Cabling of premises for telecommunications

A complete guide to home cabling

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Summary

This document provides detailed guidance to developers, builders, electricians, telecommunications cabling providers and consumers about the installation of telecommunications cabling when building or renovating a home. For summary guidance, refer to Telstra Document No. 017153a01, *Cabling of premises for telecommunications — Essential information for home cabling*.

Please think twice about printing this document for reading or future reference. If you need it away from the office, save it to your tablet or portable computer and enjoy the advantages of being able to use the hyperlinks, document search functions and on-screen magnification of photographs and drawings.

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1 PURPOSE

The purpose of this document is to provide general information and detailed technical guidance to developers, builders, electricians, telecommunications cabling providers ("cablers") and consumers about cabling a home for **broadband**, **telephone** and some **entertainment services** that may be supplied using any of the following telecommunications network technologies:

- copper twisted pair cable used for telephone and ADSL (Asymmetric Digital Subscriber Line) services
- HFC (Hybrid Fibre-Coax) — otherwise known as "Cable" (for Cable internet and Cable pay TV)
- FTTP (Fibre To The Premises) — for telephone, broadband and, in some cases, TV services
- Satellite — for broadband and, in some cases, telephone services
- 3G (3^{rd} Generation) or 4G (4^{th} Generation) wireless — for broadband and, in some cases, telephone services.

This document describes home cabling systems that are suitable for connection of telecommunications services independent of the type of telecommunications network technology used to supply the services. In particular, the practices described in this document are intended to be compatible with the National Broadband Network (NBN) to which all homes are expected to be connected eventually.

For any building in a development where NBN Co has already rolled out optical fibre and the fibre is ready and capable of connection or the rollout of optical fibre is imminent, please refer to the relevant cabling documents published by NBN Co at http://www.nbnco.com.au/getting-connected/index.html.

This document provides detailed guidance, including explanatory information, and is intended to be a reference document to the summary guidance provided in Document No. 017153a01, *Cabling of premises for telecommunications — Essential information for home cabling*.

The Telstra documents may be downloaded from the "Builders" menu of the Telstra Smart Community® website (www.telstra.com.au/smart-community/builders/).

2 SCOPE

This document applies to any building constructed for use as a **home** or to conduct a **small business**. It applies to detached buildings (single dwellings) as well as semi-detached buildings (town houses, villas, etc.). Certain aspects of this document may also be applied to the internal cabling of residential apartments. While the document generally describes cabling for **new buildings** ("greenfield"), it may also be applied to rewiring of **established buildings** ("brownfield").

3 ABOUT THIS DOCUMENT

This document is a collection of information, ideas and recommendations that has been written for a **varied audience** — from the unskilled (e.g. consumers) to the skilled (e.g. registered communications cablers). Therefore, it necessarily covers the basics as well as more advanced topics. However, it is generally confined to **cabling** matters and does not cover, for example, programming of equipment.

The intention is to provide guidance to:

- **consumers** who may be wondering how to prepare their new home for the installation of current and future telecommunications services (noting that the cabling must be installed by a registered cabler)
- **developers** and **builders** who need to know what is required to prepare the home for connection of telecommunications services
- **electricians** who may be required to provide some of the telecommunications facilities
- **registered telecommunications cablers** who need to be able to provide advice to consumers on their cabling options and install the cabling to meet the consumer's and the carrier's requirements.

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4 INTRODUCTION

4.1 What are broadband services?

"Broadband" (also sometimes referred to as "wideband") is the general term used to describe facilities or services that operate at higher frequencies or digital bit rates ("data speeds") than are necessary to transmit the human voice (e.g. for high-speed access to the internet).

Voice transmission is carried over the telephone network within the frequency range of 300 Hz to 3400 Hz or over digital systems within a 64 kbps (64,000 bits per second) bandwidth or less. Voice grade transmission is often referred to as "baseband" or "narrowband".

4.2 What is the National Broadband Network?

The National Broadband Network (NBN) is a telecommunications network that is being constructed by NBN Co Limited, a company established by the Commonwealth Government in 2009 to provide access to high-speed broadband services by all Australian residents by the year 2021.

Ultimately, NBN Co intends to provide up to 93% of homes, schools and workplaces with access to optical fibre cabling capable of supplying broadband services with speeds of 100 Mbps (100 million bits per second), with the balance being connected via fixed wireless or satellite technologies capable of supplying broadband speeds of 12 Mbps (12 million bits per second).

The NBN requires the installation of electronic equipment in the customer's home and a dedicated power point — even if the customer only wants a basic telephone service. The telecommunications services are also wired from within the home (i.e. from the NBN equipment) instead of from outside the home.

Typical NBN equipment is illustrated in Figure 1.

For more information, go to the NBN Co website at www.nbnco.com.au.

4.3 Standards

Requirements for the installation of customer premises cabling are set out in several standards and handbooks, some of which are listed below. These describe the installation of a system of cabling referred to as **generic cabling**, which is explained in 4.5. These publications are not mandatory but they can be enforceable under a contract or agreement between two or more parties, e.g. under the terms of a cabling contract between a builder or customer and the cabling installer.

The only mandatory cabling standard in Australia is Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*. This standard is enforced through the registration conditions of registered telecommunications cabling providers ("cablers") but it only sets out the minimum safety and interoperability requirements for certain cabling where such cabling is to be installed. It does not provide guidance about, for example, what method to use for cabling a home.

Australian standards and associated handbooks for the design and installation of **generic cabling** are:

- AS/NZS 3080, *Telecommunications installations — Generic cabling for commercial premises* (based on international standard ISO/IEC 11801)
- HB 29, *Communications Cabling Manual Module 2: Communications cabling handbook* (based on AS/NZS 3080)
- AS/NZS ISO/IEC 15018, *Information technology — Generic cabling for homes*
- HB 252, *Communications Cabling Manual Module 3: Residential communications cabling handbook* (based on AS/NZS ISO/IEC 15018).

At the time of writing, all of the above publications **pre-dated the NBN** and lacked practical detail in at least some aspects of telecommunications cabling. This Telstra document is intended to **update and complement**, not replace, the above standards and handbooks.

4.4 Other documents

The following documents published by the International Copper Association Australia (ICAA) (www.smartwiredhouse.com.au) may also be of interest to consumers who are building a new home:

- *Code of Practice for Home Wiring*
- *Quick Guide to Smart Wiring™*
- *Installer Cabling Handbook for Residential Wiring*.

While the above documents include NBN requirements and have a broader scope than this Telstra document – embracing additional facilities such as home automation (lighting and power control), energy management, security, and home health – they lack practical detail. For further details, refer to 10.3.8.

4.5 What is generic cabling?

The expression “generic cabling” is used to describe a **structured cabling system** that is designed to support the **flexible interconnection** of telecommunications services that may be supplied via various telecommunications network technologies (these are explained in 4.12) and which may be used in various ways. The basic principle of generic cabling is demonstrated in Figure 3.

Generic cabling provides flexibility for adaptation to any consumer requirements such as sharing of telephone and broadband services and interconnection of computer and media equipment. Generic cabling will usually meet the needs of the consumer (occupant) when the consumer’s needs are unknown and will ensure that the home is “**NBN ready**”.

4.6 What happens if I don’t cable my home properly?

Carriers and service providers are not required to pre-wire premises and the responsibility to ensure that the home is pre-wired for telecommunications services rests with the builder, owner or customer. If the home is not suitably pre-wired, the carrier or service provider is not obliged to conceal any necessary cabling in the building cavities and may elect to install the cabling on the surface of walls or ceilings.

If the home is not cabled in accordance with this guideline, while the consumer may still be able to gain access to services that are available in the area, failure to properly cable the home may result in:

- installation delays
- cabling on the surface of external and internal walls that the occupant may regard as unsightly
- additional installation costs, especially if concealed cabling is preferred
- inconvenient location of equipment and access points
- limited access to the telecommunications services from multiple access points
- the inability to use some high-speed data applications such as IPTV and media networking
- low flexibility or additional cost for adjusting to any changes in technology or future personal needs.

4.7 What about wireless?

While wireless (“Wi-Fi”) technology used in homes is improving all the time, it does not work well through masonry or metallic walls and its application is ultimately limited by the available frequency bands and the number of concurrent users. Wi-Fi will always have its place in a wired home and may meet the current needs of some consumers. However, it cannot be relied on to provide access to high-speed digital applications (such as high definition IPTV, media streaming and video calling) in all situations. It is also inadequate for the speedy exchange of large files between computers or network storage devices.

The main advantage of Wi-Fi is that it provides casual access to the home network using portable devices such as notebook computers, tablets and “smartphones”. For this reason, notwithstanding its limitations, the home cabling system should include at least one wireless access point (see 10.6).

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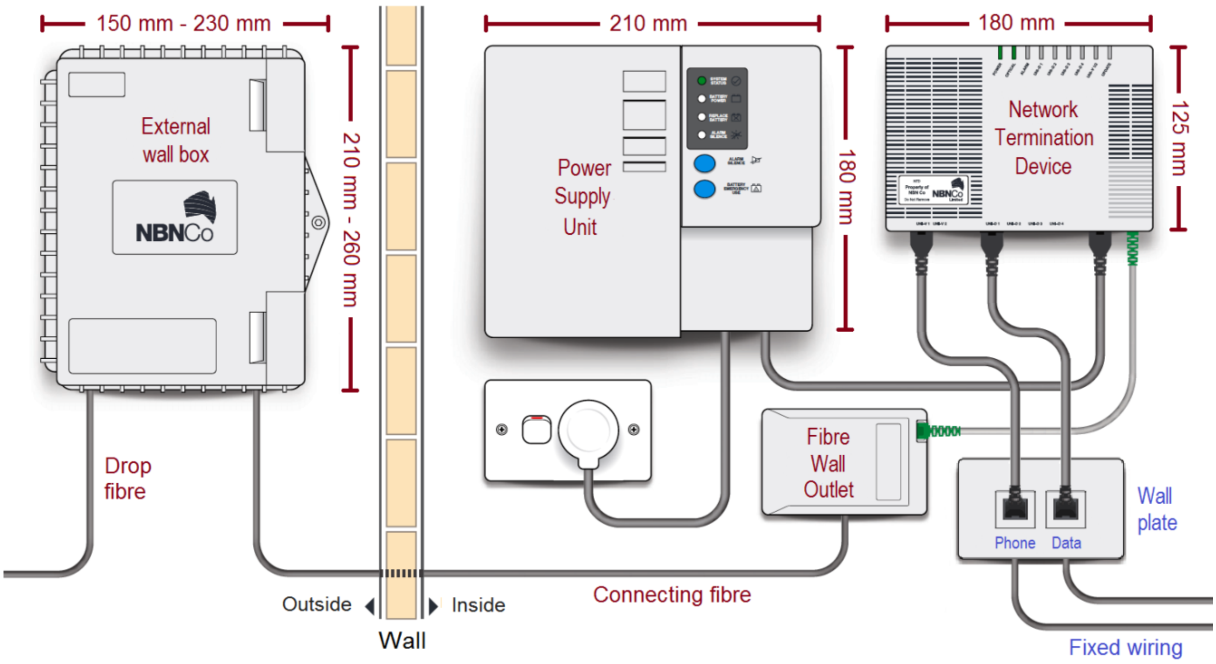
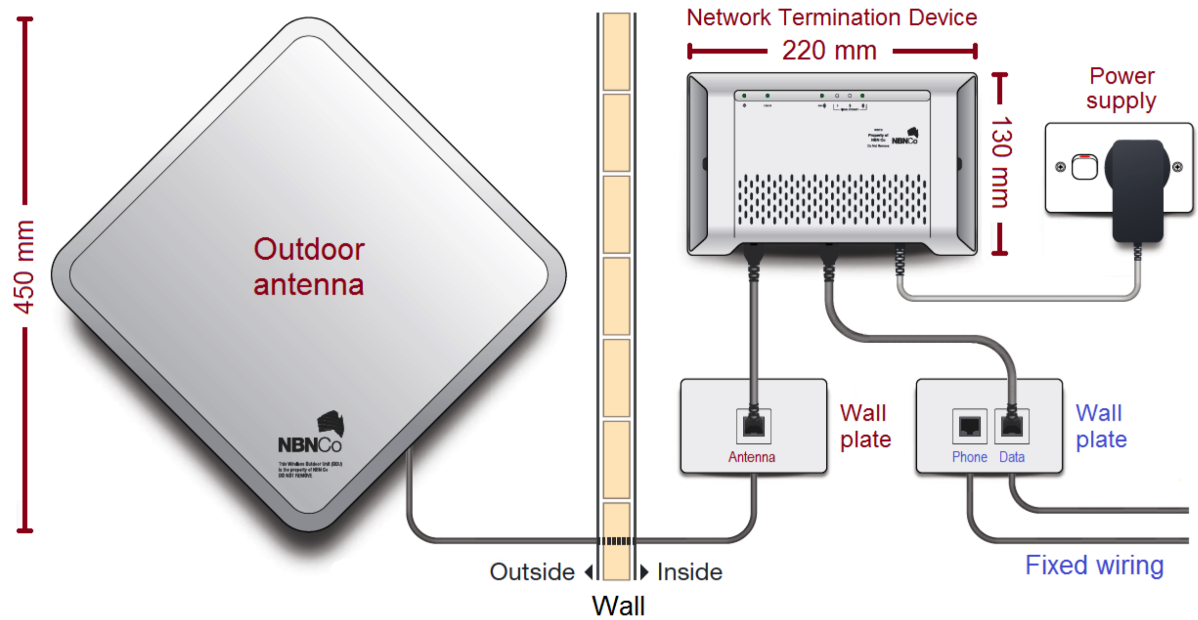
Figure 1 Basic components of typical NBN installations

(a) Fibre To The Premises (FTTP)



(b) 4G fixed wireless



Note: Refer to Figure 19 on page 31 and Figure 93 on page 120 for descriptions of the above equipment.

4.8 Home cabling requirements have changed!

Traditional cabling methods used for telephone and ADSL services are not compatible with the NBN.

4.8.1 Previous requirements ("legacy cabling")

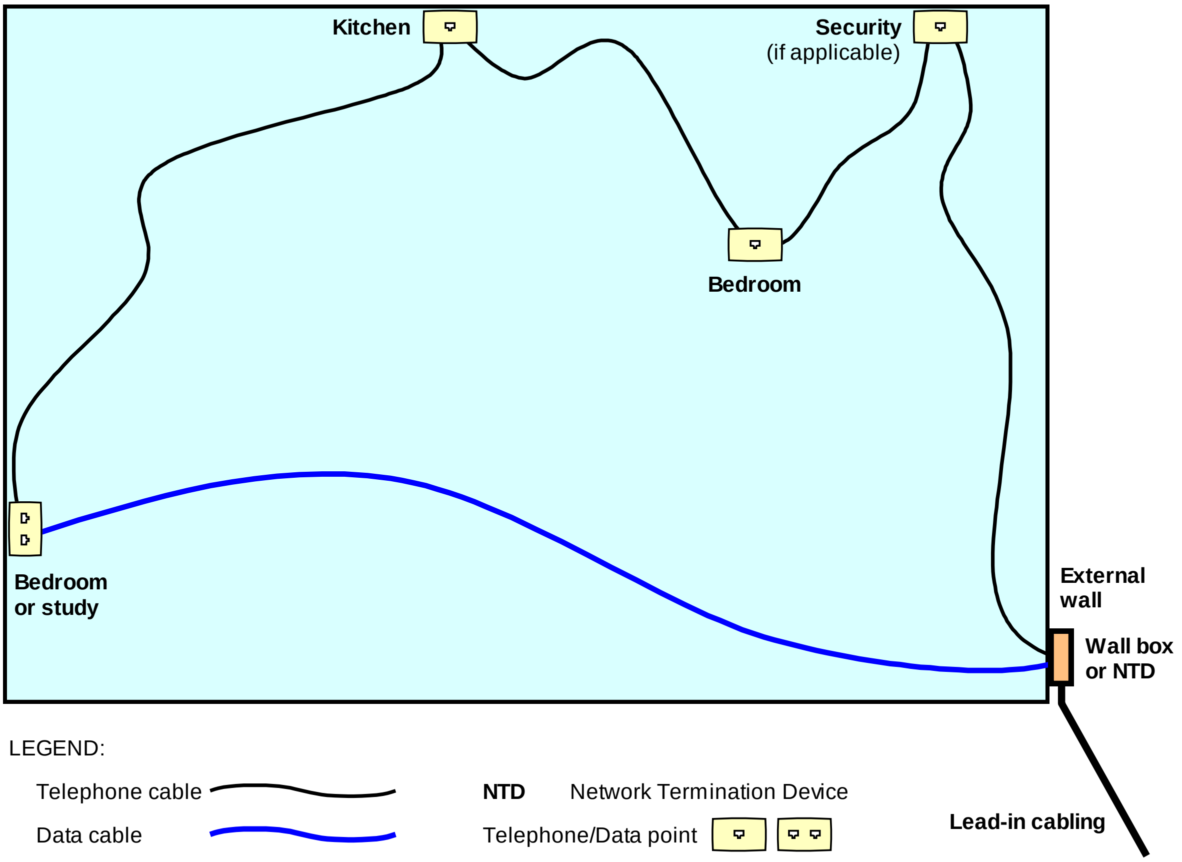
Traditionally, telephone and ADSL access points (outlets) have been wired sequentially from an external connection point (e.g. a wall box), as shown in Figure 2. In some cases, a separate cable may be installed between an external Network Termination Device (NTD) or a central ADSL splitter and an access point for connection of an ADSL modem (also shown in Figure 2).

Either telephone cable (two to three pairs) or data cable (four pairs) could be used with this cabling method.

This type of cabling is often referred to as "legacy cabling" because it is a legacy from a bygone era when telephones were the primary means of communicating with other persons outside the home.

This method of cabling is unsuitable for new homes as it will not support modern telecommunications services, especially data services supplied via the NBN.

Figure 2 An example of conventional telephone/ADSL home cabling



Note: This type of cabling is often referred to as "legacy cabling" and is an unsuitable cabling method for modern telecommunications services, especially NBN data services.

4.8.2 New requirements ("generic cabling")

Modern telecommunications services – especially NBN services – require the installation of **locally powered electronic devices** that are **located inside** the customer's building, unit or apartment.

With modern telecommunications services, access points (outlets) should be cabled radially ("star wired") from an internal **central connection point (CCP)** located next to the powered electronic devices, as shown in Figure 3 (some cabling providers may prefer to call the CCP a "cross-connection point").

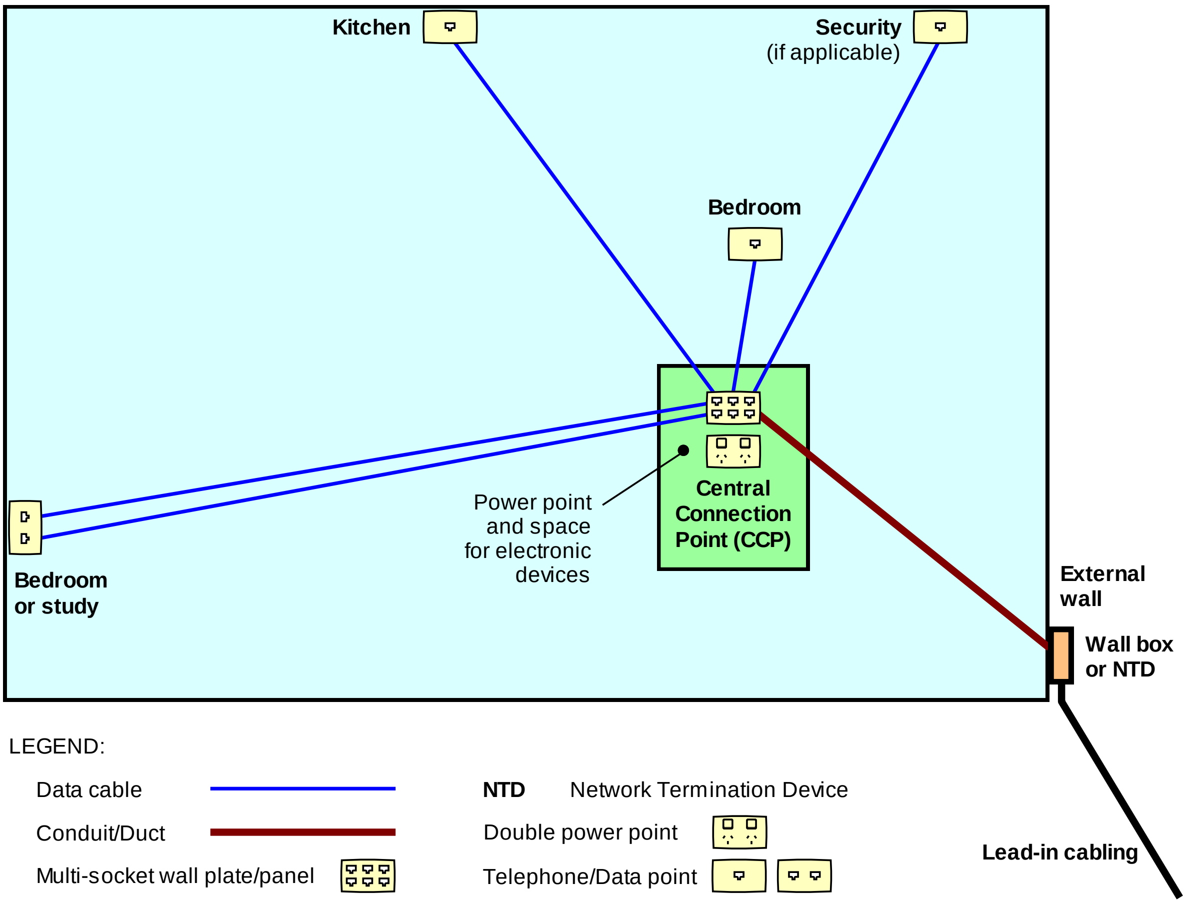
Data cable (four pairs) rated at Category 5 or better (see Note) **must be used** with this cabling method to support both telephone and Ethernet (data) connections.

