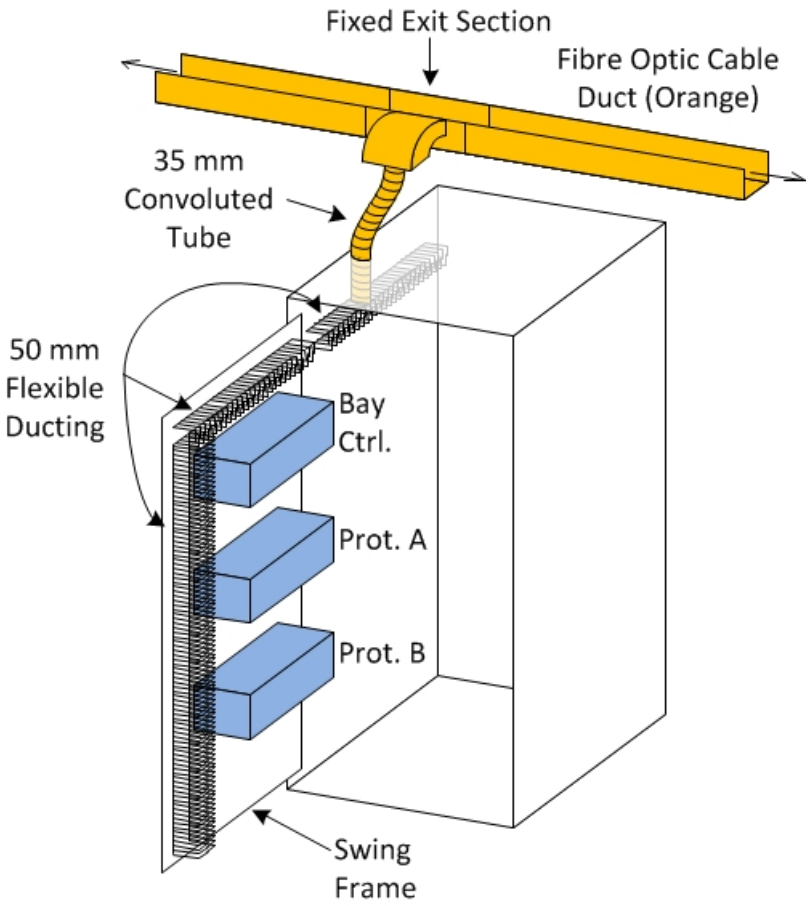


Figure 3 - Example of intended cable ducting in protection and control cabinets

Table 5 - Example recommended product ranges for fibre optic cable management

Manufacturer	Product Range
Codecom	Fibre Optic Cable Tray
Panduit	Type FL Flexible Wiring Duct

3.2

3.3 Electrical Signals

3.3.1 Electrically Conductive Data Cabling

All new electrically conductive signalling cable installed in a TasNetworks substation shall be shielded twisted pair cable. The only exception to this is cabling that is entirely internal to a rack or cabinet, in which case the twisted pair cable may or may not be shielded. Inter-rack cabling shall be

- equipped with both a low-frequency noise shielding braid and a high-frequency noise shielding foil;
- strong enough to be laid in existing conduit without protection; and
- Of appropriate electrical parameters (especially characteristic impedance) for the communications protocol being used. Refer to the following table for list of communications protocols and their corresponding characteristic impedances.

Note: For the purpose of shielding, metallic armour is not considered a shield for EMI and RFI.

Table 6 - Common communications protocols and their required cable characteristic impedances

Communications Protocol	Required Characteristic Impedance (Ohms)	Suggested Cable (or Equivalent)
G.703	120	Belden 9844
V.28 / V.24 / RS232	Not specified	Belden Datatuff 7921
V.35 / V.11 / RS485 / RS422	100	Belden Datatuff 7921 / Belden 9844
Ethernet (Twisted Pair)	100	Belden Datatuff 7921

Where new equipment areas (new buildings, building extensions, or newly established areas in existing buildings) interface with existing equipment areas, the interconnecting electrically conductive cable can be laid in the existing control cable trays without a protective conduit, but shall meet the TasNetworks LV and HV cable standards as well as the above specifications.

The requirements of AS/CA S009 – 2013 shall be complied with for cable installations. In particular section 9 details the mandatory requirements for the separation of telecommunications services from hazardous electrical and non-electrical services.

3.1.1 Sub-Ducting

User cabling (whether electrically conductive or otherwise) shall not be sub-ducted within another duct.

3.1.2 Earthing of Shielded Cables

The drain wire of any shielded cable shall be terminated on the user's communications device frame earth, and remain unterminated at the network boundary device.

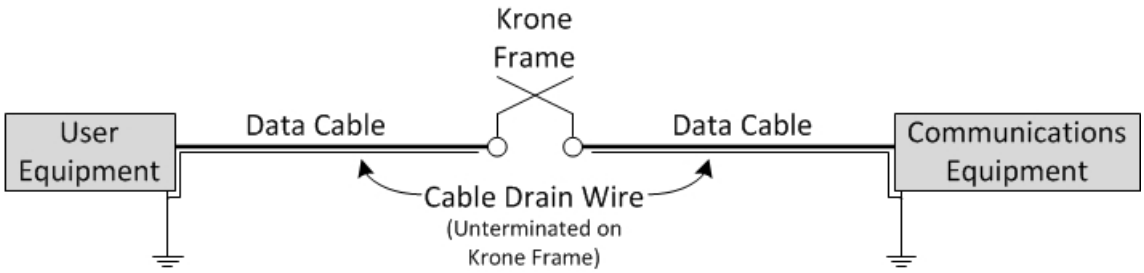


Figure 4 - Correct earthing of electrically conductive twisted pair cabling between equipment and a Krone frame

3.1.3 Terminations on a Krone Frame

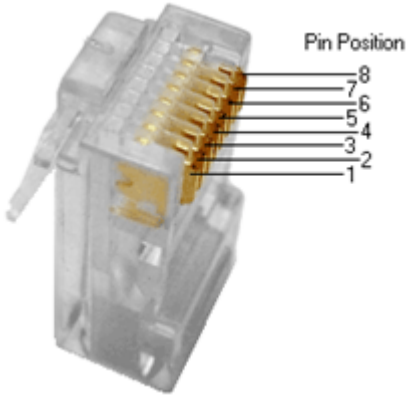
All user cables to be terminated on a Krone frame (i.e. all cables that facilitate an interface between the user and the telecommunications equipment, whether carrying Ethernet or serial communications) shall meet the requirements described in Section 3.3.1. User cables for termination on the Krone Frame shall be 24AWG non-stranded with a foil and braid shield.

For information on responsibilities associated with terminating cables on the Krone frame, refer to Section 2.8.

3.1.4 Terminations on an 8P8C (RJ45) Socket

All data cabling terminated on an 8P8C (commonly referred to as RJ45) socket, shall be terminated with a metal connector, i.e. not plastic. The metal connector shall be bonded to the drain-wire or shield of the cable for earthing purposes, as per Section 3.3.3. The twisted pair termination shall be as per TIA-EIA 568B (i.e. straight-through as opposed to cross-over), shown in the following table.

Table 7 - TIA-EIA 568B 8P8C termination colour code

Pin Number	Pair Number	Colour	Pin Numbering
1	2	white/orange	
2	2	orange	
3	3	white/green	
4	1	blue	
5	1	white/blue	
6	3	green	
7	4	white/brown	
8	4	brown	

3.2 Optical Signals

3.2.1 Fibre Optic Cabling

Where new equipment areas (new buildings, building extensions, or newly established areas in existing buildings) interface with existing equipment areas, the interconnecting fibre optic cable can be laid in the existing control cable trays without a protective conduit, but shall be a 'tactical' optical fibre cable. Tactical in this context refers to fibre optic cables that are much stronger, more rugged, and survivable than standard fibre optic cables. Note that riser cables do not conform to the tactical classification.

All inter-rack fibre optic cabling shall be multi-mode riser cable. The cable size shall be matched to any existing fibre to which it connects and for the equipment it is connecting to. Where there are no other factors limiting the core size the fibre to be used is multi-mode fibre with a core diameter of 50µm.