Note: Category 5 is the minimum required to support 100 Mbps Ethernet; however, Telstra recommends the installation of Category 6 cable as a minimum (see 4.14.5). For an explanation of cable "category" and "Ethernet", refer to 4.14.4.

In this document, this cabling methodology is referred to as "**generic cabling**" (see 4.5).

Note: In the standards described in 4.3, the CCP may be described as a "Home Distributor" (HD). However, if only a few outlets are installed (as shown in Figure 3), the CCP is not a distributor and the cabling may be installed by a cabling provider with either "Restricted" or "Open" registration.

Figure 3 Home cabling method for modern telecommunications services (e.g. NBN)



Notes:

1. The Central Connection Point (CCP) provides a common point for connection of the incoming service cables, telephone/data point cables and electronic devices such as a modem/gateway or NBN equipment. The CCP may consist of a single, multi-socket wall plate or a "Home Distributor" (HD), depending on the number of outlets.
2. In this document, this cabling methodology is referred to as "generic cabling" (see 4.5).

4.9 Other changes

While power for operating a telephone service has traditionally been supplied via the copper telephone line from the telephone exchange, new technologies, such as Fibre To The Premises (FTTP), satellite and fixed wireless used for the NBN, use transmission media that do not conduct electricity (namely optical fibre and radio waves). Therefore, a power supply must be installed inside the home to operate the electronic equipment. This requires the provision of a **dedicated power point** and the supply of **continuous power** for the equipment — even if the customer only wants a basic telephone service.

The customer may also be required to maintain a **backup battery** if the operation of a "lifeline" telephone service is essential during power failure (e.g. a blackout). This is a new requirement.

When it comes to cabling a new home, there are other differences between NBN services and traditional copper-based services supplied by Telstra, described below. While, for the time being at least, Telstra continues to provide copper-based services in small property developments and established areas, ultimately, Telstra will cease installing copper networks and will supply Telstra services via the NBN.

To summarise **what has changed** for **cabling a new home**:

- Where services will be supplied to the premises via NBN FTTP (urban areas):
  - The builder or customer is required to **supply and install the lead-in conduit**, to NBN Co specifications, between the property boundary and the building.
  - The builder or customer must **provide an internal conduit or accessible cabling pathway**, to NBN Co specifications, between the external wall of the building where the lead-in conduit terminates and the location of the internal electronic equipment.

    Note: In the case of apartments, a contiguous conduit or an accessible pathway is typically required between the floor riser cupboard and the electronic device location inside the apartment.
- The builder or customer must **provide a suitable internal enclosure or space** to accommodate the electronic equipment, power point, a central connection point and associated connecting cords.
- The builder or customer must **provide at least one dedicated, double-socket power point** for the electronic equipment even if the customer only requires a basic telephone service.
- The builder or customer must **provide the internal cabling** between the central connection point and the outlets to be used to access the telecommunications services in the selected rooms.

4.10 Things you need to know

4.10.1 Terminology

A full list of definitions for acronyms and expressions used in this document is provided in section 17. However, before you read on, you will need a proper understanding of the meaning of certain expressions used extensively throughout this document but which may be used in a different context in other related documents.

In this document:

- **Premises** has the meaning defined in section 89 (2) of the Telecommunications Act 1997 and in section 3 of Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)* and includes **land** together with any **building or buildings** situated on that land.
- **Building** refers to a **permanent structure** (e.g. a house) constructed, or to be constructed, within the premises.
- **Gateway** refers to a **modem**, **router** or combined **modem/router** used to connect a service to the customer's cabling or equipment. In this document, the expressions **modem** and **gateway** are interchangeable.
- **Consumer**, **customer**, **end-user** and **occupant** refer to any person who may own, live in, or use a telecommunications service in, the home.
- **Data cable** refers to a type of twisted pair cable described in 4.14.4 of this document that may be used to connect both digital (e.g. internet) and analogue (e.g. telephone) services and equipment.

4.10.2 The network boundary

While telecommunications cablers will be familiar with the concept of the network boundary, developers, builders, electricians and consumers may not. Put simply, the network boundary is the point in a telecommunications system that is deemed to be the end of a **carrier's** or **carriage service provider's** telecommunications network. Any cabling or equipment connected to the network that is outside the boundary of that network is deemed to be **customer cabling** or **customer equipment** that is subject to **technical regulation** by the ACMA (Australian Communications and Media Authority).

Notes:

1. A **carrier** is the owner or operator of network infrastructure used to supply **carriage services** (network services). A **carriage service provider** is a provider of network services to consumers using the network infrastructure of a carrier. Telstra is a carrier because it owns and operates network infrastructure and is also a carriage service provider because it uses that infrastructure to supply telephone and data services to consumers.
2. **Technical regulation** includes the setting of standards for customer cabling and customer equipment, compliance labelling of products and registration of customer cabling installers.

Generally the carrier or service provider supplies, installs and maintains its cabling, equipment and services up to the network boundary but may not accept any responsibility beyond that point. However, there are exceptions to this basic rule. For example, carriers and service providers may require the customer to provide certain facilities on the "carrier side" of the network boundary within their premises (such as trenching for underground cabling or accessible pathways for installing network cables in buildings), and service providers may supply certain cabling or equipment on the "customer side" of the network boundary as part of the service being supplied (such as gateway devices).

The location of the network boundary for each type of broadband service is described in 4.12.2 to 4.12.6.

4.10.3 Lead-in cabling

Lead-in cabling is the cabling between the point of connection in the telecommunications network (usually in the street) and the network boundary, e.g. the Network Termination Device (NTD), in the premises. Lead-in cabling may be provided in two segments — the underground or aerial cabling to the building and the indoor cabling to the network boundary (e.g. an indoor FTTP NTD).

In urban areas, underground lead-in cable is usually installed in pipe ("conduit"). In rural areas, the cable may be directly buried in the ground without conduit.

4.10.4 Service agreements

For all services made available to consumers, service providers are required to publish the standard charges, terms and conditions that apply to each service in a **Standard Form Of Agreement (SFOA)**. Telstra calls its SFOA **Our Customer Terms (OCT)** and these are published on the internet at www.telstra.com.au/customer-terms/.

The SFOA/OCT sets out certain customer obligations, which may include the need for the customer to:

- **pay the relevant service connection fees** for the type of service being supplied
- **assure safe access to the premises** by the carrier or service provider for the installation of the facilities and services
- warrant that the **permission of the owner** of the premises and/or the body corporate, as applicable, has been obtained for the installation of the facilities and services before the work commences
- **arrange and pay for any trenching** or, if applicable, **pay for the installation of any poles**, required between the carrier's property entry point and the building for the installation of the underground or aerial lead-in cabling, including clearing and reinstatement of the land
- **arrange and pay for any facilities required within the premises** for the installation of carrier or service provider facilities, e.g. conduit, equipment enclosures or other cabling pathways or spaces
- **arrange and pay for any customer cabling** or equipment required to access the services
- **make available a suitable power point** for the operation of any equipment required for the supply of the service and pay for any power consumed by the equipment
- ensure that the carrier's or service provider's equipment is **not misused, damaged or stolen**.

4.10.5 Steps for arranging the connection of services

If you are building a new home, follow these steps to assure timely and economical access to telecommunications services:

- Check that the development has suitable infrastructure in place (street conduit, pits, etc.) to support the installation of the services required.

  Note: It is also worth checking whether external TV antennas or satellite dishes are permitted because, if not, there may be additional home cabling requirements to gain access to TV services, e.g. TV services may be separately distributed throughout the development via community coaxial or optical fibre cabling.

- Ascertain whether the developer has an agreement with a specific service provider for the supply of services to the residents (this may limit your choice of services or service providers).
- Ensure that suitable trenching is provided for the lead-in cabling and that the service provider is notified in advance of the availability of the open trench for installation of the conduit or cable. For Telstra services, refer to Telstra's "Moving Home" website http://www.telstra.com.au/moving-home/.

  Note: If the development is in NBN Co's "long-term fibre footprint", the lead-in conduit is to be supplied and installed by the developer, builder, electrician or owner to NBN Co's specifications.

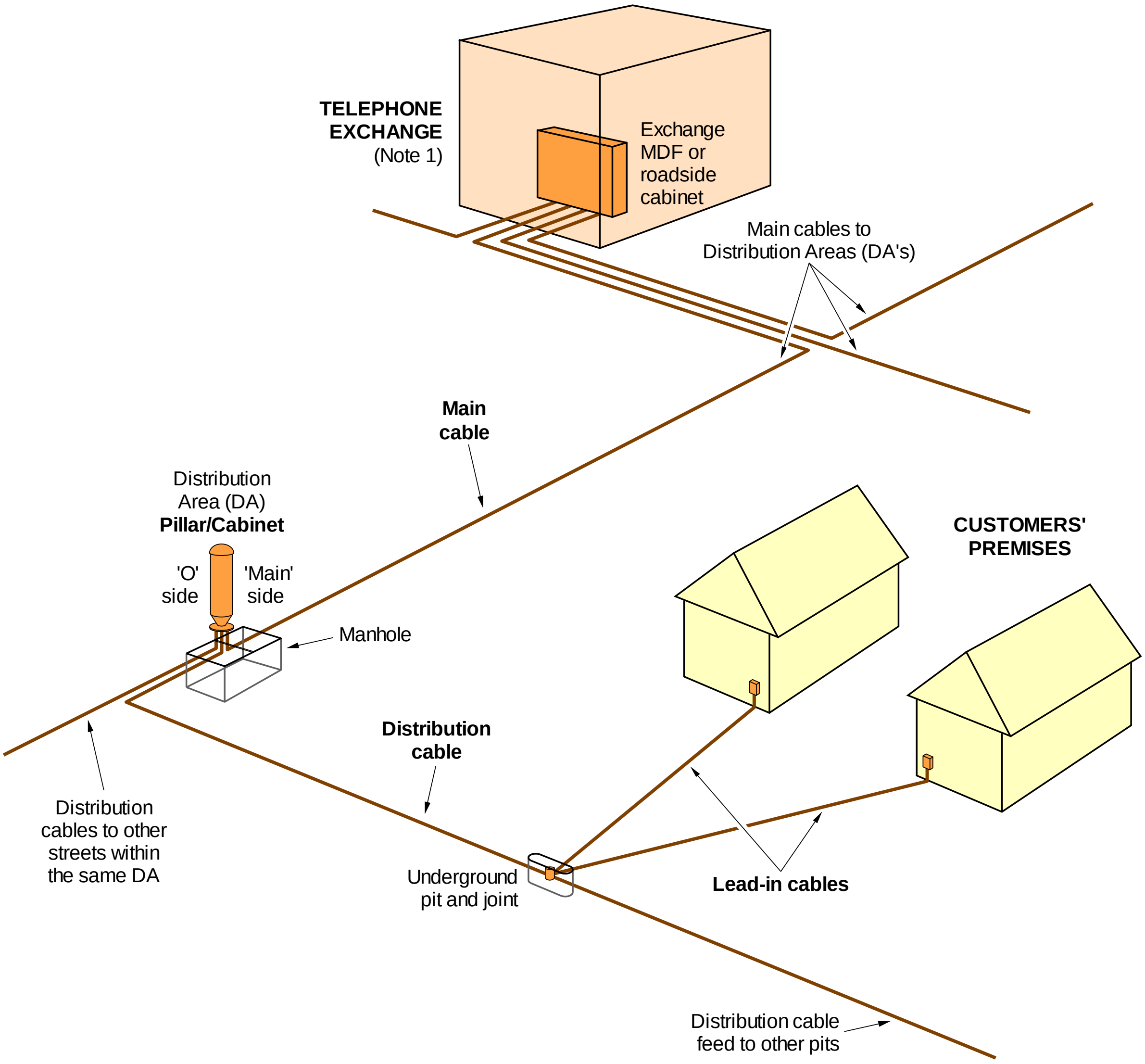
- Cable the home in accordance with this document to assure convenient access to services no matter what telecommunications network technology is used. In urban areas, the home will ultimately be connected to NBN optical fibre (see Figure 5).
- Advise your chosen service provider in advance of the planned date of occupancy so that the services may be connected to the home in a timely manner.

4.11 Telecommunications network architecture

Figure 4 illustrates typical underground copper twisted pair network architecture used in Australia for distribution of telephone and broadband services. While this is regarded as a “legacy” network with the advent of NBN, it will still be around for a long time and services will be supplied to the majority of homes via this network for many years.

For HFC and FTTP networks, the distribution architecture from the telephone exchange or “node” to the pits feeding customers’ premises is different but the final method of connection to the premises is the same, i.e. the lead-in cables are fed to the individual premises from pits (or poles) located on the footpath or, in some areas (e.g. Canberra), from the rear easement.

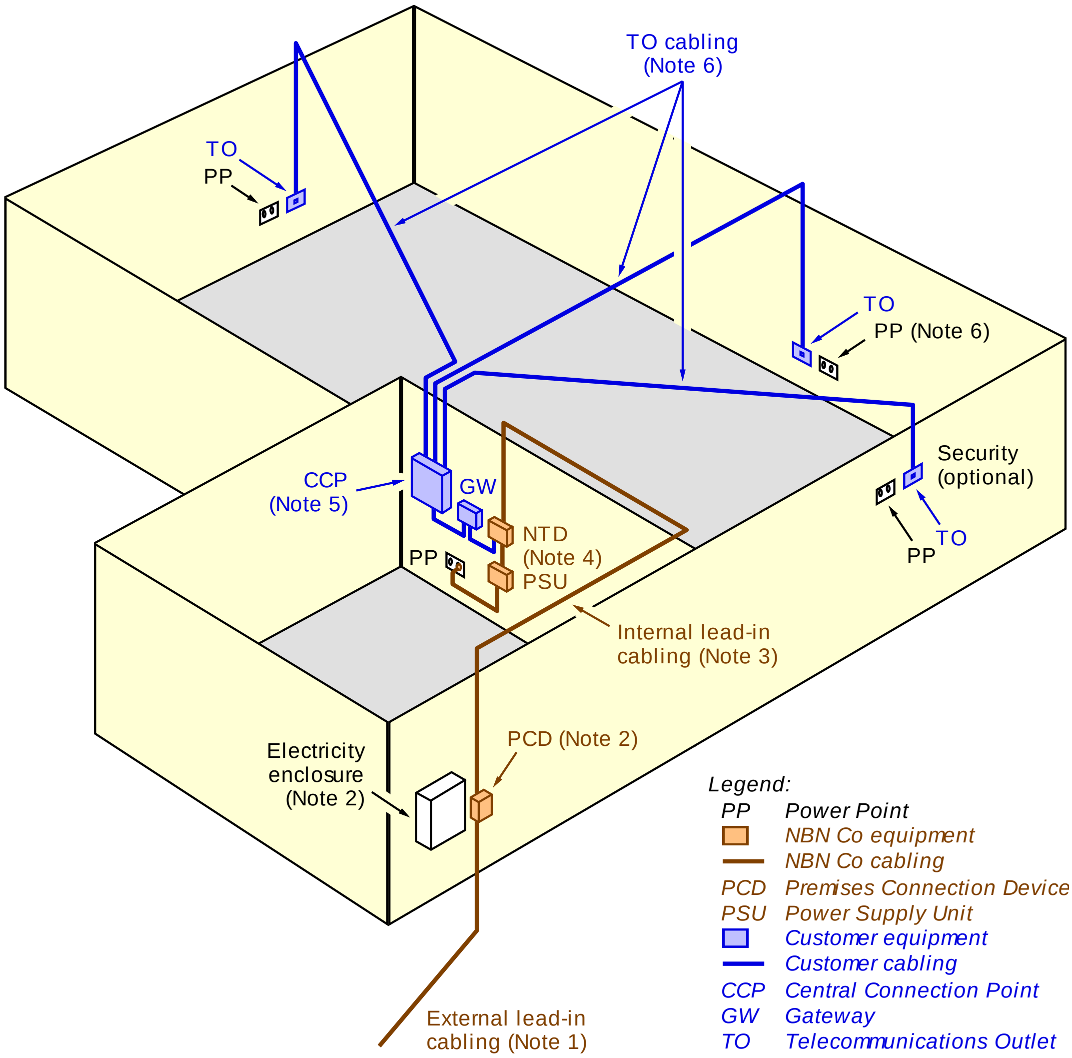
Figure 4 Typical underground copper twisted pair network architecture



Notes:

1. In modern residential developments, the services are usually fed from a roadside cabinet (RIM/CMUX/ISAM) that is connected to the telephone exchange via optical fibre cable.
2. The network architecture used for HFC or FTTP is slightly different but the distribution method at the customer premises end is essentially the same in that the lead-in cables are fed to the individual premises from pits (or poles) located on the footpath or, in some areas (e.g. Canberra), from the rear easement.

Figure 5 Home cabling architecture for NBN FTTP



Notes:

1. With NBN, the builder or customer is required to provide the lead-in ("drop") conduit to NBN Co's specifications between the "starter conduit" at the property boundary and the location of the PCD at the building. NBN Co will install the optical fibre lead-in cable in the conduit. Refer to section 5 for more information.
2. The PCD is a splice box used to connect the outdoor optical fibre lead-in ("drop") cable to the indoor optical fibre lead-in cable ("connecting fibre"). The PCD should ideally be located next to the external electricity enclosure (meter panel or switchboard) for convenient access. A combined electricity and telecommunications enclosure is recommended. See sections 6 and 7 for details.
3. An accessible cabling pathway is required between the PCD and the indoor NTD for installation of the indoor optical fibre lead-in cable ("connecting fibre") **after completion of the building**. The cabling pathway should comprise at least one rigid conduit with a minimum inside diameter of 23 mm and having no more than the equivalent of three 90° large radius bends. NBN Co will install the optical fibre lead-in cable in the conduit. See section 8 for details.
4. The NTD and the associated PSU are installed by NBN Co. An additional gateway device will be provided by the service provider to connect a broadband data service. At least one double-socket power point is required at the CCP location to power the NTD/PSU and the gateway device. Refer to section 9.
5. The CCP consists of a socket array for connection of the fixed customer cabling to the service ports of the NTD or the gateway via flexible connecting cords. Refer to section 10 for details.
6. A TO consists of a wall plate with at least one socket for connection of customer equipment. A power point should be located near each TO for powering of customer equipment (e.g. cordless telephone, computer). Refer to section 10 for more information.

4.12 Telecommunications network technologies

4.12.1 General

The common methods currently used to supply broadband services to homes and small businesses are described in 4.12.2 to 4.12.6 below.

Ultimately, the Commonwealth Government, through its wholly-owned Commonwealth company NBN Co, intends to connect 93% of homes, schools and workplaces to FTTP (Fibre To The Premises), with the balance being connected via fixed wireless or satellite technologies. In the meantime, broadband services will be supplied to consumers using the available technologies such as ADSL, HFC ("Cable"), satellite and 3G/4G wireless.

This document describes how a home may be cabled for the relevant available technology in a way that will provide for easy migration to the NBN. While underground cabling to the building is depicted in the following examples, aerial cabling may be used in some established areas. The variations applicable to aerial cabling are described later in this document. Telephone service cabling is also included in the following examples.

If you see any unfamiliar expressions or abbreviations in this document, refer to section 17.

The diagrams that follow show cabling to access points called **Telecommunications Outlets (TOs)** connected via a common cabling point referred to in this document as a **Central Connection Point (CCP)**. The CCP is the heart of a home cabling system and is described in more detail in 10.2.

4.12.2 ADSL (Asymmetric Digital Subscriber Line)

4.12.2.1 Description

ADSL is a technology that enables broadband internet services to be supplied using the existing telephone cabling. It is the most common technology used to supply broadband services to consumers.

The ADSL service is supplied via the same pair of wires used to supply a telephone service. The high frequency ("broadband") ADSL signals are combined with the low frequency ("baseband") telephone signals at the telephone exchange or roadside cabinet and then "filtered out" of the line at the customer premises using "filters" or "splitters". The ADSL signals are encoded and decoded by a modem which may be connected either directly to the computer or to a router to provide multiple user access to the service. Most modern ADSL modems include a wireless router and are often referred to as a "gateway".

The concept of ADSL is illustrated in Figure 6. The ADSL modem/gateway has an inbuilt high-pass filter that blocks the baseband telephone signals. Any telephone equipment connected to the line must be connected via a separate low-pass filter to block the broadband signals. This may be done by using individual "in-line" or "distributed" filters for each item of equipment or by installing a "central filter" or "remote splitter" in the home cabling to separate the telephone cabling from the ADSL cabling. A central filter usually provides better ADSL performance than distributed filters and is recommended.

In this document, a reference to ADSL includes a reference to all forms of this technology including ADSL, ADSL2, ADSL2+ and VDSL2 (Very-high-speed Digital Subscriber Line 2). ADSL transmission is carried over the telephone network within the frequency range of 25.875 kHz to 2208 kHz for ADSL2+ and up to 30 MHz for VDSL2, providing theoretical data speeds of up to 100 Mbps. In reality, the maximum available data speeds **under ideal conditions** are approximately:

- ADSL ("ADSL1") 8 Mbps downstream and 1 Mbps upstream
- ADSL2 12 Mbps downstream and 1.1 Mbps upstream
- ADSL2+ 24 Mbps downstream and 1.1 Mbps upstream
- VDSL2 70 Mbps downstream and 30 Mbps upstream.

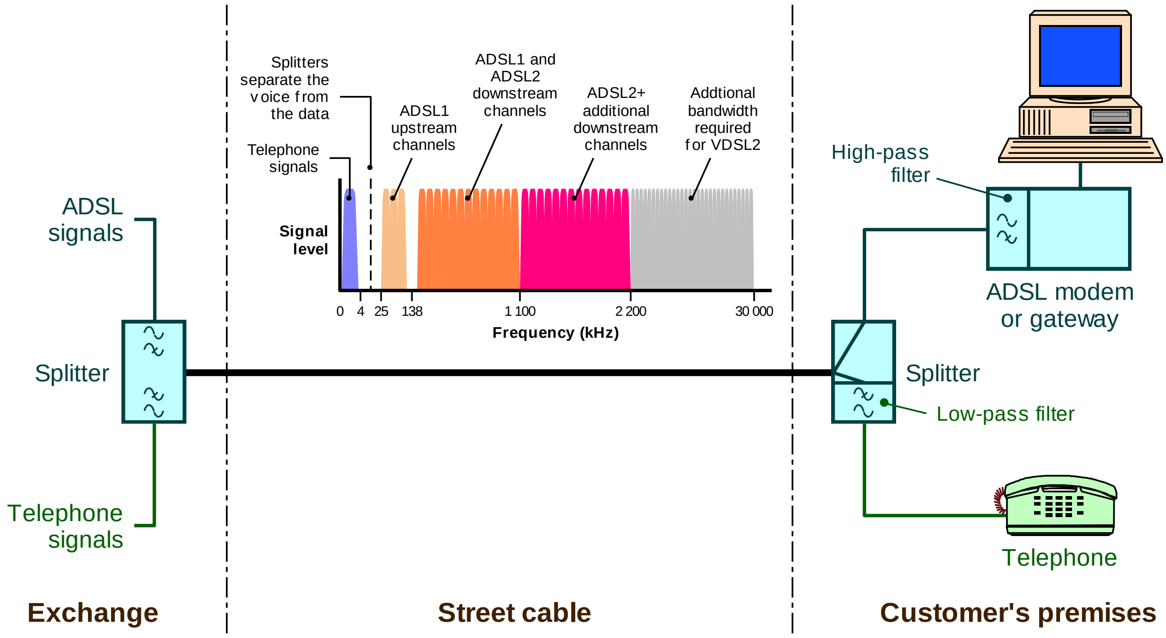
Note: ADSL2+ superseded ADSL2, so ADSL2 may not be offered by any service providers in Australia. VDSL2 is only offered by a limited number of service providers. Service providers may offer broadband plans with lower data speeds than the maximum speeds shown above.

ADSL reach is typically limited to a cabling distance of between 4 km (e.g. urban) and 7 km (e.g. rural) from the telephone exchange or roadside cabinet, depending on the quality of the street cabling (e.g. age, wire gauge, number of joints, etc.) and any sources of interference (e.g. other high-frequency services carried within the same cable). As the distance from the exchange/cabinet increases, the available data speed decreases. The service will automatically "range down" to a speed that the line is capable of supporting until the broadband signal is so weak that the ADSL modem simply will not synchronise ("sync") with the network equipment.

Thus an ADSL2+ service may not perform much better than an ADSL1 service in some circumstances. The quality of the cabling inside the customer's building is important with ADSL2+ and VDSL2 services. A dedicated "data" cable (described in 4.14.4 on page 34) from a central filter to the modem is recommended for optimal performance. A central filter is always required if "Mode 3" telephone equipment is installed, e.g. a monitored security alarm or personal response (emergency call) system.

Note: "Mode 3" is explained in 10.4.7.4 on page 159.

Figure 6 ADSL concept



Notes:

1. ADSL technology delivers a high-speed data ("broadband") service to the customer using a standard telephone line without significantly disturbing the customer's telephone service, by transmitting the data signals over the copper pair at a higher frequency than the telephone signals.
2. A low-pass filter must be fitted to the customer's telephone equipment to block the high frequency data signals to minimise data signal loss through the telephone equipment and to prevent the generation of audible noise in the telephone equipment. The filter may take the form of a centralised filter ("central filter" or "remote splitter") or may consist of a distributed ("in-line") filter connected at each item of telephone equipment. The ADSL modem has a built-in high-pass filter to block the telephone signals to ensure reliable ADSL service operation.
3. In theory, ADSL1 filters should also work for ADSL2+ and VDSL2 because the signal to the ADSL modem is not filtered and the low-pass band (for telephone signals) remains the same. In practice, however, factors like common mode noise (line unbalance about earth) and telephone signalling transients become a greater concern with the higher frequencies used for ADSL2+ and VDSL2 and these services may be degraded if existing ADSL filters are used. A central filter is recommended for ADSL2+ and VDSL2 and, in any case, is required if "Mode 3" telephone equipment is installed, e.g. a monitored security alarm or personal response (emergency call) system.
4. An ADSL1 modem will not support ADSL2+ or VDSL2 but ADSL2+ and VDSL2 modems are usually backwards compatible.

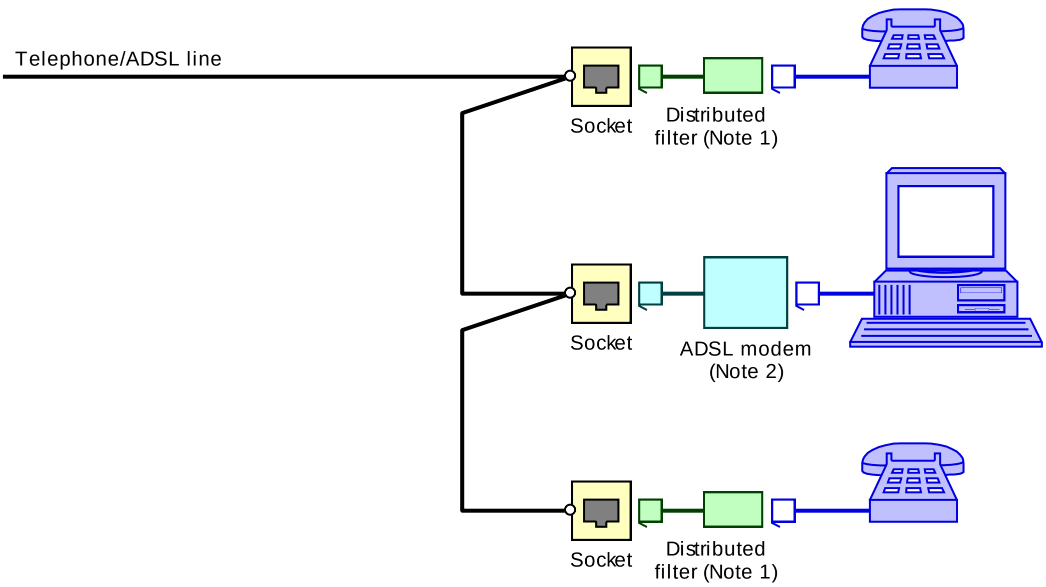
4.12.2.2 ADSL connection methods using "legacy" cabling

As ADSL is supplied to customers' premises via normal telephone cabling (often referred to as "legacy" cabling), the existing home telephone cabling can be used to access the ADSL service at virtually any existing telephone socket. In most cases, no cabling alterations are necessary — the customer merely needs to nominate which socket to use for connection of the ADSL modem and connect distributed (in-line) ADSL filters in series with the connecting cord of any telephone equipment that is also connected to the line. This arrangement is shown in Figure 7. Typical distributed filters are shown in Figure 8.

If additional cabling is required to provide a new socket for connection of the ADSL modem (because there is no existing socket for the modem at the preferred location or the existing cabling is substandard for ADSL), it is recommended to have a central filter installed at the same time, as shown in Figure 9.

Detailed guidance for connecting ADSL using legacy cabling are provided in section 10 of Telstra Specification 012882, *Alteration of Telstra Facilities in Homes & Small Businesses — Information for Cabling Providers*, which may be downloaded from www.telstra.com.au/smartcommunity/mybuilder.html.

Figure 7 Connection of an ADSL service using legacy cabling and distributed (in-line) filters



Notes:

1. Distributed filters must be fitted to all telephone equipment including fax machines, answering machines, tone ringers, etc. A distributed filter should not be used to connect "Mode 3" equipment, e.g. a security alarm panel or a personal response (emergency call) system. Mode 3 equipment should be connected via a hard-wired central filter in accordance with Figure 9.
2. The ADSL modem has an in-built high-pass filter to block voice frequencies and may be connected directly to any socket without a filter.

Figure 8 Typical distributed (in-line) filters

Standard

For a wallphone

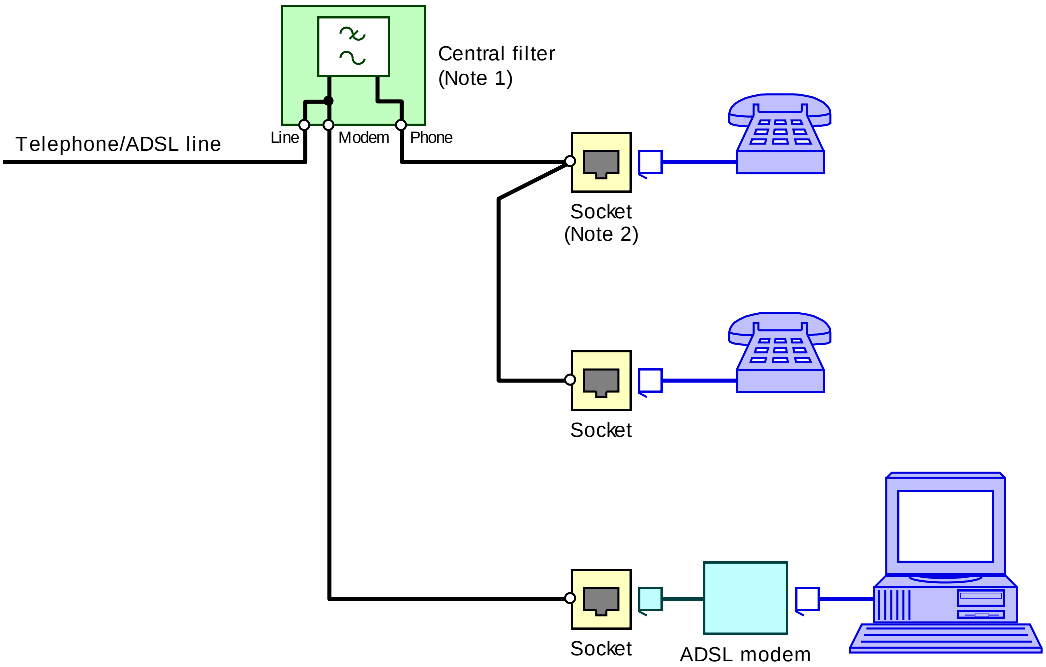
A central filter should be installed as shown in Figure 9 if the customer has any of the following:

- a “Mode 3” connection, e.g. for a security alarm or personal response (emergency call) system (see Note 1)
- four or more telephone devices that would otherwise require the use of four or more distributed filters
- multiple star-wired telephone points, whether or not they are being used (Note 2).

Notes:

1. “Mode 3” is explained in 10.4.7.4 on page 159.
2. Star wiring creates an impedance mismatch at the star wiring point that could cause reflection of ADSL signals (see 4.14.4.3 for an explanation of “reflection”). Additional wiring on the “line” (unfiltered) side of the filters also increases exposure to disturbing influences such as electrical impulse noise from switch-mode power supplies and arcing electric motors used in certain appliances like hair driers and electric drills.
3. Other cabling factors can have a detrimental effect on ADSL signalling, such as poor connections or connecting the ADSL modem/gateway via long, flat telephone extension cords that have low immunity to electrical impulse noise from other services or appliances.

Figure 9 Connection of an ADSL service using legacy cabling and a central filter



Notes:

1. The ADSL circuit is not filtered, i.e. the ADSL modem is effectively connected directly to the incoming line.
2. If a Mode 3 connection is required, e.g. for a security alarm panel or a personal response (emergency call) system, the Mode 3 socket must be connected as the first point on the “Phone” side of the central filter. Refer to 10.4.7.4 on page 159 for more information.
3. Typical central filters are pictured in Figure 11 and Figure 12.

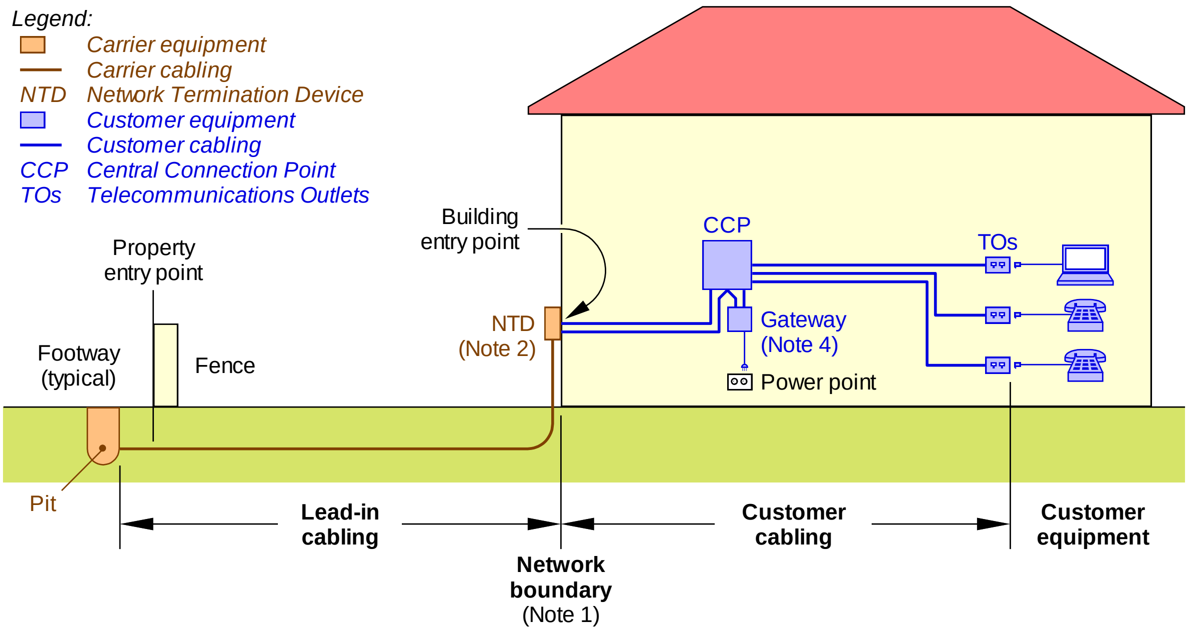
While the cabling arrangements shown in Figure 7 and Figure 9 are serviceable for telephone and ADSL services, they are **not adaptable to FTTP or the NBN** because the broadband service supplied from FTTP/NBN is “Ethernet” (Ethernet is explained in 4.14.4 on page 34), which must be connected via a properly installed high-grade data cable with four pairs (ADSL only requires one pair of a low-grade telephone cable). Therefore, for new homes or new home cabling it is strongly recommended that cabling be installed as described in 4.8.2 (page 11) and 4.14 (page 32), which will provide the necessary flexibility for adaptation to FTTP/NBN.

4.12.2.3 ADSL connection using generic cabling

With generic cabling, the copper twisted pair lead-in cabling is connected to an outdoor Network Termination Device (NTD) and the cabling is extended from the NTD to a **Central Connection Point (CCP)** from which cabling to the **Telecommunications Outlets (TOs)** emanates. This cabling arrangement is shown in Figure 10. This cabling is **readily adaptable to FTTP/NBN** and provides additional benefits (explained in 4.5) that are not provided by "legacy" cabling.

For re-cabling of established buildings, Telstra authorises a registered cabling provider to retrofit a Telstra NTD under the terms and conditions set out in Telstra Specification 012882, *Alteration of Telstra Facilities in Homes & Small Businesses — Information for Cabling Providers*, which may be downloaded from www.telstra.com.au/smartcommunity/mybuilder.html.

Figure 10 Typical generic cabling for connection of an ADSL service



Notes:

1. The network boundary is at the cable connection terminals on the "customer side" of the NTD.
2. An NTD must be installed on the external wall for connection of the twisted pair lead-in cabling. This cabling must not be connected directly to the CCP. The NTD should be interconnected to the CCP by at least two "data" (twisted pair) cables — one for the ADSL service and one for the telephone service(s). While this particular type of NTD may be located away from the building (e.g. on the fence or a detached garage), this is not recommended as it would make the installation incompatible with FTTP and the NBN. With FTTP/NBN, for technical and safety reasons the NTD **must** be located at the building in which the services will be used. For re-cabling of established buildings, Telstra authorises a registered cabling provider to retrofit a Telstra NTD on the external wall of the building under the terms and conditions set out in Telstra Specification 012882, *Alteration of Telstra Facilities in Homes & Small Businesses — Information for Cabling Providers*, which may be downloaded from www.telstra.com.au/smartcommunity/mybuilder.html.
3. ADSL is supplied over the same pair of wires used to supply a telephone service. Unless the customer is supplied with a "naked DSL" service, it is necessary to install a low-pass filter ("central filter" or "remote splitter") in the incoming line to separate the low frequency (baseband) telephone signals from the high frequency (broadband) ADSL signals. This filter may be installed at either the NTD or the CCP.
4. While the gateway is classified as customer equipment, it may be supplied initially by the service provider as part of the broadband service connection. Responsibility for the gateway usually passes to the customer at the expiration of the service contract or the equipment warranty period.

ADSL central filter

A central filter should be used for generic cabling to simplify connection arrangements at the CCP and avoid the need to used distributed (in-line) filters for each telephone equipment connection.

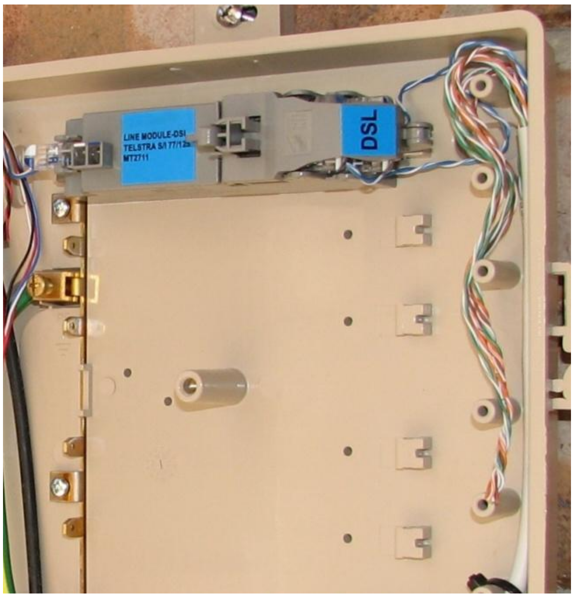
The central filter may be:

- integrated in the line module installed in the NTD as shown in Figure 11 (a);
- installed within the NTD on the customer side of the NTD as shown in Figure 11 (b); or
- installed inside the building, preferably at the CCP (see Figure 12).

A central filter/remote splitter installed on the customer side of the Telstra NTD may be any of the certified types listed on Telstra's website at http://www.telstra.com.au/adsl/equipmnt.htm.

Figure 11 Central filter installed within the external NTD

(a) Line module with integrated central filter



(b) Separate central filter on customer side of NTD

Figure 12 Central filter installed inside the building (e.g. at the CCP)

(a) Wall-mounted type

(b) Wall-plate-mounted type

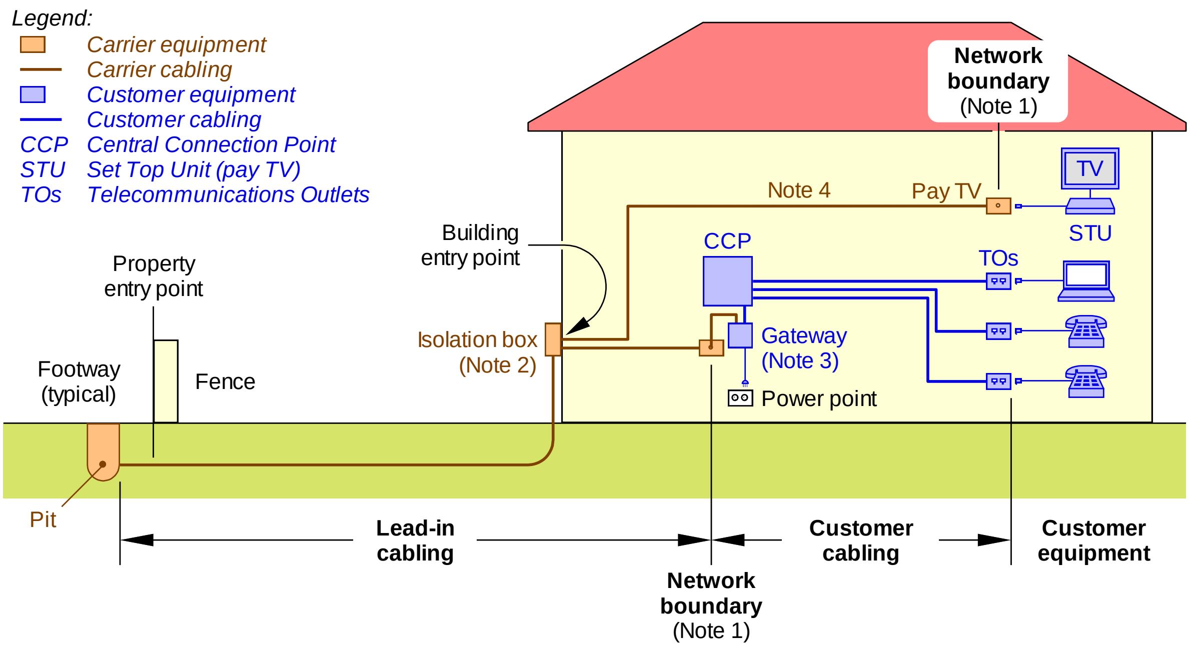
4.12.3 HFC (Hybrid Fibre-Coax)

The HFC network (otherwise known simply as “Cable”) uses radio frequency (RF) signalling within a bandwidth of 5 MHz to 862 MHz over a cabled network to supply broadband internet (e.g. BigPond® Cable) and pay TV (e.g. FOXTEL*) services to consumers. HFC is only available in some metropolitan areas. Telstra’s HFC network supplements, and does not replace, the copper twisted pair network.