Under no circumstances may unlike diameter fibre optic cables or ports be connected together, for example 62.5µm multi-mode cable shall not be mated with 50µm multi-mode cable, and any multi-mode cable shall not be mated with a 9µm single-mode cable, etc. Fibre optic equipment ports and existing fibre optic infrastructure must be examined to determine the intended cable termination before ordering patch or riser cables.

All fibre optic cabling that is run underfloor in existing trenching and cable supports shall be tactical fibre optic cabling.

3.2.1.1 Patch Cords

Fibre optic patch cords to be installed on a TasNetworks' site, shall be chosen by the cabling provider, shall be compatible with the equipment and other fibres to which it is connecting and shall comply with all relevant Australian standards and the requirements listed below.

The fibre core size in the optical patch cords shall be matched to the fibre core size of any cable to which it connects.

Fibre optic patch cords shall only be used for patching within a rack, from termination to equipment. Any inter-rack connections shall be made with a riser cable, as specified in Section 3.4.1.

3.2.1.2 Multi-core Patch Cords or Riser Cables

Multi-core patch cords or riser cables to be installed on a TasNetworks' site, shall be chosen by the cabling provider, shall be compatible with the equipment and other fibre to which it is connecting and shall comply with all relevant Australian standards and the requirements listed below. In particular, any buffer tubes, the optical fibre cladding, and the optical fibres themselves must be marked by a coloured coating with different colours according to ANSI/TIA/EIA 598-C and, more specifically, ANSI/EIA 359-A (see the following for an example).
Multi-core patch cords or riser cables shall be chosen appropriately to endure the environment they will be installed in, with consideration of crushing, bend radii, weathering, UV (sunlight), chemicals, and any other environmental factors. As per the requirements of Section 2.38

Table 8 - An example of fibre optic colour coding for a 12-core fibre separated into three buffer tubes

Buffer Tube Number	Buffer Tube Colour	Fibre Number	Fibre Colour
1	Blue	1	Blue
		2	Orange
		3	Green
		4	Brown
2	Orange	5	Blue
		6	Orange
		7	Green
		8	Brown
3	Green	9	Blue
		10	Orange
		11	Green
		12	Brown

3.2.2 Fibre Optic Cable Terminations

Where it is not dictated by the equipment being used, or when there is an option to choose the type of fibre optic cable terminations used, for example when selecting a fibre optic patch panel or when equipment port types can be defined at the time of order, Protection and Control fibre optic terminations shall be of type ST (Stab-Twist), or, when higher connector density or SFP's are required, LC (Little Connector), in particular, MT-RJ (Mechanical Transfer Registered Jack) connectors shall not be installed.

Figure 5 - ST Connector and feed-through

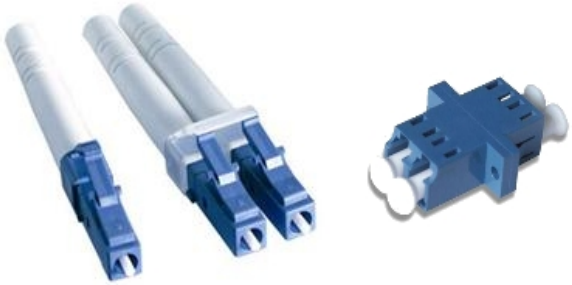


Figure 6 - LC Connectors (left: simplex, centre: duplex) and feed-through

Under no circumstances may unlike connectors be connected together, even if they seem to fit together well (for example an SC connector will seem to fit to an SC/APC feed-through), as this will cause damage to both sides of the fibre termination.

3.2.3 Substation LAN Cabling

Substation LAN Ethernet ring cabling shall be fibre optic cabling which complies with the above specifications.

3.2.4 Fibre Optic Patch Panels

All users' cabling to be terminated on a fibre optic patch panel performing the function of a Network Boundary (see Section 2.8) should be run to the patch panel by the user or the contractor acting on their behalf, but shall not be terminated on the patch panel. The termination shall be carried out by TasNetworks' telecommunications network technical staff or a contractor acting on their behalf.