The home is connected to the HFC network via a single coaxial cable which terminates on an “isolator” within an external wall box (called an “isolation box” for obvious reasons). The isolation box may also contain an RF splitter to provide separate outlets for broadband internet and pay TV access (or multiple pay TV access points). For the broadband internet service, a coaxial cable is required between the isolator/splitter in the isolation box and a coaxial “F-connector” on a wall plate for connection of the cable modem. The modem encodes and decodes the RF signals for connection to the computer or, for multiple user access to the service, to a router. The modem may include a wireless router, in which case it may be referred to as a “gateway”.

For generic home cabling, the modem/gateway — and, therefore, the coaxial F-connector required to connect it to the HFC network — should be located at the CCP as shown in Figure 13. However, any F-connector required to access pay TV (FOXTEL*) **must not** be located at the CCP but at the location of the TV set to be used to watch the FOXTEL* programs.

Figure 13 Typical generic cabling for connection of an HFC broadband service



Notes:

1. The network boundary for each coaxial cable is on the “customer side” of the coaxial cable socket on which the cable is terminated (i.e. the network boundary is the “first socket” on the cable).
2. If twisted pair lead-in cabling is also installed (e.g. for the supply of a telephone service), Figure 10 applies to that cabling and there will be two separate connection devices on the external wall — an NTD for the twisted pair cabling and an isolation box for the coaxial cabling.
3. While the gateway is classified as customer equipment, it may be supplied initially by the service provider as part of the broadband service connection. Responsibility for the gateway usually passes to the customer at the expiration of the service contract or the equipment warranty period.
4. Any outlet required for access to pay TV (FOXTEL*) **must not** be located at the CCP. For pay TV access, a separate coaxial cable must be run directly from the isolation box to the location of the Set Top Unit (STU) where the TV set that will be used to watch pay TV will be located. See 9.5.2 (page 113) for details.

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* Registered trade mark of Twentieth Century Fox Film Corporation

4.12.4 FTTP (Fibre To The Premises)

With FTTP, telecommunications services are supplied to the customer premises via optical fibre cabling. The optical fibre terminates at the customer premises on an electronic device called an Optical Network Terminal (ONT) that converts the optical (light) signals to electrical signals for connection of conventional telephone and data equipment. As optical fibre can't conduct electricity from the carrier's network to the premises, local power is required to operate the ONT and this is provided by a Power Supply Unit (PSU) that plugs into a standard power point.

You may see this technology described elsewhere as FTTH (Fibre To The Home) or FTTU (Fibre To The User) but they mean the same as FTTP. The term FTTx (Fibre To The Premises/Home/User) may also be encountered but it captures FTTN (Fibre To The Node) which is a different technology to FTTP.

Note: Fibre To The Node (FTTN) is actually a form of ADSL technology in which optical fibre distribution is taken closer to customers' premises so that the copper twisted pair cabling to the premises is shortened, reducing cable attenuation and enabling higher ADSL data speeds. It may also be referred to as FTTC (Fibre To The Curb). This technology is not used by Telstra.

Telstra may use an outdoor ONT or an indoor ONT, depending on the circumstances. In both cases, the ONT is designated as a Network Termination Device (NTD). Both types of ONT require a power supply, which must be installed inside the building. Eventually it is expected that Telstra will use indoor ONTs for all FTTP installations.

To date, NBN Co has used an indoor ONT and has indicated that it will be using an indoor ONT for its FTTP deployment in new developments. The NBN Co ONT is also designated as an NTD.

The ONT may be referred to in various documents as an ONT (Optical Network Terminal), ONU (Optical Network Unit), NTU (Network Termination Unit) or NTD (Network Termination Device). In all cases, functionally it is an NTD, so henceforth it will be called an NTD in this document.

FTTP networks may be used to supply one or more of the following services from the NTD (ONT):

- broadband internet
- telephone
- RF TV (e.g. free-to-air channels, community channels or pay TV).

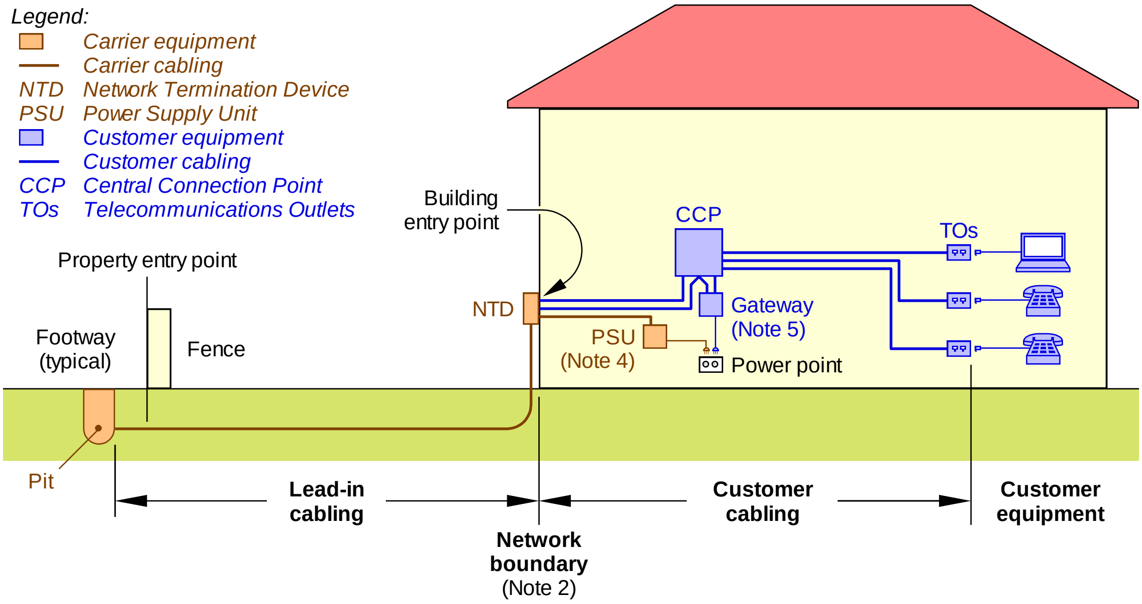
The NBN only supplies broadband internet and telephone services from its NTD but may support multicast IPTV via the broadband internet service. Some service providers using the NBN to supply their services may elect to provide telephone services using VOIP (Voice Over Internet Protocol) from their gateway.

One of the cabling systems described in 10.3 (page 124) must be installed for connection of FTTP services. Conventional ADSL (telephone) service cabling (as shown in Figure 7 and Figure 9) **is not suitable for FTTP**, especially where an indoor FTTP NTD is used.

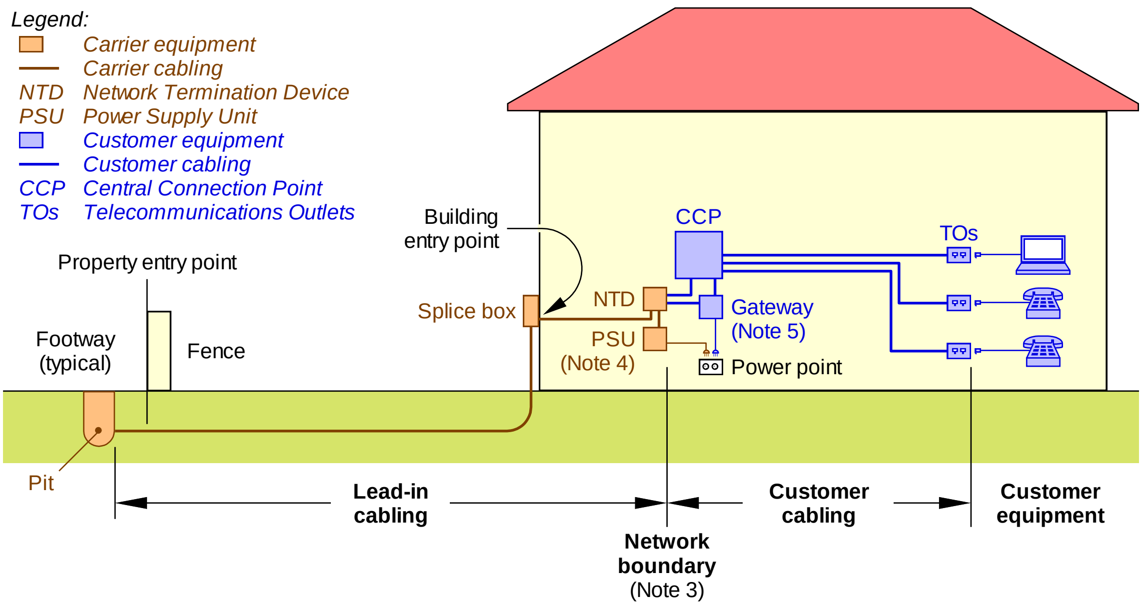
Refer to Figure 14.

Figure 14 Typical generic cabling for connection of FTTP services

(a) Outdoor NTD (Note 1)



(b) Indoor NTD (Note 1)



Notes:

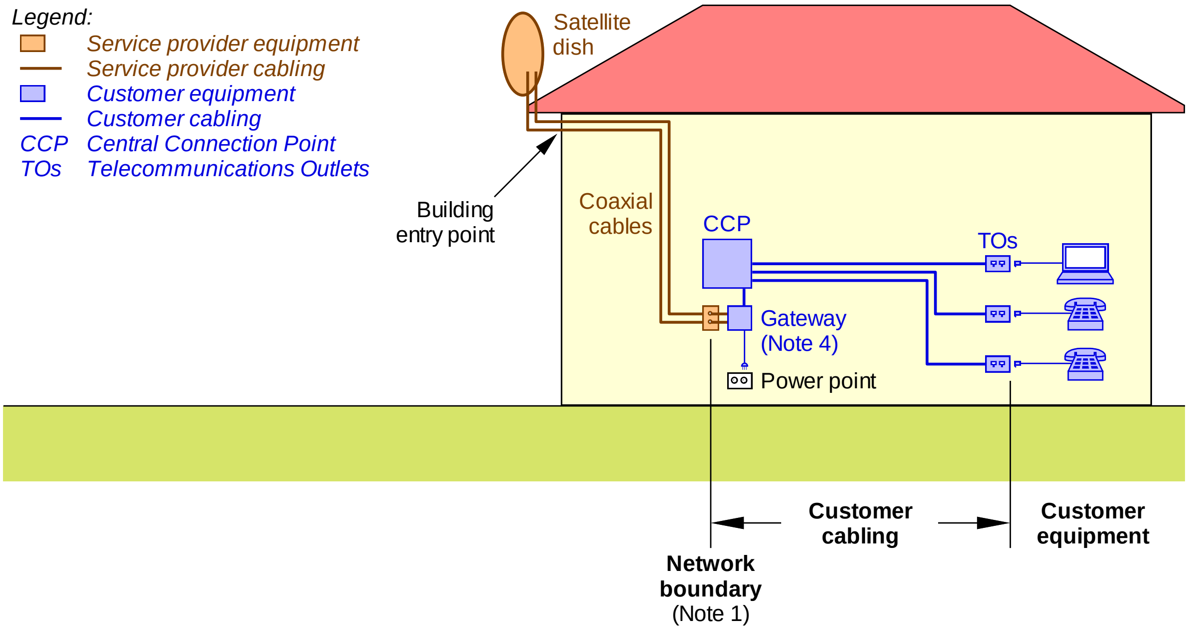
1. Telstra may use an outdoor or indoor NTD depending on the circumstances. NBN Co currently uses an indoor NTD. For technical and safety reasons **the NTD cannot be located away from the building** in which the services will be used (such as in a detached garage).
2. Where an outdoor NTD is used, the network boundary is at the cable connection terminals on the “customer side” of the NTD (ONT). The PSU is part of the NTD even though it is located inside the building and it must be located within 25 m radial distance of the outdoor NTD.
3. Where an indoor NTD is used, the network boundary is at the service ports on the indoor NTD (ONT). The PSU is part of the NTD and must be located within 1 m of the NTD.
4. The **PSU and the indoor NTD are designed for indoor installation and they must not be located outdoors** whether or not they are sheltered from the weather (such as in an open veranda or an external enclosure).
5. While the gateway is classified as customer equipment, it may be supplied initially by the service provider as part of the broadband service connection. Responsibility for the gateway usually passes to the customer at the expiration of the service contract or the equipment warranty period.

4.12.5 Satellite

Satellite broadband is generally only used in areas where other broadband telecommunications network technologies are not available. Telstra's BigPond satellite broadband uses the AsiaSat 3S satellite, which is a different satellite to that used for pay TV services (e.g. FOXTEL) and a separate satellite dish is required. One of four dish sizes will be used depending on geographic location and the prevalent weather conditions. Dish sizes are 74 cm, 98 cm, 120 cm or 180 cm. The 180 cm dish is too large to be mounted on the building and must be installed on a freestanding pole. The satellite dish must be mounted at least 2 m above ground level and will face a northerly direction to the satellite, which means the dish will normally be installed on the northern side of the building. The angle of the dish will depend on the proximity of the premises to the equator and there must be current and future guaranteed unobstructed line of sight to the satellite (e.g. allowance must be made for future building activities or the growth of any existing trees).

Two coaxial cables are required between the satellite dish and the gateway — one for transmit (Tx) and one for receive (Rx). These cables are installed by the service provider (e.g. Telstra) and will terminate on a wall plate with two coaxial "F-connector" sockets for connection of the satellite gateway. DC power is fed from the gateway to the LNB (Low Noise Block-converter) and radio transmitter on the satellite dish via the coaxial cables. Modern satellite gateway devices have at least one "Ethernet" port for connection of the broadband service to a home network ("Ethernet" is explained in 4.14.4). Earlier gateway devices may only provide a USB (Universal Serial Bus) port for connection to a single PC.

Figure 15 Typical generic cabling for connection of a satellite broadband service



Notes:

1. The service is supplied by means of coaxial cables from the satellite dish that enter the building and the network boundary point is at the coaxial cable sockets used for connection of the gateway (i.e. at the "first socket" for each cable).
2. If twisted pair lead-in cabling is also installed (e.g. for the supply of a telephone service), Figure 10 applies to that cabling.
3. In some cases, the satellite dish may be located away from the building (e.g. mounted on a freestanding pole), in which case the cabling arrangement may resemble Figure 13 but with two coaxial cables connected between the satellite dish and the gateway.
4. While the gateway is classified as customer equipment, it is normally supplied initially by the service provider as part of the broadband service connection. Responsibility for the gateway may pass to the customer at the expiration of the service contract or the applicable warranty period.

4.12.6 3G (3rd Generation) or 4G (4th Generation) wireless

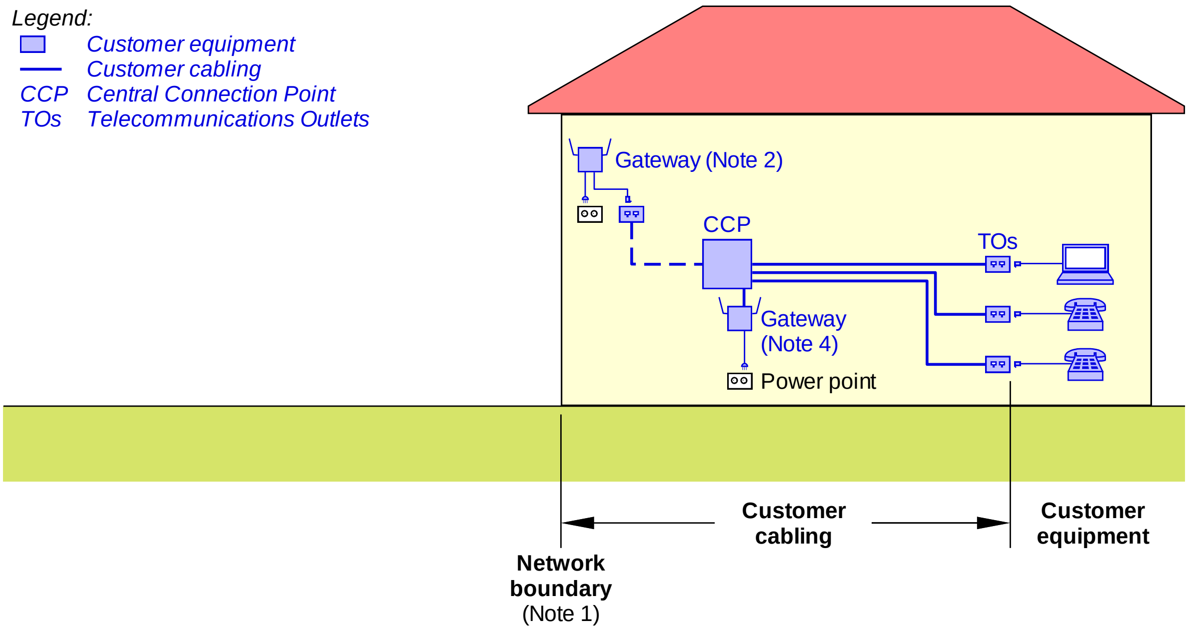
Wireless (e.g. Telstra Next G™) telecommunications network technology may be used in virtually any area where mobile access is available, as an alternative to other broadband telecommunications network technologies or where other technologies are not available.

In urban and regional areas, there is usually sufficient radio frequency (RF) signal strength to use a wireless gateway with an inbuilt antenna — although the gateway may need to be located in a certain part of the building to obtain optimal reception and data speed. Data speed will usually reduce with reduced RF signal strength.

In rural and remote areas, an external antenna may be required. In some cases, the antenna may be located some distance from the building and the services may be connected to the building via twisted pair cabling, in which case Figure 10 applies.

Refer to Figure 16 and Figure 17.

Figure 16 Typical generic cabling for connection of a 3G/4G wireless service (indoor antenna)



Notes:

1. The 3G/4G gateway is normally portable with this arrangement (e.g. self-installed by the customer) and the network boundary point is at the nearest mobile service transmission antenna, i.e. effectively at the building perimeter.
2. The gateway may need to be located some distance from the CCP for optimal radio reception, in which case it must be interconnected to the CCP by cable as indicated.
3. If twisted pair lead-in cabling is also installed (e.g. for the supply of a telephone service), Figure 10 applies to that cabling.
4. While the gateway is classified as customer equipment, it may be supplied initially by the service provider under the terms of the broadband service contract. Responsibility for the gateway usually passes to the customer at the expiration of the service contract or the equipment warranty period.

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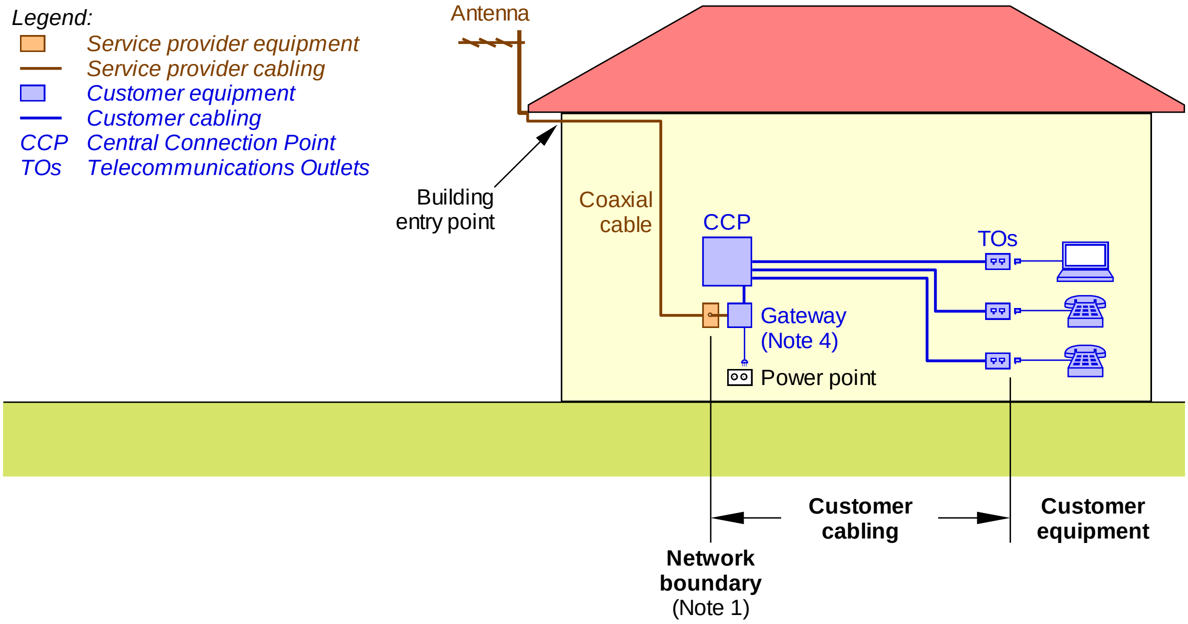
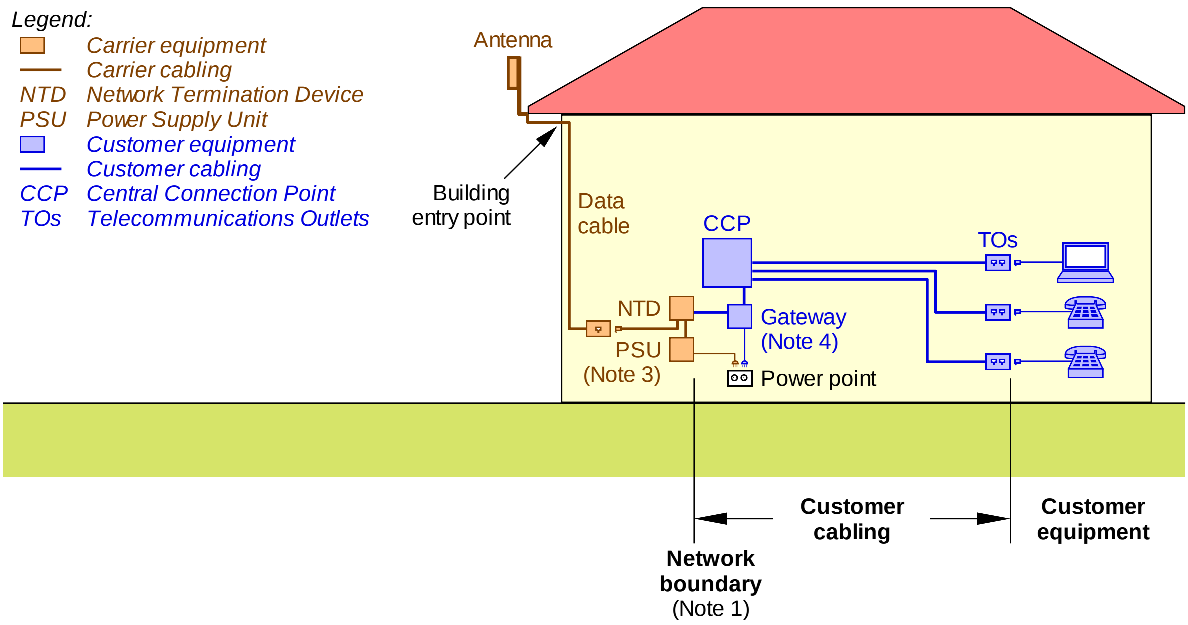
Figure 17 Typical generic cabling for connection of a 3G/4G wireless service (external antenna)

(a) Telstra Next G™ Wireless Loop (NGWL)



(b) NBN fixed wireless



Notes:

1. The service is supplied by means of an antenna cable that enters the building and the network boundary point is:
   - for Telstra NGWL, the coaxial cable socket that connects the antenna to the gateway (the "first socket")
   - for NBN, the service ports on the NTD (the PSU is part of the NTD and is located within 1 m of the NTD).
2. If twisted pair lead-in cabling is also installed (e.g. for the supply of a telephone service), Figure 10 applies to that cabling.
3. In some circumstances, the antenna and associated equipment may be located away from the building with services being connected to the building via copper twisted pair cabling, in which case Figure 10 applies.
4. While the gateway is classified as customer equipment, it may be supplied initially by the service provider as part of the broadband service connection. Responsibility for the gateway may pass to the customer at the expiration of the service contract or the applicable warranty period.