Where intra-site multi-core fibre optic cables are terminated, a Belden Modular Industrial Patch Panel (MIPP) or equivalent fibre optic break out tray (FOBOT) shall be used, fitted out for both ST and LC terminations. The MIPP shall be chosen such that at least 20% of the total available ST terminations and 20% of the total available LC terminations are spare at the completion of the work to be undertaken. Alternatively, the DIN rail that the MIPP is mounted on can be left with sufficient space to install at least one more MIPP double module.

3.2.5 Fibre Optic Cable Splicing

Any fibre optic cable splices performed on cables that are or will be owned or utilised by TasNetworks shall achieve a maximum loss of 0.2 dB Any new splices made shall be tested immediately after splicing to ensure that this requirement is met.

4 Detailed Requirements for TasNetworks' Telecommunications Network Cabling

4.1 Cable Support Systems

Any electrically conductive support system for cables shall be connected to the site's protective earth and equipotentially bonded. This includes metallic cable trays, conduits, trunking systems, distribution frames, mounts, enclosures, racks, cabinets, or catenary supports. Note the distinction between the protective earth system and the telecommunications reference conductor (TRC). The TRC shall not be used as a protective earth.

4.2 Electrical Signals

4.2.1 LV Telecommunications Circuits

Any cable carrying an LV telecommunications circuit that exceeds the limits of the Telecommunications Network Voltage (TNV) shall be clearly identifiable at any access point as well as separated from other services as described below.

A cable carrying an LV telecommunications circuit shall not be installed in the same conduit or duct as a cable carrying an ELV or TNV circuit unless it meets the criteria stated in Clause 8.3.3.2 of AS/CA S009.

4.2.2 Electrically Conductive Data Cabling

All new electrically conductive signalling cable installed in a TasNetworks' electrical infrastructure site or telecommunications site shall be shielded twisted pair cable. The only exception to this is cabling that is entirely internal to a rack or cabinet, in which case the twisted pair cable may or may not be shielded. The exact cable to be used is at the discretion of the cabling provider; however some recommended cables are listed in the following Table. In all cases, the cable shall be appropriately chosen to match the characteristic impedance of the communications protocol being used.

The requirements of AS/CA S009 – 2013 shall be complied with for cable installations. In particular section 9 details the mandatory requirements for the separation of telecommunications services from hazardous electrical and non-electrical services.

Table 9 - Some Recommended Electrical Telecommunications Cables

Manufacturer	Cable	Notes
Belden	Datatuff	Foil-shielded, has low-frequency noise shield (braid)
Panduit	PFL6004 BU-G	Foil-shielded, Cat-6, smaller diameter, superior flexibility
Panduit	TX6A-SD	Un-shielded, Cat-6a, small diameter, very flexible, de-rated to 70 meter maximum cable channel – ideal for intra-rack cabling

4.2.3 Earthing of Shielded Cables

The drain wire of any shielded cable shall be terminated on the communications equipment frame earth, and remain unterminated at the Krone frame

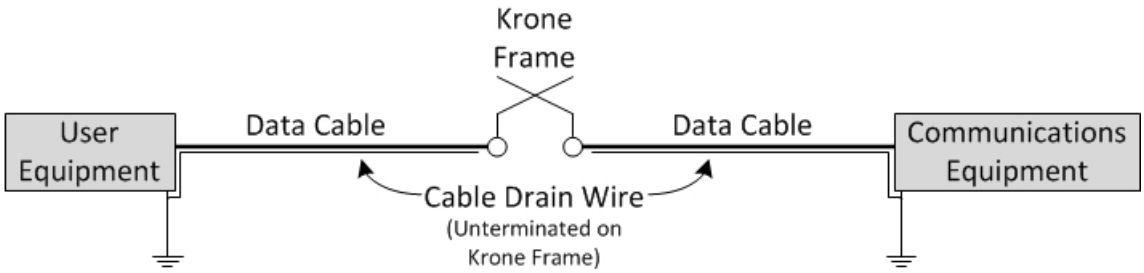


Figure 7 - Correct earthing of electrically conductive twisted pair cabling between equipment and a Krone frame

4.2.4 Sub-Ducting

Electrically conductive data or signalling cabling shall not be laid in the same conduit or duct as any HV or greater service. Electrically conductive data or signalling cabling shall not be laid in the same conduit or duct as any LV service, unless it is sub-ducted within that conduit or duct.

4.2.5 Terminations on a Krone Frame

All terminations on a Krone block shall be performed using the appropriate Krone termination tool. This is to prevent damage to the terminal post which could necessitate replacement of the entire Krone block, potentially disrupting one or many critical circuits. All cables terminated on a Krone frame shall be solid core and of an appropriate cross-sectional area for the particular Krone terminal being used.

4.3 Optical Signals

4.3.1 Fibre Optic Cabling

Where new equipment areas (new buildings, building extensions, or newly established areas in existing buildings) interface with existing equipment areas, the interconnecting fibre optic cable can be laid in the existing control cable trays without a protective conduit, but shall be a "tactical" optical fibre cable. Tactical in this context refers to fibre optic cables that are much stronger, more rugged, and survivable than standard fibre optic cables. Note that riser cables do not conform to the tactical classification.

All fibre optic cabling that is run underfloor in existing trenching and cable supports shall be tactical fibre optic cabling.

4.3.1.1 Patch Cords

Fibre optic patch cords to be installed on a TasNetworks' site may be chosen at the discretion of the cabling provider and shall comply with all relevant Australian standards and the requirements listed below.

4.3.1.2 Multi-core Patch Cords or Riser Cables

Multi-core patch cords or riser cables to be installed on a TasNetworks' site, may be chosen at the discretion of the cabling provider, and shall comply with all relevant Australian standards and the requirements listed

below. In particular, any buffer tubes, the optical fibre cladding, and the optical fibres themselves must be marked by a coloured coating with different colours according to ANSI/TIA/EIA 598-C and, more specifically, ANSI/EIA 359-A (see **Error! Reference source not found.** for an example).

Multi-core patch cords or riser cables shall be appropriate to endure the environment they will be installed in, taking consideration of crushing, bend radii, weathering, UV (sunlight), chemicals and any other environmental factors as per section 2.3.

4.3.2 Fibre Optic Cable Ducting

Where fibre optic cable is run over a distance that is greater than between two adjacent racks, it shall be run in dedicated ducting. The ducting should be capable of interfacing with Codecom Fibre Optic Cable Tray. Communication Services ducting shall be yellow in colour.

These duct systems shall be used solely for fibre optic cables and no cable, duct, or conduit of any other type may be laid in, fixed to, or otherwise restrict access to the fibre optic cable duct and its contents. Conversely, fibre optic cable duct shall not be installed in such a way that it impedes access to any other cabling or cabling infrastructure.

Fibre optic cable duct shall be labelled at appropriate intervals with a suitable warning that it may contain hazardous light sources.

4.3.3 Fibre Optic Cable Terminations

Where it is not dictated by the equipment being used, or when there is an option to choose the type of fibre optic cable terminations used, for example when selecting a fibre optic patch panel or when equipment port types can be defined at the time of order, Communication Services fibre optic terminations shall be of type SC/APC (Square Connector / Angled Physical Connection), or, when higher connector density or SFPs are required, LC (Little Connector). This is in order to maintain a maximum connector loss by minimising reflections and back-scatter.

Note that the green colour of the SC/APC connector denotes the angled face of the fibre. These green connectors will only safely interface with other SC/APC connectors and shall therefore only be connected to another green connector through a specific green coloured thru-connector. Under no circumstances shall a blue thru-connector be used with green SC/APC connectors or a green thru-connector is used with the blue standard SC connectors. The blue and green connectors are not compatible, and attempting to connect them will cause damage to both sides of the fibre termination.