4.13 Common cabling elements

From **Figure 10 to Figure 14** it can be seen that the same cabling topology may be used for all cabled ("wireline") technologies (i.e. telephone/ADSL, HFC and FTTP), comprising the following elements:

- **lead-in cabling** from the property entry point to the building
- an outdoor connection device (referred to henceforth as a **Premises Connection Device** or **PCD**) to connect the outdoor lead-in cabling to the indoor cabling
- indoor cabling (referred to henceforth as **tie cabling**) between the outdoor connection device (PCD) and the indoor equipment (PSU, NTD or gateway)
- a **Central Connection Point (CCP)** from which the internal cabling radiates to the rooms where the services are to be accessed by the occupants
- **customer cabling** between the CCP and the rooms where access to the services will be required
- **Telecommunications Outlets (TOs)** to connect the customer's equipment to the customer cabling.

These elements and the differences between them for the various telecommunications network technologies are summarised in Table 1.

Figure 15 to Figure 17 demonstrate that the same customer cabling topology (CCP to TOs) can be used to access the satellite and wireless services at multiple points.

In all cases:

- the customer cabling between the CCP and the TOs should be identical;
- some form of powered equipment is always installed at the CCP; and
- except in the case of Figure 16, an accessible cabling pathway is required for installing the tie cabling between the building entry point and the CCP.

Figure 18 illustrates a generic cabling model that can be applied to all "wireline" telecommunications network technologies incorporating the above elements and that provides for easy upgrade from copper-based network technologies (telephone/ADSL, HFC) to FTTP, 3G/4G wireless or satellite technology.

Table 1 Differences between "wireline" telecommunications network technologies

<table>
<tr><th colspan="2">telecommunications network technology</th><th>Lead-in cabling</th><th>PCD</th><th>Tie cabling</th><th>Powered equipment</th><th>Customer cabling</th></tr>
<tr><td colspan="2">ADSL</td><td>Twisted pair cable</td><td>NTD (needs earthing)</td><td>2 x data cables</td><td>Gateway</td><td rowspan="5">Star-wired data cables between a CCP and the TOs</td></tr>
<tr><td colspan="2">HFC</td><td>Coaxial cable</td><td>Isolation box</td><td>1 x coaxial cable</td><td>Gateway</td></tr>
<tr><td rowspan="2">FTTP</td><td>Outdoor NTD</td><td>Optical fibre cable</td><td>NTD (needs earthing)</td><td>1 x PSU cable, 2 x data cables, 1 x coaxial cable**</td><td>PSU + Gateway</td></tr>
<tr><td>Indoor NTD</td><td>Optical fibre cable</td><td>Splice box</td><td>1 x optical fibre cable</td><td>NTD + PSU + Gateway</td></tr>
<tr><td>Generic‡</td><td>Outdoor or indoor NTD</td><td>1 x 23 mm ID* conduit</td><td>Outdoor space or enclosure with earthing</td><td>1-2 x 23 mm ID* conduit†</td><td>Indoor space or enclosure</td></tr>
</table>

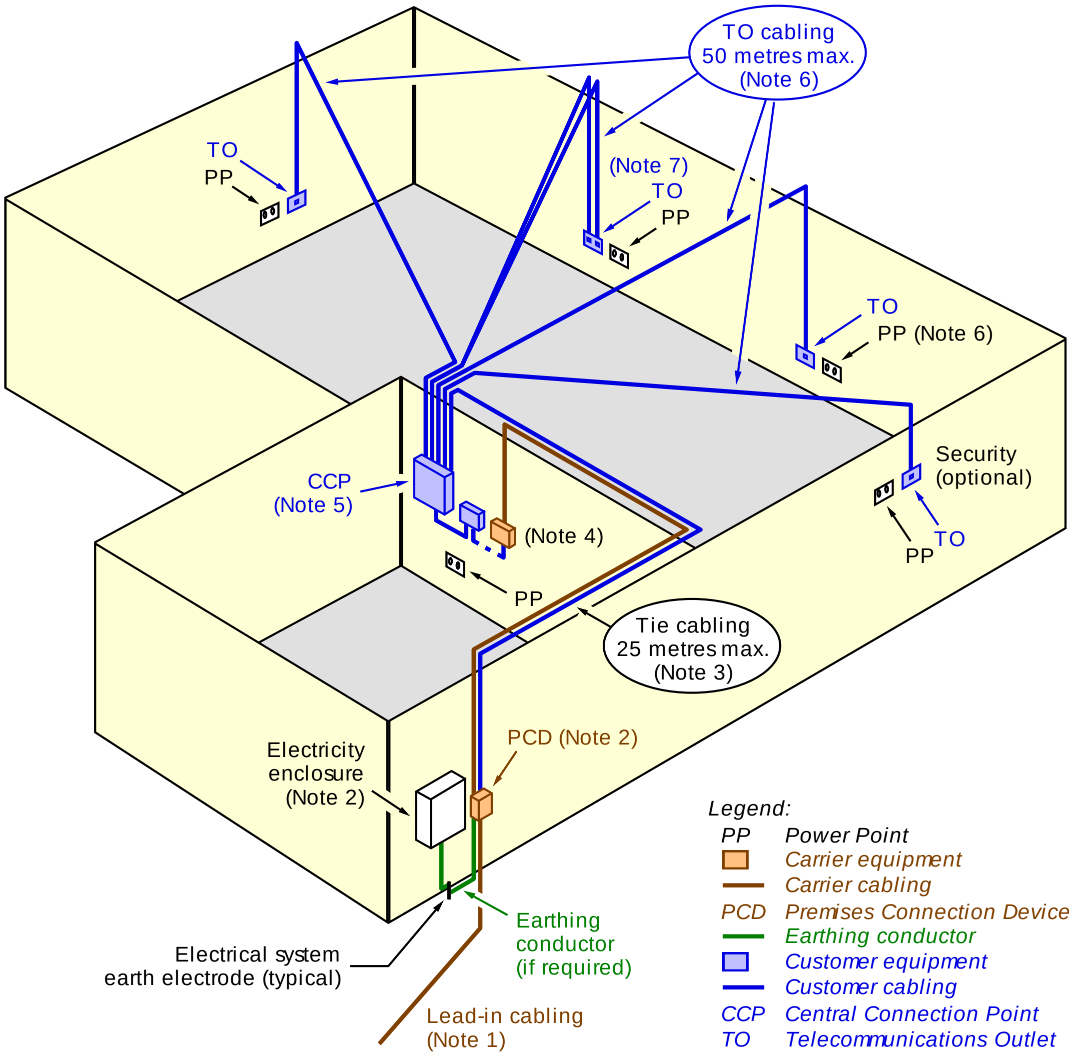
* ID = Inside Diameter

** A coaxial cable may be required if the NTD supports RF TV distribution (e.g. some Telstra FTTP installations).

‡ The required elements for a generic cabling solution (i.e. technology-independent) are shaded like this. Refer to 4.13.

† Separate conduits are required for twisted pair cables and coaxial cables, e.g. where both twisted pair (ADSL) and coaxial (HFC) lead-in cables are to be installed (Figure 10 and Figure 13) or where an outdoor FTTP NTD that supplies RF TV will be installed by the carrier in accordance with Figure 14 (a).

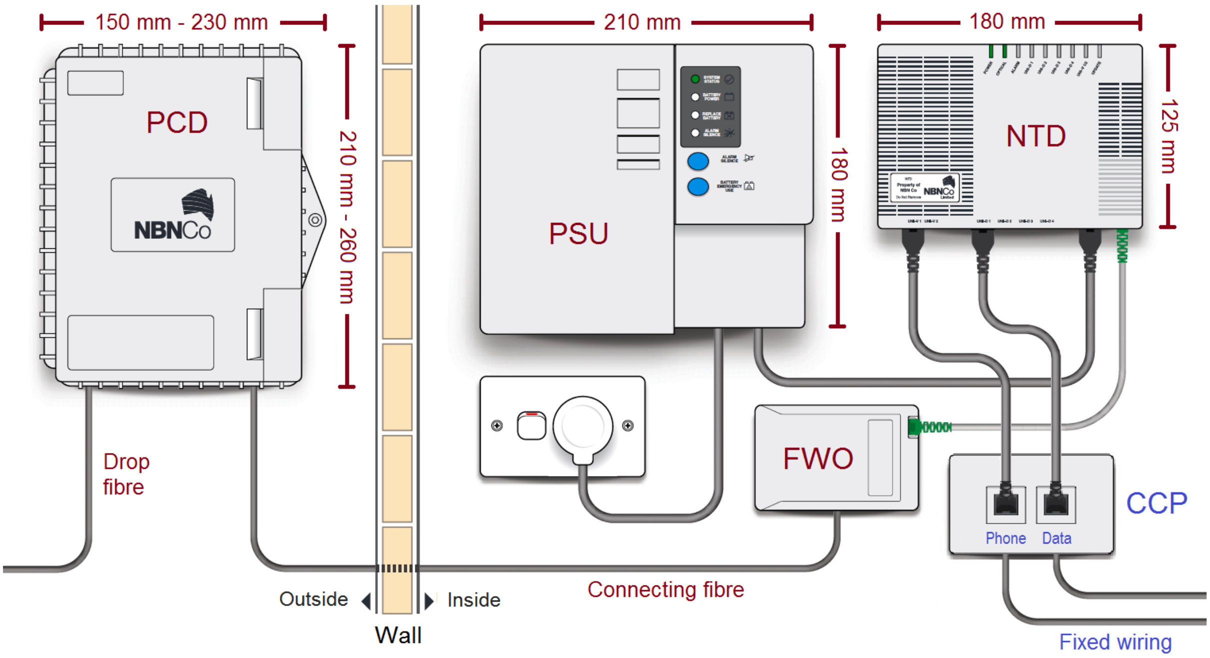
Figure 18 Generic home cabling elements



Notes:

1. The builder or customer is required to arrange and pay for digging and reinstatement of a suitable trench for the lead-in cabling between the carrier's property entry point and the location of the PCD at the building. Depending on the carrier, the builder or customer may also be required to arrange and pay for the installation of the lead-in conduit to the carrier's specifications. Refer to section 5 for more information.
2. The PCD should be located near the external electricity enclosure (meter panel or switchboard) for convenient access and earthing purposes. A combined electricity/telecommunications enclosure is recommended. See section 6 for details.
3. An accessible cabling pathway is required between the PCD and the CCP for installation of the tie cabling **after completion of the building**. The tie cabling may consist of carrier cabling, customer cabling or both. Where practicable, the cabling pathway should comprise at least one rigid conduit with a minimum inside diameter of 23 mm and having no more than the equivalent of three 90° large radius bends. The length of cable between the PCD and the CCP should not exceed 25 m if possible. See 8.2.2.2 for details.
4. Depending on the telecommunications network technology to be used to supply the broadband service, powered equipment may be provided by the carrier, service provider or customer. At least one double-socket power point must be provided at the CCP location for this equipment. The CCP enclosure may be sized to house some or all of the powered equipment or the equipment may be mounted outside the CCP enclosure. Refer to section 9.
5. The CCP should comprise a multi-socket wall plate or a patch panel. Refer to section 10 for details.
6. A double-socket power point should be located near each TO for powering of customer equipment (e.g. cordless telephone, PC or fax machine). The length of cable between the CCP and any TO should not exceed 50 m. Refer to section 10 for more information.
7. At least two data cables and sockets should be provided at the following locations:
   - the master bedroom or any room to be used as a study or home office (see 10.3.6.2 on page 146)
   - the home entertainment centre (see 10.7.4 on page 192).

Figure 19 NBN FTTP components (as at December, 2012)



PCD = Premises Connection Device PSU = Power Supply Unit FWO = Fibre Wall Outlet

NTD = Network Termination Device

CCP = Central Connection Point

Notes:

1. The PCD provides an intermediate connection point for transition from the relatively stiff underground (or aerial) lead-in cable to more pliable indoor type cable. The PCD may also serve the following functions:
   - It provides for storage of excess cable where the excess cannot be stored in a building cavity.
   - It facilitates replacement of either the outdoor cable or the indoor cable if it goes faulty without the need to replace the whole cable run from the pit to the NTD.
   - It provides facilities for fusion splicing of fibres if necessary (i.e. using one or more splice trays).
   - It provides a carrier test point outside the building for measuring optical power levels, which may avoid the need to access inside the building in some cases.
2. The indoor type cable ("connecting fibre") used between the PCD and the FWO is more pliable than outdoor type cable, which allows it to be pulled through smaller radius conduit bends and to be safely bent within wall cavities and enclosures.
3. While the optical fibre cable from the PCD could be connected directly to the NTD, the cable connection and the cable itself are exposed and fragile, and could be easily damaged accidentally by the customer. This would necessitate replacement of the cable between the PCD and the NTD. Therefore, an FWO is used to terminate the indoor cabling from the PCD, and the NTD is connected to the FWO by a fly lead that can be easily replaced if damaged.
4. A PSU is required to power the NTD and this should be located within 1 m of the NTD. The power point required for the PSU should be located within 1 m of the PSU.

4.14 Pre-wiring the home

4.14.1 There is no such thing as "future-proof" cabling!

Telecommunications technology is advancing at a rapid rate and there is no such thing as "future-proof" cabling. At best, current home cabling technology will meet consumer expectations for **10-15 years**, which is a fraction of the life expectancy of both the home and the occupants.

Therefore, when building a new home it is important to **make provision for easily and economically augmenting or replacing the cabling** at some future time by providing suitable accessible cabling pathways and spaces. This is the only real way to "future-proof" a home to ensure continued access to modern telecommunications services.

4.14.2 Telecommunications network technology changes

Ultimately, as described in 4.2, it is expected that up to 93% of homes, schools and workplaces will be connected to FTTP. Accordingly, any homes and small businesses that will initially be connected to the existing ADSL (telephone) or HFC ("cable") network will need to provide an upgrade path for FTTP. Even with FTTP, the home should be provisioned for the possibility of either an outdoor or an indoor FTTP NTD in case the carrier or the FTTP cabling methodology changes.

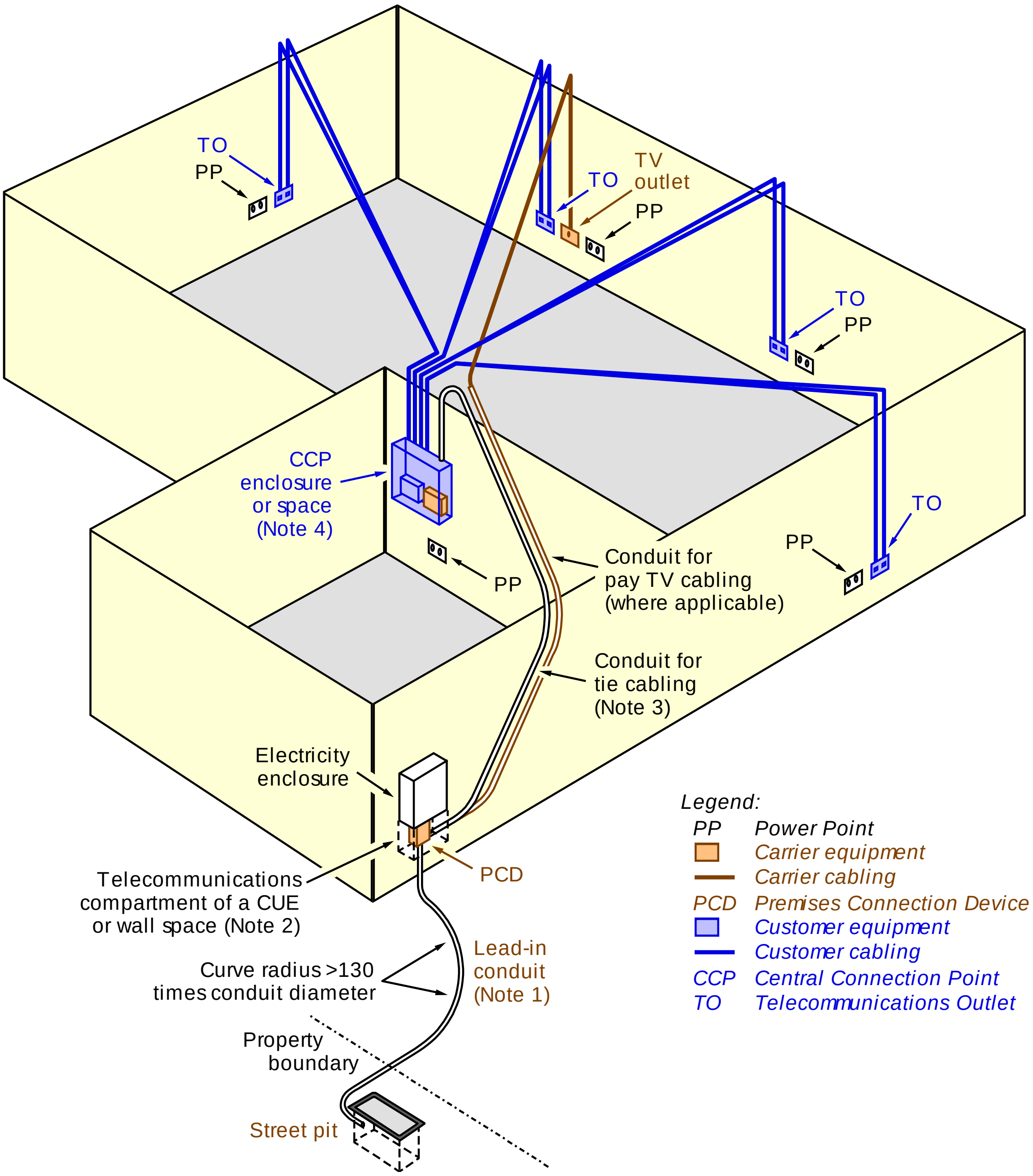
4.14.3 Generic pre-wiring

Figure 20 shows the key elements needed to provide an upgrade path for the telecommunications network cabling to the CCP. This is especially relevant where a home is being cabling for current telephone, ADSL or HFC technologies but needs to be easily upgraded to NBN technologies in the future.

Irrespective of the telecommunications network technology used, the customer cabling methodology between the CCP and the TOs will be the same regardless of the level of cabling sophistication that the customer requires. Figure 20 shows a "standard" home networking system described in 10.3.6 (page 138), which is recommended for family homes. No matter what level of customer cabling is installed initially, allowance should be made for future upgrading of this cabling by providing suitable accessible pathways and spaces for the installation of additional or replacement cables long after the building has been completed. This is relatively easy to do for a single-storey building with accessible roof or underfloor space but may be more challenging for a multi-storey home or an apartment. Refer to 10.9 on page 224 for cabling guidance.

All twisted pair cabling should be 4-pair **data cable** (e.g. Category 6) as described in 4.14.5.2, which may be used for either digital ("data") or analogue ("voice") applications.