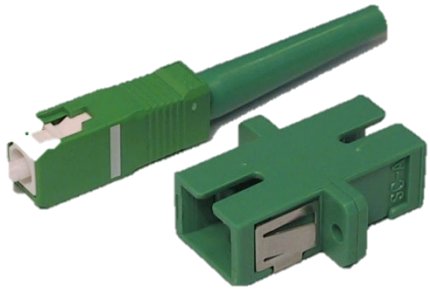


Figure 8 - SC/APC Connector and feed-through

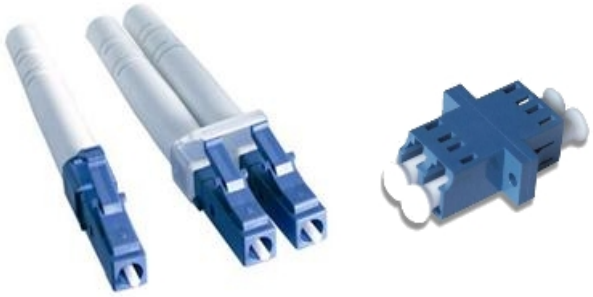


Figure 9 - LC Connectors (left: simplex, centre: duplex) and feed-through

4.3.4 Fibre Optic Patch Panels

At sites where an inter-site fibre optic cable (such as OPGW, ADSS, or OPUC) is terminated, the termination of such a cable should be in a dedicated fibre termination cabinet, if there is available room. If there is to be a significant number of inter-site fibre optic cable terminations (more than three), at the time of work or in the foreseeable future, the termination of the cables shall be in a dedicated fibre termination cabinet. Within this cabinet, patch panels shall be either AFC or MSS brand. Care shall be taken to ensure that closing the door of the cabinet does not squash and damage the fibres terminated on the patch panel. This problem can be mitigated by ordering patch panels with the terminations on an angle (for example 45degrees to the door), or installing the patch panel deeper in the rack.

A fibre termination cabinet shall be fitted out for neat and efficient cable management. This includes (as a minimum):

- A swing frame if the rear of the cabinet is inaccessible;
- A vertical finger duct on each of the two front rails;
- A 1 RU fibre management drawer directly below each patch panel; and
- Punched sections at regular intervals on each side of the rack for coiling excess incoming multi-core cable.

Rittal cabinets have been used as appropriate fibre termination cabinets, and examples of useful parts for fibre management are included in the following table.

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Table 10 - Example components for Rittal cabinet fibre management

Component	Rittal Part Number
Vertical finger duct	TS-8800.750
1 RU fibre management drawer	DK-1063.200

At sites where demand is not likely to increase and only one or two inter-site cables are terminated, a "wall-box" style patch panel can be used, although a dedicated cabinet is still preferable. When installing a wall-box patch panel, the panel must be selected such that at least 24 spare ports are available after the current work has been completed. This is to minimise the number of wall-box patch panels at a site in the case of unforeseen future expansion.

The fibre optic termination cabinet or any other fibre optic patch panel enclosure (for example a wall-box style patch panel) and any patch panels contained within are the responsibility of the TasNetworks; TasNetworks' Telecommunications Operations Group. As such they shall be purchased, installed, and maintained by the TasNetworks' Telecommunications Operations Group. This includes record-keeping (see below). All users' cabling to be terminated on the fibre optic patch panel should be run to the patch panel by the users' or the contractors acting on their behalf, but shall not be terminated on the patch panel. The termination shall be carried out by a member of the TasNetworks' Telecommunications Operations technical staff or a contractor acting on their behalf.

4.1.1.1 Fibre Optic Patching Records

Upon installation of a new fibre optic patch panel, a patching record shall be created. Existing records are located in the TasNetworks' Document Management Systems, and the format of any new record should be based upon an existing one before being saved in the same location. Only information that is known should be documented in the record – any information that is suspected but not known, or simply unknown, should not be recorded but a note made to be confirmed. Hardcopies of the records shall be made available on site, and kept in close proximity to the patch panel.

When patching is to be altered or added to, the records shall be consulted prior to works commencing to ensure that no existing services will be disrupted. Once work is completed, the records (online and on-site) shall be updated to reflect any changes made.

4.1.2 Fibre Optic Cable Splicing

Any fibre optic cable splices performed on cables that are or will be owned or utilised by TasNetworks' shall achieve a maximum loss of 0.1 dB Any new splices made shall be tested immediately after splicing to ensure that this requirement is met.

4.2 IEEE 802.11 Wireless Signals

4.2.1 IEEE 802.11 Wireless Access Points

All IEEE 802.11 wireless access points installed at TasNetworks' sites shall be powered by Power over Ethernet (PoE) either directly from the Ethernet source device or via a dedicated PoE injector device. Under no circumstances should an IEEE 802.11 wireless access point be powered directly using the DC input jack.