Figure 20 Generic cabling pathways and spaces for home cabling



Notes:

1. The lead-in conduit is used for pulling in twisted pair, coaxial, or optical fibre lead-in cabling, as required.
2. The use of a Combined Utilities Enclosure (CUE), described in 6.2 (page 71), is recommended. A CUE will house any style of PCD and avoids the need to work out lead-in or building entry conduit positioning for the PCD.
3. An accessible cabling pathway is required between the PCD and the CCP for installation of the tie cable(s) **after** completion of the building. The conduit for the tie cabling is used for pulling in twisted pair, coaxial, power supply or optical fibre cabling, as required. Another conduit may be required for coaxial cabling for pay TV (if available). The length of cable between the PCD and the CCP location **should not exceed 25 m** if possible (see 8.2.2.2).
4. The CCP enclosure may be sized to house some or all of the powered equipment or the equipment may be located outside the CCP enclosure or in a separate enclosure.
5. If possible, ensure that permanent access will be available for future installation of additional or replacement cables between the CCP and the TOs.
6. Where suitable access will not be available for future installation of additional or replacement cables, consider installing rigid conduit with large radius bends between access points. Bend radius should be 100 mm or more.
7. The length of cable between the CCP and any TO **should not exceed 50 m**. See 10.5.7 (page 181) for details.

4.14.4 Data cabling description

4.14.4.1 Cabling standards

Historically, different cabling systems were provided in customer premises for different applications. For example, telephone systems were interconnected via twisted pair cabling installed specifically for telephony purposes, whereas computer systems were interconnected via a separate Local Area Network (LAN) using coaxial cabling or some other cabling medium.

In the early 1990s, standards were developed to support the use of a universal or "**generic**" system of cabling that could be used for a wide range of communications applications including, but not limited to, distribution of telephone, PABX and ISDN services and interconnection of computers. The generic cabling standard that applies in Australia, **AS/NZS 3080**, was first published in 1992 and was based on USA standard ANSI/TIA/EIA 568-A. The current version of AS/NZS 3080, *Telecommunications installations — Generic cabling for commercial premises*, published in 2003 and last amended in 2008, is based on International Standard ISO/IEC 11801, which was initially published in 1995.

A generic cabling standard for homes, **AS/NZS ISO/IEC 15018**, *Information technology — Generic cabling for homes*, was published in 2005 and includes requirements for the installation of broadcast (TV) cabling and building services/control cabling (e.g. home automation, security). However, AS/NZS 3080 is the primary reference for cabling system classification, described below.

4.14.4.2 Cabling system classification (cable "category")

With the generic cabling standards came a classification scheme for installed cabling systems that was developed to support known applications and in anticipation of future applications. The classification scheme defines "classes" of cabling systems and "categories" of cabling components. A cabling **class** sets out performance requirements over a **channel** or a **permanent link** (i.e. end to end) while a component **category** is specified to meet or exceed the requirements for a particular cabling class.

A **channel** is an end-to-end transmission path connecting any two pieces of application-specific equipment and includes the fixed cabling, sockets, plugs and connecting cords but not the connecting socket in the equipment itself. A **permanent link** is a transmission path of an installed cabling subsystem including the fixed cabling and connecting hardware (e.g. sockets) at the ends of the installed cable. The difference between a channel and a permanent link is explained pictorially in Figure 21.

Cabling classes are defined largely to support the various iterations of **Ethernet**. Ethernet is a standard communications protocol used within premises to interconnect computers and other data equipment such as modems, printers, scanners and storage devices. While Ethernet may be used over coaxial cabling (obsolete) or optical fibre cabling, the use of Ethernet over twisted pair cabling is now so widespread that nearly every electronic device produced today is equipped with an "RJ45" Ethernet port for connection of the device to the home network or directly via a modem/gateway to the internet.

Modern data equipment that contains an Ethernet port will support the three common forms of Ethernet, namely **10Base-T** ("standard" Ethernet), **100Base-TX** ("Fast" Ethernet) and **1000Base-T** ("Gigabit" Ethernet). Such equipment may be described as supporting "10/100/1000" Ethernet. While **10GBase-T** (10 Gigabit Ethernet or "10 GE") has been defined in the standards, it may be some time before it becomes an economical proposition for home networks. It took almost ten years for Gigabit Ethernet to become universally available at a reasonable cost for domestic applications.

Table 2 lists cabling system classes, the corresponding component categories and their typical application. Refer to Figure 21 for a pictorial explanation of channel, permanent link and the difference between a cabling system class and a component category.

Cables and connecting hardware of different categories may be mixed within a channel. However, the resultant cabling performance (class) may be determined by the lowest category of component used. This would need to be confirmed by certification testing in accordance with 14.2 (page 268).

Table 2 Cabling system classes and component categories (AS/NZS 3080)

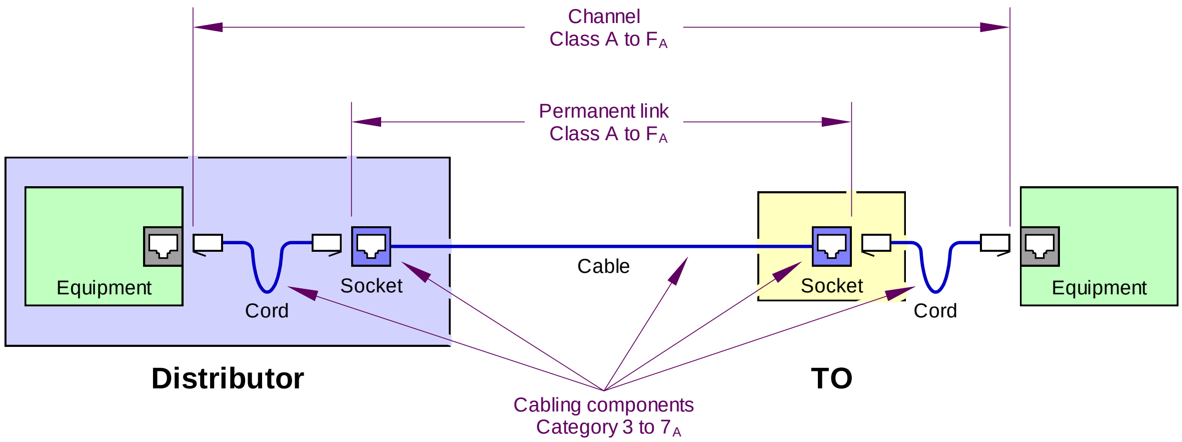
Cabling Class	Component Category	Maximum frequency	Typical application	Pairs used	Cable type *	Comments
A **	— **	100 kHz	Telephony	1	UTP	Twisted pair or star quad telephone cabling
B **	— **	1 MHz	ISDN	2	UTP	Indoor twisted pair telephone cabling
C **	3 or 4 **	16 MHz	10Base-T	2	UTP	Standard Ethernet (10 Mbps)
D	5 (or 5e ***)	100 MHz	100Base-TX	2	UTP	Fast Ethernet (100 Mbps)
			1000Base-T	4	UTP	Gigabit Ethernet (1000 Mbps)
E	6	250 MHz	1000Base-T	4	UTP	Gigabit Ethernet and limited 10G Ethernet
E_A	6_A	500 MHz	10GBase-T	4	UTP	10 Gigabit (10G) Ethernet (10,000 Mbps)
F	7	600 MHz	10GBase-T	4	STP	10 Gigabit (10G) Ethernet (10,000 Mbps)
F_A	7_A	1,000 MHz	10GBase-T	4	STP	10 Gigabit (10G) Ethernet (10,000 Mbps)

* UTP = Unscreened Twisted Pair, STP = Screened Twisted Pair (see 4.14.4.4)

** While it could be assumed that Category 1 and Category 2 are the corresponding component categories for Class A and Class B cabling respectively, component categories were never assigned to Class A and Class B. Specifications for Classes A, B and C and Categories 3 and 4 have been removed from AS/NZS 3080.

*** Category 5e ("Category 5 enhanced") was an interim specification issued to support Gigabit Ethernet on a Class D cabling system using bidirectional transmission over four cable pairs. The enhanced requirements were incorporated in the Class D/Category 5 requirements in the second edition of ISO/IEC 11801 and the 2002 edition of AS/NZS 3080, i.e. Category 5 of the current standard corresponds to the interim Category 5e and Category 5e is not defined in the standard. Products manufactured to the current Category 5 requirements will meet or exceed the previous Category 5e requirements. However, products are still marketed and described as "Category 5e", presumably to avoid doubt.

Figure 21 Channel, permanent link, Class and Category



Notes:

1. Installed cabling systems are generally described as meeting a certain level or "Class" of performance whereas cabling components (such as cable and connecting hardware, including plugs and sockets) used to build the cabling system are described as meeting a certain "Category". While it is common for a system installed using, say, Category 5 components, to be described as a Category 5 cabling system, technically it is more correct to describe it as a Class D cabling system. Refer to Table 2 for corresponding Classes and Categories.
2. Specifications for Classes A, B and C cabling and Category 3 and 4 components have been removed from International Standard ISO/IEC 11801 and Australian Standard AS/NZS 3080.
3. Category 1 and Category 2 components were never defined in the standards but they are notionally equivalent to Class A and Class B cabling respectively (see Table 2).

4.14.4.3 Nominal impedance

The **nominal impedance** of a data channel (see Figure 21) is **100 ohms**. Given that the cabling may be used to carry telephone and ADSL services, it is interesting to compare this with the nominal impedance for **telephone networks**, which is **600 ohms**. However, this apparent mismatch does not create any problems. The reasons for this are explained below (some knowledge of transmission theory may be required to understand it). It is worthwhile discussing nominal impedance further to understand why it is important to install data (and coaxial) cables and components with care. Maintaining cabling system "balance" is fundamental to assuring maximum performance of the installed cabling system.

The nominal impedance of a line (i.e. a pair of conductors) is the approximate or averaged value (in ohms) of the **characteristic impedance** of that line over a **specified frequency** or range of frequencies (bandwidth). The characteristic impedance of a line is the impedance that an infinite length of that line would exhibit at a particular frequency when measured at the near end of the line. While it is not possible to provide an infinite length of line, with any line there will be a finite length at which either short-circuiting the distant end or leaving it open-circuit will have virtually no effect on the impedance of the line measured at the near end. This impedance will be its characteristic impedance.

To explain this further, each line has a value of **resistance**, **capacitance** and **inductance**. For DC voltage, capacitance and inductance have no effect on current flow, only resistance. However, for AC voltage, resistance has the same effect as for DC but capacitance also has a shunting effect while inductance has a further resistive effect on current flow. The overall opposition to the flow of AC current is referred to as **impedance**. It is important for any termination on a line to have the same impedance as the characteristic impedance of the line to avoid **reflection** of some of the signal back to the source, which will result in **signal loss** and **distortion** of the original signal. For voice signals, this may result in poor audible quality or echo; for video signals this may result in poor picture quality or ghosting; and for digital signals, the result may be excessive bit errors and slower data speed because the faulty data has to be retransmitted.

At lower frequencies, the characteristic impedance varies greatly with frequency. For example, a typical "unloaded" telephone line has a nominal impedance of 600 ohms at voice frequencies (300 - 3400 Hz) but, in reality, the characteristic impedance is around **1115 ohms at 800 Hz** and about **570 ohms at 3000 Hz**. For long telephone lines, a technique called "**loading**" (inserting extra inductance and capacitance in the line at regular intervals) may be used to provide a more even impedance across the voice frequency bandwidth to improve the quality of the signal. Loading increases the line impedance (loaded lines have a nominal impedance of **1200 ohms**). However, while it is good for improving voice signalling, loading is toxic to ADSL because it severely attenuates the high ADSL frequencies.

At **higher frequencies**, characteristic impedance tends to be more **constant** across the bandwidth as the capacitive and inductive characteristics of cables tend to counteract each other, i.e. with increased frequency, capacitive reactance reduces while inductive reactance rises. For example, a typical **telephone line** has a characteristic impedance of around **130 ohms at 100 kHz** (quite a difference from 570 ohms at 3 kHz) but this only reduces to about **110 ohms at 1 MHz**. However, **signal attenuation increases with frequency** as more of the signal is shunted by reduced capacitive reactance and impeded by increased inductive reactance. A phenomenon called **skin effect** also comes into play **above about 1 MHz** in which the high-frequency currents only flow in the outer layer ("skin") of the conductor. This effectively increases the resistance of the conductor as the frequency rises because less of the conductor is used for current flow.

From the above, it can be seen that the characteristic impedance of telephone lines is roughly the same as the nominal impedance of data cable at frequencies above about 1 MHz (e.g. ADSL frequencies) so, for this bandwidth at least, there is no significant impedance mismatch where telephone/ADSL lines are connected to 100-ohm data cabling. However, what about voice and ADSL frequencies below 1 MHz? Well, there is another factor to be considered — wavelength — as described below.

In order for a cable's characteristic impedance to make any difference to the way the signal passes through it, the cable must be **at least a large fraction of a wavelength long** (one tenth or more) for the particular frequency it is carrying. Most lines will have a speed of travel for AC current of 60% to 70% of the speed of light or about 200 million metres per second. Using the formula for calculating wavelength (speed ÷ frequency), an audio frequency of **3000 Hz** will have a wavelength of around **67 km**, so any impedance mismatch within a cabling distance of less than 6.7 km will not have a significant effect on the signal. Therefore, any impedance mismatch in **home cabling**, such as **using 100-ohm data cable** or **star wiring telephone outlets**, **will have no adverse effect on voice signals** carried by telephone lines. For **ADSL frequencies between 25 kHz and 1 MHz**, the wavelength of the signal will vary between **8 km and 200 m**. It is only at the upper limit of that bandwidth that cable impedance becomes important but, even then, only for a cabling length of 20 m or more. For the **upper bandwidth of ADSL2+** (1.1 MHz to 2.2 MHz), the wavelength will be around **180 m to 90 m**, so any impedance mismatch in cabling lengths of **9 m or more** may begin to **have an effect** on the signal — but at those frequencies, the telephone and data cables should be a close impedance match, as explained on the previous page. However, any significant cabling mismatch such as a **star wiring** point may cause **signal reflections at ADSL frequencies** that could reduce ADSL performance. **Star wiring will have no effect on voice signals.**

For **Category 5 to 7_A** components that are designed to support frequencies from **100 MHz to 500 MHz** (see Table 2), **component impedance becomes very important** as the wavelengths of the signal frequencies will be very short — between **0.4 m and 2 m**. For these frequencies, a kink or a sharp bend in the cable or excessive untwisting of the cable pair at the termination can cause an impedance mismatch, signal reflection, loss of signal power transfer, increased crosstalk and resultant bit errors.

4.14.4.4 Cable composition

Twisted pair cable used for generic cabling is referred to as **balanced cable**. This expression is not used in this document (the term **data cable** is used) but you will need to recognize it in case you encounter it in cabling specifications or tender documents. The other type of metallic conductor cable specified in some cabling standards is coaxial cable, which is referred to as **unbalanced cable** because the conductors of a coaxial cable (i.e. the centre conductor and the outer conductor or shield) are of different composition.

With twisted pair cables, there are two main types of construction — unscreened and screened. The former is commonly described as **UTP** (Unscreened Twisted Pair or Unshielded Twisted Pair) while the latter is commonly described as **STP** (Screened Twisted Pair or Shielded Twisted Pair). You may also encounter the expression **FTP** (Foil-screened Twisted Pair) but “STP” is more commonly used.

UTP cable is relatively inexpensive and easy to install. Conversely, STP is more expensive and more difficult to install than UTP. As you can see from Table 2, Category 7 and 7_A cables are manufactured as STP — this is how their outstanding performance is achieved but it comes at a cost. With Category 7 and 7_A cables, both the individual pairs and the cable core are screened, which means the sockets must be appropriately screened as well.

Category 5, 6 and 6_A cables are available as STP but the screening is normally only around the cable core (not the individual pairs) and it does not improve the cable performance per se but improves noise immunity in noisy (usually industrial) environments to maintain channel/link performance. For home cabling, the use of STP should only be necessary if there is a likely source of external interference (e.g. a powerful nearby radio transmitter) or the cable will be used for an application that may be more suited to coaxial cabling (e.g. TV RF distribution). **For most homes, only UTP is necessary.**

For a physical comparison of Category 5/5e, 6 and 6_A UTP cables, refer to 10.5.5.

Only cable with solid copper conductors should be used for fixed cabling, while patch cords and equipment connecting cords should have stranded conductors for flexibility. Cable with stranded conductors should not be used for fixed cabling because it has higher attenuation (loss) than solid-conductor cable.

Beware of cables being sold (usually on the internet) that have copper-clad or copper-coated aluminium conductors. These are illegal to use in Australia. They may precipitate corrosion at terminals that are only designed for use with solid copper conductors and they may overheat and cause a fire if used for Power over Ethernet (PoE) due to the lower current-carrying capacity of aluminium compared to copper.

4.14.4.5 Cable length

The maximum length of data cable allowed in the standards for a **permanent link** (i.e. between a distributor and a TO) is **90 m**. Allowance is made in the standards for an **additional 10 m of patch cords and connecting cords**, making a total **channel length** of **100 m**. Because **stranded-conductor cable** used for cords has **higher attenuation** than solid-conductor cable used for the fixed cabling, exceeding 10 m of cords will reduce the permissible length of fixed cable. However, neither of these limits (90 m of cable, 10 m of cords) is significant for most homes, as cable runs rarely exceed 40 m.

Note: Category 6 cabling exceeding a length of 50 m is unlikely to support 10GBase-T, while Category 6_A cabling will support 10GBase-T for the full 100 m channel length.

For a large home, it is recommended that the CCP be located such that none of the TO cables (i.e. between the CCP and the socket on the wall plate) exceeds a length of **50 m** to ensure compatibility with most applications (refer to 10.4.2 on page 148). This is particularly important if Class E (Category 6) cabling is expected to support future 10GBase-T Ethernet (refer to the Note above).

4.14.4.6 Underground and aerial cabling

If it is necessary to run a **cable to a separate building** in the premises (e.g. a detached garage, shed or “granny flat”):

- If the cable will be installed **underground**, special cable rated for underground use must be used whether or not it is installed in conduit. This is both a legal and technical requirement. Water will seep or condense into the conduit no matter how carefully it is installed and that water will eventually migrate through the sheath of indoor type cable into the cable core and render the cable unusable. Cable designed for underground use has a high-density sheath (usually polyethylene) and the core is filled with a water-blocking compound such as grease, gel or a special swelling agent such as yarn, powder or tape, to prevent the spread of water within the cable in case it does penetrate the sheath (e.g. due to a manufacturing defect or sheath damage).
- If **aerial** cabling is to be installed, the cable must be a special cable rated for underground or aerial use or must be protected from exposure to direct sunlight by such means as enclosure in conduit.
- **Surge suppression** should be installed on the cable where it enters/exits each building to protect the end-user from lightning-induced overvoltages.
- **Most powered electronic equipment used in the home will not support the connection of metallic underground or aerial cabling to its ports and it would be illegal to do so.** See section 12 (page 252) for more information.

4.14.4.7 Compliance testing

Compliance with a cabling Class cannot be guaranteed by simply installing components of a certain Category. The combination of long cable runs, careless installation and electromagnetic interference from other systems or equipment may degrade the cabling system performance. Compliance with a cabling Class is confirmed by testing each channel or permanent link using expensive testing equipment. Such testing is generally described as “certification” testing.

However, certification testing is not usually specified for home networks due to:

- the cost of purchasing or hiring the test equipment for use on relatively small home installations;
- the fact that only short cable runs are employed in most homes; and
- the general absence of interference sources in the home environment.

Compliance testing in homes is usually limited to continuity or “wiremap” testing (often described as “verification” testing) to confirm that the cables are connected correctly at each socket. Refer to section 14 (page 268) for more information.

4.14.5 Recommended cabling classification for homes

4.14.5.1 Analysis

It may be argued that the fastest broadband speed currently available is 100 Mbps (up to 1000 Mbps is forecast for FTTP in the future) and that Class D (Category 5/5e) cabling supports data signalling up to 1000 Mbps, so Category 5/5e is more than adequate for home cabling. This may be true for the cabling between the NTD and the CCP but the cabling between the CCP and the TOs may be used for exchanging data files between computers or other devices and, for this purpose, the faster the better.

Furthermore, even though Class D cabling (Category 5/5e components) will support 1000 Mbps (Gigabit Ethernet), which is the highest level of sophistication for consumer-grade electronics currently, Class E cabling (Category 6 components) has lower insertion loss, better noise immunity at higher frequencies and will produce a higher signal-to-noise ratio than Class D. This provides an increased performance margin for Gigabit Ethernet and will support 10 Gbps (10 Gigabit Ethernet) over a limited cabling distance (up to about 50 m) when 10 Gbps routers and switches become economically viable. Category 5/5e cable and components are already becoming obsolescent and the price premium for Category 6 cable and components continues to fall.

While Class E_A cabling (Category 6_A components) will support 10 Gbps over the full channel length of 100 m, Category 6_A components are around double the cost of Category 6 components and, for home cabling, this extra expense may be wasted. Class E_A cabling has superior alien crosstalk performance for commercial cabling environments but alien crosstalk (noise induction from adjacent cables) is not a significant concern in homes.

4.14.5.2 Class E cabling (Category 6 components) is recommended

It is recommended that Class E cabling (Category 6 components) be installed at the outset if the budget permits; otherwise install Class D cabling (Category 5/5e components). Class E cabling should support 10 Gigabit Ethernet for a cabling length of up to 50 m. Class D cabling will support Gigabit Ethernet (albeit with possible bit errors in some circumstances) but it will not support 10 Gigabit Ethernet.

Class E_A cabling (Category 6_A components) is not considered necessary for home cabling and is not recommended due to its cost. If the cost of Category 6_A components reduces substantially, it may be worth the extra expense for peace of mind. Whatever Class of cabling is installed, the connectors used should be compatible with the commonly used “RJ45” plugs and sockets used for Ethernet connections.

For a physical comparison of Category 5/5e, 6 and 6_A UTP cables, refer to 10.5.5.

For most homes, only Unscreened Twisted Pair (UTP) cable is necessary. The use of Screened Twisted Pair (STP) cable should only be necessary if there is a likely source of electromagnetic interference (e.g. a large, neighbouring radio transmitter).

4.14.5.3 What about Class F cabling (Category 7 components)?

Installing Class F or F_A cabling (Category 7 or 7_A components) is another option but this is very expensive, difficult to terminate on sockets, does not provide any better performance for 10G Ethernet, and is therefore hard to justify for home cabling. Backwards compatibility of connectors (i.e. with the ubiquitous “RJ45”) is also an issue to be considered.

4.14.5.4 What about optical fibre LAN cabling?

Optical fibre cabling may also be installed for the home network but it is very expensive and may need to be augmented by twisted pair cabling for the following reasons:

- Fibre does not conduct electricity. Therefore, applications that rely on power feed from the source, such as a telephone service or PoE (Power over Ethernet) equipment, will need to be connected via powered adaptors (“media converters”) or via a separate twisted pair cable home network.
- Optical fibre connectors are sensitive to contamination from foreign particles and this may preclude “plug-and-play” operations by the consumer.

- Optical fibre Ethernet for homes does not enjoy high market penetration and few, if any, consumer products have an optical Ethernet port (not to be mistaken for TOSLINK or S/PDIF). Therefore, special powered adaptors ("media converters") will be required, initially at least, to connect common Ethernet equipment to the optical home network.

4.14.6 What about wireless?

Wireless ("Wi-Fi") technology cannot be relied on to provide access to high-speed digital applications in all situations and is generally inadequate for exchanging large files between computers or network storage devices. Therefore, it is not a suitable substitute for a wired network (refer to 4.7). However, at least one wireless access point should be installed in the home to provide access to the home network and the internet by portable devices such as notebook computers, tablets and "smartphones" (see 10.6).

5 LEAD-IN CABLING

5.1 Description

5.1.1 General

Lead-in cabling is the cabling from the last distribution point in a carrier's telecommunications network to the network boundary in the customer's premises.

Lead-in cabling will normally be installed underground unless aerial cabling distribution is already being used in the street and/or the ground conditions or circumstances preclude underground installation. Where aerial lead-in cabling is used, the cabling principles and practices in the building are basically the same as for underground lead-in cabling apart from the cable entry point.

Telecommunications carriers decide whether to install their lead-in cabling underground or aerial based on technical, safety, economic and any applicable environmental or regulatory factors. Underground cabling is used in virtually all new property developments.

5.1.2 Multiple buildings

Where the premises will contain two or more buildings and the buildings will require separate telecommunications services, separate lead-in cabling may be required for each building. For more information, refer to 5.2.4.4 on page 49.

5.2 Underground lead-in cabling

5.2.1 General

Where underground lead-in cabling is to be installed, the builder, home owner or customer is required to arrange and pay for suitable trenching for the lead-in cabling between the carrier's cabling entry point at the boundary of the premises ("property entry point") and the cabling entry point at the building ("building entry point"). "Trenching" means clearing of land along the cabling route, digging of the trench and reinstating the land after the cabling is installed. Refer to 5.2.5 on page 54 for details.

The builder, owner or customer may also need to supply and install the lead-in conduit (see 5.2.2.1).

In **urban areas**, lead-in cabling is installed in conduit irrespective of the distance between the property boundary and the building. Where the total length of the conduit **will exceed 50 m**, **intermediate pits** are required at no more than **50 m intervals** to provide access points for pulling cables (see Figure 24).

In **rural areas**, Telstra installs its lead-in cable directly in the ground without conduit except for about the last 3 m to the building where conduit is used for additional cable protection.

Note: It is unlikely that FTTP will be installed in rural areas in the foreseeable future. In rural areas, NBN services are likely to be supplied by fixed wireless or satellite. Nevertheless, copper lead-in cabling may be required for the supply of a telephone service and, if available, an ADSL service may also be supplied via this cable.

5.2.2 Conduit requirements

5.2.2.1 Who provides the conduit?

In new developments that are in NBN Co's "long-term fibre footprint", the lead-in conduit and any necessary pits are to be supplied and installed by the builder, owner or customer to NBN Co's specifications. In the absence of any NBN Co specifications for lead-in conduit, the lead-in conduit requirements described in this document may be used as a guide.

Where the lead-in cabling is to be connected to the Telstra network to supply a Telstra service, the supply and installation the lead-in conduit and any necessary pits in a customer-supplied trench are included in the Telstra connection charge for the service. However, the builder or owner may opt to supply and install the lead-in conduit for expediency, in which case it must be installed in accordance with Telstra's requirements as described in this document.

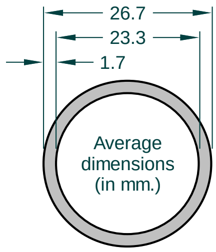
5.2.2.2 Conduit material and size

For an individual home, the lead-in conduit must be **rigid UPVC** with an **inside diameter** (**ID**) of **23 mm**. Flexible or corrugated conduit must **not** be used for underground lead-in cabling. The cross-sectional dimensions of the conduit are illustrated in Figure 22.

Notes:

1. This conduit size is referred to by Telstra as "20 mm" conduit (its nominal inside diameter) or "P20" ("Plastic 20 mm").
2. Any conduit manufactured to Australian Standard AS/NZS 2053 (e.g. marked as "20 mm", "25 mm" or "32 mm" and including "2053" in the markings) is physically incompatible with Telstra and NBN Co networks and is **not** suitable for lead-in cabling. Polyethylene conduit or pipe is also **not** suitable for lead-in cabling.

Figure 22
Conduit dimensions



5.2.2.3 Conduit colour and markings

Lead-in conduit and bends must be coloured **white**. Conduit of any other colour is **not** acceptable. For **Telstra** lead-in cabling, the conduit and bends may be marked "Telstra", "NBN" or "Communications". Any of these markings are acceptable to Telstra as long as the conduit ID is 23 mm.

Note: Alternative conduit markings may not be acceptable to NBN Co for NBN lead-in cabling.

5.2.2.4 Bends and curves

No more than **two underground 90° bends** with a minimum inner bend radius of **300 mm** are permitted between access points. Composite bends may be used at the building footings as shown in Figure 57 on page 78. A **third 90° bend** with a minimum inner bend radius of **100 mm** is permitted **above ground** at the cable access point **at the building** (e.g. in the wall cavity). Only **prefabricated bends** may be used. Conduits must **not** be bent on site (e.g. by application of heat).

Curvature of glued lengths of conduit **is allowable** without affecting the number of bends that may be used as long as the **curvature radius** is no less than **130 times the nominal inside diameter of the conduit** (in practical terms, this means curving the conduit without distorting the cross-sectional roundness of the conduit). Refer to Figure 24.

Where it would be necessary to use more than two underground 90° bends (e.g. to effect a sharp change of direction in the middle of the conduit run), an intermediate access pit must be used as a cable pulling point. Refer to Figure 25.

5.2.2.5 Conduit installation

Conduit and bend joints must be glued with solvent cement.

The conduit markings should face upwards when the conduit is laid in the trench so as to be visible if the conduit is exposed by digging after its initial installation.

A pull-cord or cable must be threaded through the lengths of conduit during assembly for later installation of the lead-in cable by the carrier. Each end of the conduit must be plugged to prevent the ingress of silt or debris into the conduit.

5.2.2.6 Conduit integrity

To be “FTTP ready”, the lead-in conduit and bends must be capable of passing an optical fibre cable that has a pre-terminated connector protected by stiff plastic tubing and covered by a polypropylene hauling sock. This assembly has a total diameter of up to 18 mm for a length of about 800 mm and is semi-rigid. The protective tubing and hauling sock protect the optical fibre and optical connector while the cable is being pulled through the lead-in conduit and ensure that no pulling force is exerted on the connector. The sock will not pull through small-radius conduit bends due to its large diameter and relative stiffness.

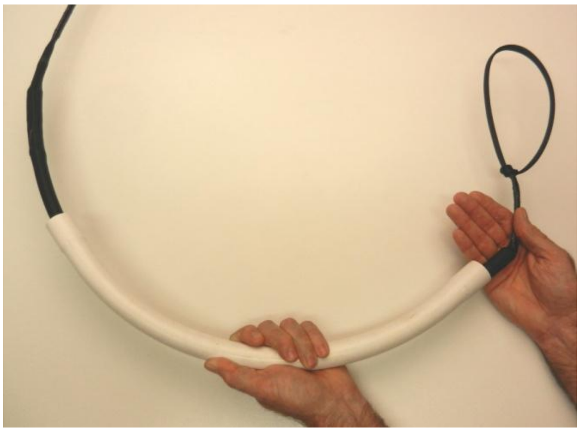
Figure 23 shows an optical fibre cable assembly threaded through 300 mm and 100 mm radius bends.

Note: Optical fibre cables with factory-fitted connectors may be preferred by some carriers to simplify installation and reduce installation costs by avoiding the need for expensive field splicing equipment and skilled operators. The main disadvantages of using cable with factory-fitted connectors are:

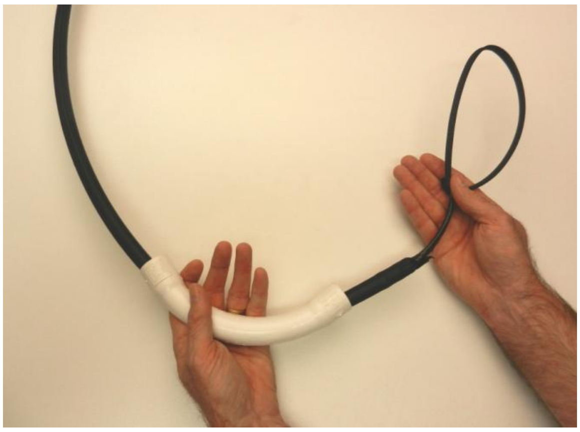
- The integrity of the conduit used to pull in the cable is very important.
- The cables are supplied in predetermined lengths, so slack cable needs to be stored somewhere (e.g. in the pit, PCD or building cavity).

Figure 23 Pre-terminated optical fibre lead-in cable threaded through 23 mm ID conduit bends

(a) 300 mm radius bend (for use underground)



(b) 100 mm radius bend (for use in the wall cavity)

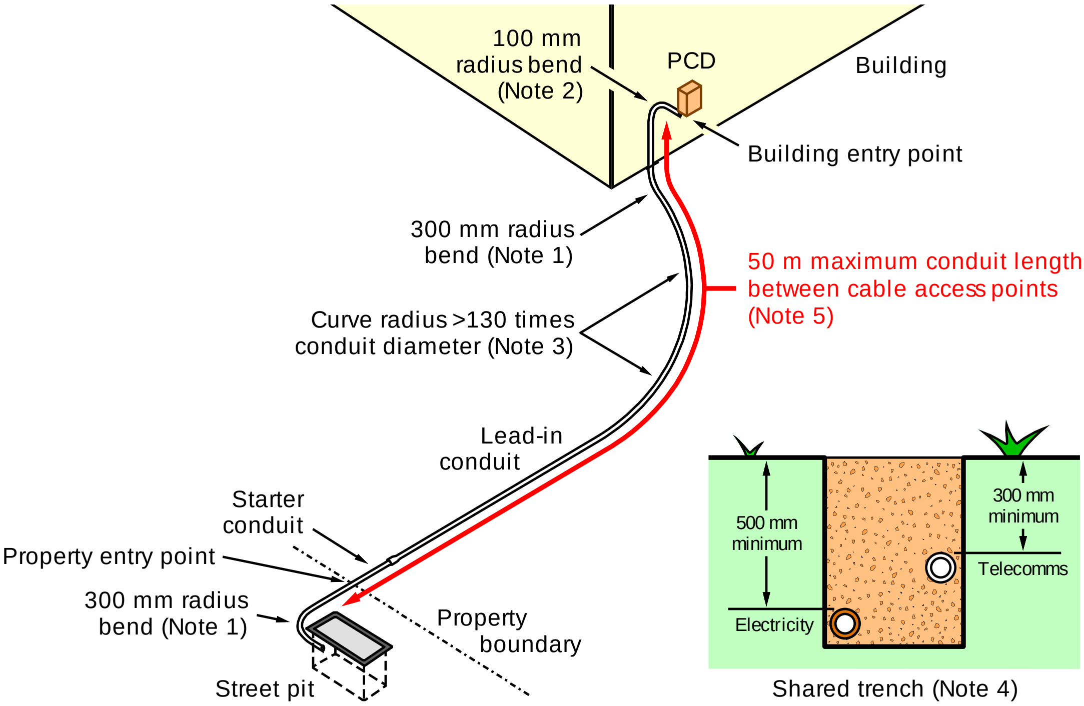


Notes:

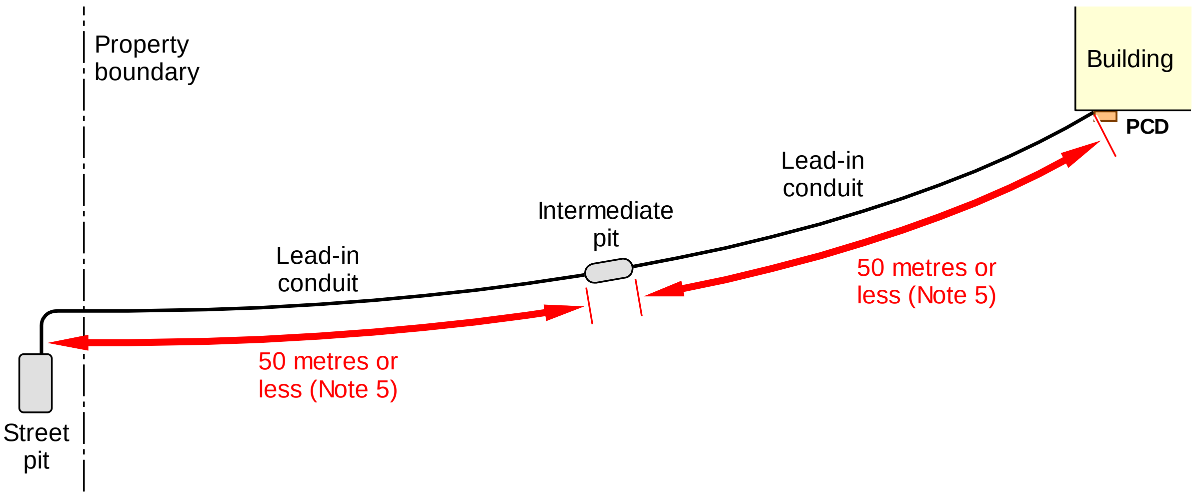
1. 300 mm radius bends are used at pits and vertically at the building footings.
2. A 100 mm radius bend is only permissible in the wall cavity of the building.
3. It can be seen from the above pictures that the cable hauling sock is a tight fit in the conduit, so clear, undamaged conduit and large radius bends are essential.

Figure 24 Lead-in conduit length, curvature and bend limitations

(a) Standard urban lot



(b) Large urban lot (or street pit distant from the premises)



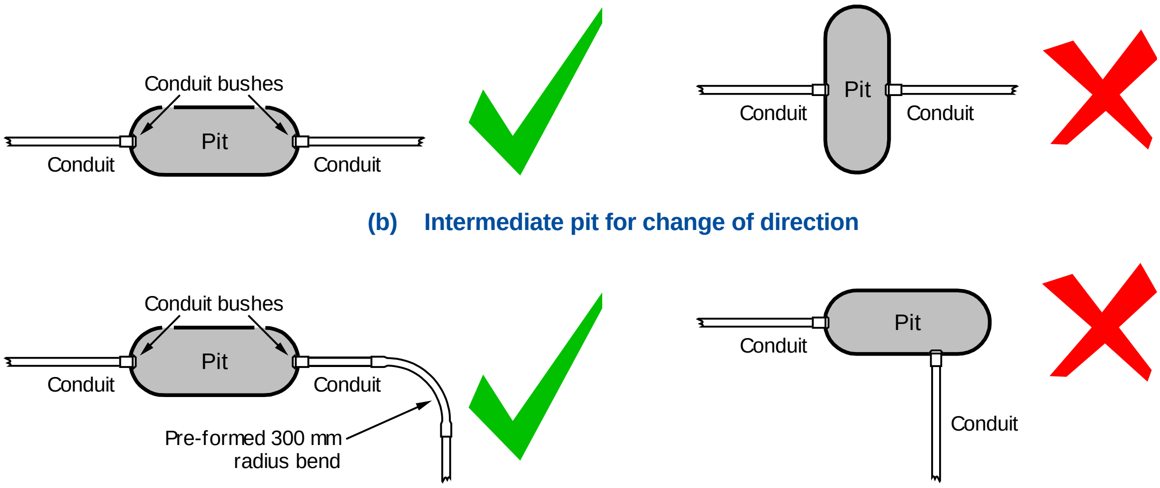
Notes:

1. Underground bends must have a minimum inner bend radius of 300 mm. Composite bends may be used at the building footings as shown in Figure 57 on page 78.
2. A prefabricated bend with a minimum inner bend radius of 100 mm is allowable in the wall cavity of the building.
3. The conduit may be curved to a minimum radius of 130 times the nominal inside diameter of the conduit (i.e. 2600 mm in the case of 23 mm ID conduit which has a nominal inside diameter of 20 mm). In practical terms, this means curving the conduit without distorting the cross-sectional roundness of the conduit.
4. A shared trench with the electricity mains is recommended. No separation is required between the orange electricity conduit and the white telecommunications conduit but the white conduit should be laid above (on top of) the orange conduit where possible. Refer to 5.2.5.8 on page 58 for details.
5. If the total length of conduit between access points will exceed 50 m, one or more intermediate pits must be installed at intervals not exceeding 50 m.

Figure 25 Right and wrong use of intermediate pits

(a) Intermediate pit for pulling cables

(b) Intermediate pit for change of direction



Notes:

1. A size 2 ("P2") pit may be used as an intermediate pit for lead-in conduit to a single dwelling. The minimum internal dimensions (in mm) of a size 2 pit are 490 L x 125 W x 500 D. These pits are usually round-ended as shown above.
2. The conduit should be glued to a bush that is installed flush with the inside wall of the pit except in highly reactive soils where the conduit may be extended no more than 50 mm inside the pit. The bush or conduit must be a tight fit through the pit wall to minimise the entry of silt into the pit.
3. The bottom edge of the conduit must enter the pit no less than 50 mm above the inside surface of the bottom of the pit (this is to reduce the risk of silt or debris entering and clogging the conduit over time).
4. Where more than one conduit enters the same end of the pit (e.g. for branching of conduits as shown in Figure 32 on page 51), the conduits must be separated at the pit by at least 25 mm.

5.2.2.7 Use of lead-in conduits/pits/cables

Lead-in **conduit** must **not** be used for customer cabling (e.g. for private cabling to another building in the premises). Customer cabling must be installed in separate conduit but may share the lead-in trench. Separate conduit must be provided for the installation of customer cabling between buildings.

Lead-in **pits** should not be used for customer cabling unless this is unavoidable (e.g. due to limited space for locating pits), in which case only lead-in pits supplied and installed by the builder, owner or customer may be shared with customer cabling. In such cases, the customer cabling must be clearly labelled in the pit. Lead-in pits installed by the carrier (i.e. with the carrier's markings) must **not** be used for customer cabling.

5.2.3 Property entry point

5.2.3.1 Description

The property entry point is the point where the carrier's lead-in cabling will enter the private land in which the building is located, including

- any land occupied in common with, or shared with, multiple occupants (e.g. land controlled by a body corporate); and
- any private easement or right of way (e.g. a driveway).

The carrier determines the location of the property entry point based on the location of the nearest suitable lead-in cable connection point. Where radio technology is used to supply a service to the premises, the property entry point is the base of the radio shelter or antenna structure from which the cabling runs to the building.

5.2.3.2 Urban residential areas

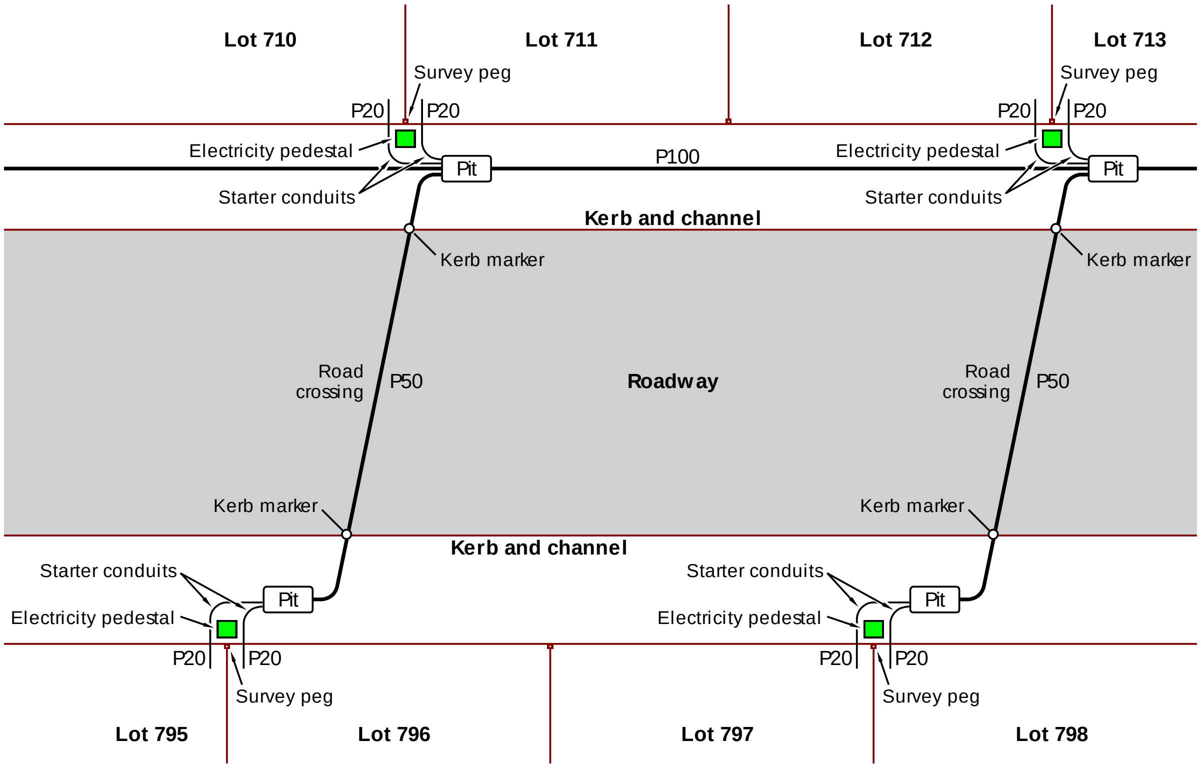
In urban residential areas, underground lead-in cabling is typically fed from a pit or pole in the street or a public easement adjacent to (usually at the rear of) the property. In some cases, the property entry point location will be evident from the location of the telecommunications pits and may be confirmed by digging at the property boundary to locate the “starter conduit”. In other cases, the location of the property entry point may not be obvious and the relevant carrier may need to be consulted.

Typical street cable distribution arrangements for new urban residential estates are illustrated in Figure 26 and Figure 27. Figure 28 shows typical “starter conduit” locations.

5.2.3.3 Commercial/Industrial and rural areas

The cable distribution arrangements for homes located in commercial/industrial areas and rural communities may differ from the arrangements shown in Figure 26 and Figure 27, and are not specifically covered by this document. You are advised to seek advice from the relevant carrier as to the location of the property entry point in such cases. For Telstra contact details, see 5.2.4.6 (page 53).

Figure 26 Typical telecommunications street distribution cabling for new urban residential estates using single-sided distribution with pits on both sides of the street

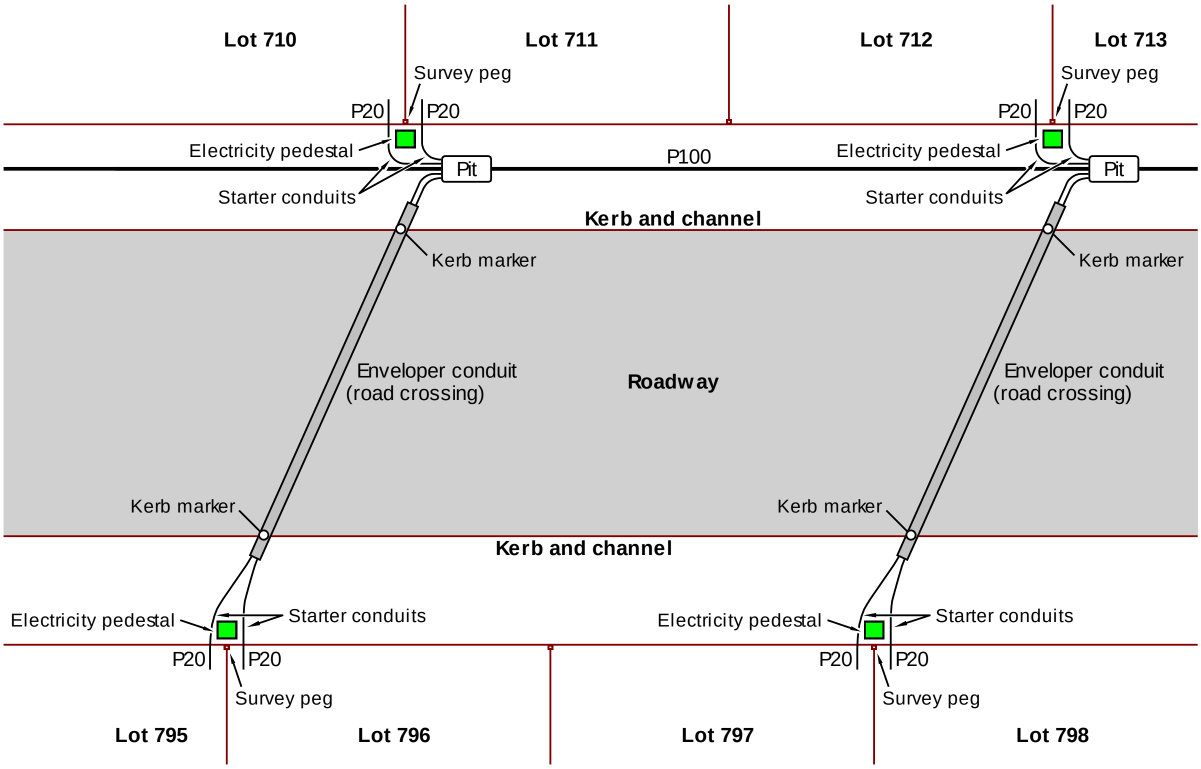


LEGEND:	P20	Plastic 20 mm (nominal inside diameter) conduit
	P50	Plastic 50 mm (nominal inside diameter) conduit
	P100	Plastic 100 mm (nominal inside diameter) conduit

Notes:

1. The lead-in cable may be coiled up in the nearest pit ready to pull through the lead-in conduit to the building. The cable is only to be pulled in by the carrier’s installer. Other persons are **not** authorised to open the pit or to pull in the lead-in cable.
2. The starter conduits should extend at least to the property boundary and may extend one to two metres into the property (see Figure 28).

Figure 27 Typical telecommunications street distribution cabling for new urban residential estates using single-sided distribution with pits on one side of the street only



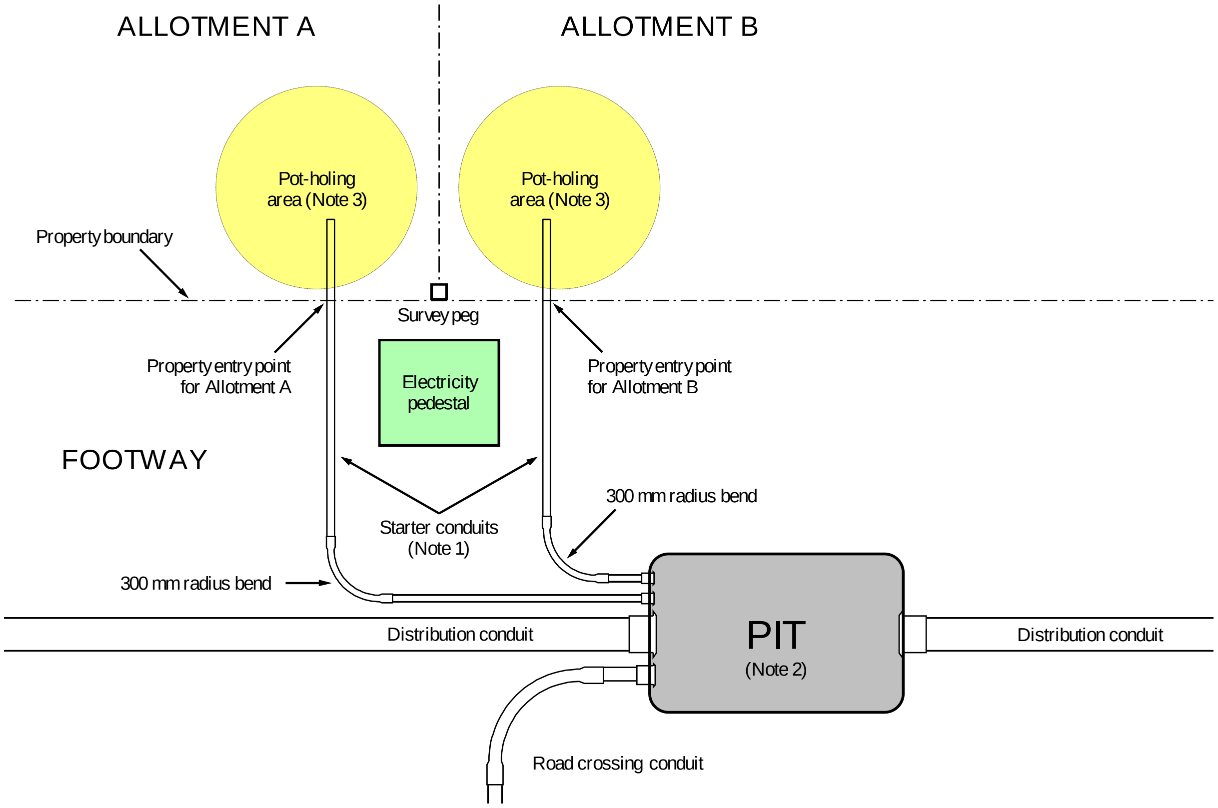
LEGEND: P20 Plastic 20 mm (nominal inside diameter) conduit

P100 Plastic 100 mm (nominal inside diameter) conduit

Notes:

1. The lead-in cable may be coiled up in the nearest pit ready to pull through the lead-in conduit to the building. The cable is only to be pulled in by the carrier's installer. Other persons are **not** authorised to open the pit or to pull in the lead-in cable.
2. The starter conduits should extend at least to the property boundary and may extend one to two metres into the property (see Figure 28).

Figure 28 Typical starter conduit arrangements (urban residential)



Notes:

1. In new urban residential estates, starter conduits will usually be provided as shown and be installed at least to the property boundary but they may extend one to two metres into the property. The minimum depth of cover for these conduits is normally 300 mm — or 450 mm if the conduit runs parallel with the property boundary for some distance before it enters the property.
2. Where pits are only installed on one side of the street (see Figure 27), the starter conduits on the non-pit side of the street should straddle the electricity pedestal as indicated in Figure 27.
3. “Pot-holing” (e.g. careful hand digging with a wooden-handle shovel) may be necessary to confirm the location of the starter conduit. With new building construction, the starter conduit may be exposed when the trench is being dug for the electricity mains.

5.2.4 Lead-in cabling route

5.2.4.1 Copper lead-in cabling

By default, any lead-in cabling that is not being provided in a designated FTTP estate is deemed to be copper cabling. With copper lead-in cabling, separation from electrical power hazards and the ability to provide effective lightning surge suppression are primary considerations in determining the lead-in cabling route. For a typical urban home, the lead-in cabling should take the shortest practicable path between the starter conduit and the **side of the building where the electricity enclosure is located**.

Complications may arise where:

- there is more than one building in the premises;
- the electricity enclosure is located at a detached building or structure; or
- power is fed to the premises from a nearby HV transformer (rural premises).

The flow chart in Figure 34 may be used to determine the appropriate lead-in cabling route for copper lead-in cabling.

5.2.4.2 Optical fibre lead-in cabling

Any lead-in to be provided in a designated FTTP estate is deemed to be an optical fibre lead-in. If there is any doubt, the lead-in must be treated as a copper lead-in.

With optical fibre lead-in cabling, there is less concern about electrical power hazards and there is no need to consider lightning surge suppression requirements. Nevertheless, an external FTTP NTD requires connection to the building electrical earthing system (although the length of the earthing conductor is not important, as is the case with lightning surge suppression). For a typical urban home, the lead-in cabling may take the shortest practicable path between the starter conduit and the building entry point which should preferably be near the electricity enclosure for the reasons given in 5.2.4.3.

Conduit integrity is very important with optical fibre lead-in cabling.

5.2.4.3 Single dwelling

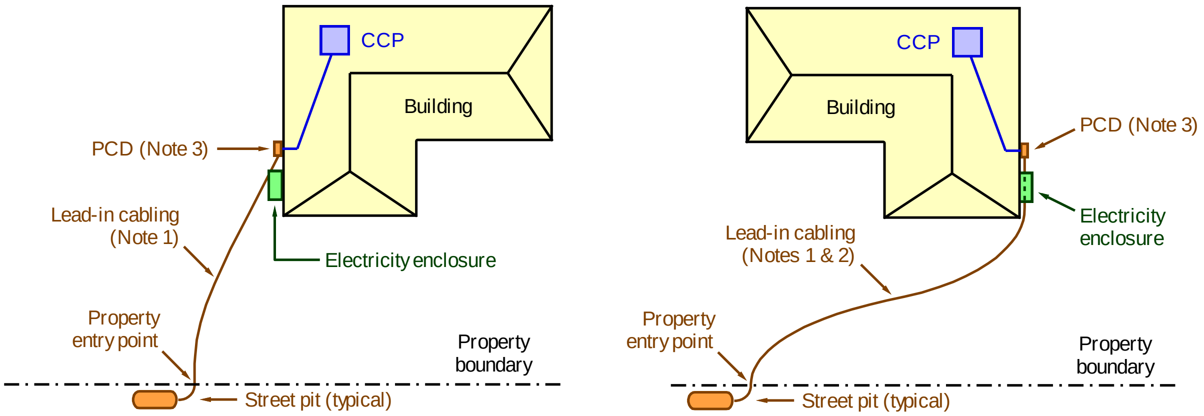
For a single residential dwelling, the building entry point should be located near the electricity enclosure (meter panel or switchboard) to ensure that the carrier has future ready access to the PCD, to facilitate earthing of the PCD to the building electrical earthing system where necessary and to keep away from any gas cylinders that may be installed at the building. Accordingly, the lead-in cabling should run from the starter conduit at the property entry point to the electricity enclosure location — even if this means trenching across the front of the building. Refer to Figure 29.

Where trenching across the front of the building is not possible (e.g. due to difficult terrain, extensive landscaping, retaining wall, paved driveway, swimming pool, etc.), the lead-in cabling may take the most direct path to the building. In such cases, care must be taken to avoid gas cylinders (see 6.3.3 on page 75) which are normally located away from the electricity enclosure. Also, if the premises is in a defined lightning risk situation and is connected to a copper network, there may be a need to install “lead-in extension” cabling for the purpose of providing effective lightning surge suppression (see Figure 30).

Figure 29 Typical path of the lead-in cabling to a single dwelling

(a) Electricity enclosure on the same side of the building as the property entry point

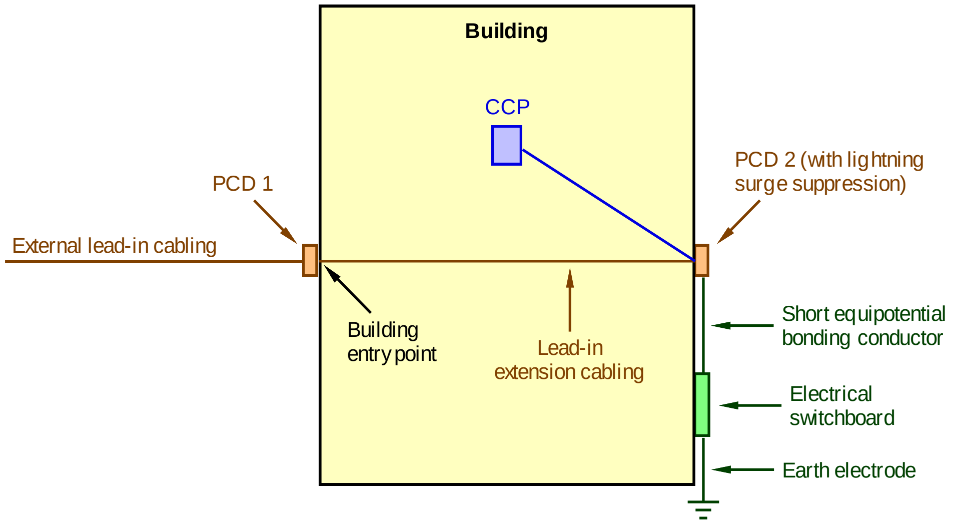
(b) Electricity enclosure on the opposite side of the building to the property entry point



Notes:

1. The cabling path must be such that there are no bends in the conduit between the starter conduit and the building footings unless these are made via an intermediate pit (see 5.2.2.4). Sweeping curves that will allow the glued lengths of conduit to be laid in the trench without significant stress are permitted, as indicated in example (b) above.
2. Where trenching across the front of the building is not possible (e.g. due to difficult terrain, extensive landscaping, etc.), the lead-in cabling may take the most direct path to the building. In such cases, care must be taken to avoid gas cylinders (see 6.3.3 on page 75) which are normally located away from the electricity enclosure. Also, if the premises is in a defined lightning risk situation and is connected to a copper network, there may be a need to install “lead-in extension” cabling for the purpose of providing effective lightning surge suppression (see Figure 30).
3. The carrier’s PCD will be mounted on the wall below or beside the electricity enclosure where practicable.

Figure 30 Lead-in extension cabling for lightning surge suppression (copper lead-ins)



Notes:

1. Where copper lead-in cabling runs to the opposite side of the building to the electrical switchboard and lightning surge suppression is required, the installation of "lead-in extension cabling" will be necessary to achieve a short equipotential bonding conductor between the electrical earthing system and the lightning surge suppressors. The total length of the bonding/earthing conductor between the earthing bar in the electrical switchboard and the lightning protector should preferably be less than 1.5 m but in any case must not exceed 10 m.
2. Where lead-in extension cabling is required, such cabling must either be installed on the external perimeter of the building or the conductors of the cable used must be at least double the cross-sectional area of the external lead-in cabling conductors to minimise the risk of fire under surge conditions. Lead-in extension cabling is installed by the carrier.
3. More information about lead-in extension cabling is provided in Telstra Specification 012882, *Alteration of Telstra Facilities in Homes & Small Businesses — Information for Cabling Providers*.

5.2.4.4 Multiple buildings

5.2.4.4.1 General

Where the premises will contain two or more buildings (e.g. the main building and an "outbuilding") and the buildings will require separate telecommunications services, separate lead-in cabling and/or separate PCDs may be required for each building. Whether or not separate lead-in cables will be required may depend on the lead-in cabling technology used, i.e. whether the cable is copper or optical fibre. Refer to 5.2.4.4.2 and 5.2.4.4.3.

5.2.4.4.2 Copper twisted pair lead-in cabling

With copper lead-in cabling, it is essential that the lead-in cabling runs to the building or structure where the electrical switchboard is located to ensure that effective lightning surge suppression can be provided if required.

Where the electricity enclosure is installed at a separate detached building or structure (e.g. a fence, pole or garage), the lead-in cabling may need to be run via the building or structure at which the electricity enclosure is located, as shown in Figure 31 and Figure 33 (a). However, care must be taken to avoid any pole carrying a power transformer as shown in Figure 33 (b). In some cases, it may be possible or desirable to run separate lead-in cabling directly to an outbuilding, as shown in Figure 32.

The appropriate lead-in cabling method may be determined using the flow chart in Figure 34 — but the relevant carrier should be contacted for advice in such cases prior to digging the trench for the cabling.

5.2.4.4.3 Optical fibre lead-in cabling (FTTP)

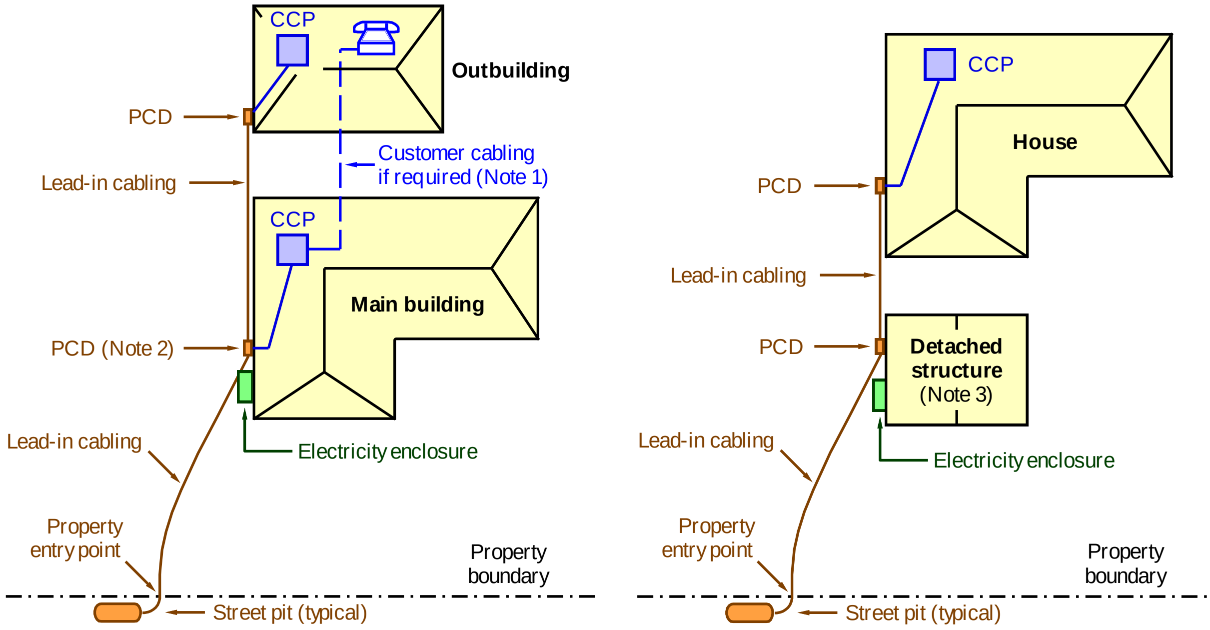
With optical (FTTP) networks, the lead-in cabling may run directly to the building no matter where the electrical switchboard is located but, for technical and safety reasons, the FTTP NTD must be installed at the same building where the telecommunications service is to be used by the occupant. However, while the FTTP NTD cannot be located at a detached building or structure such as a separate garage or a fence, a separate PCD (i.e. a splice box) may be located at a detached building to provide an intermediate connection point, e.g. for branching of a separate optical fibre cable running to a separate building. Refer to Figure 31 for examples.

In some cases, it will be more expedient to run separate lead-in cabling to the separate buildings in accordance with Figure 32.

Figure 31 Typical path of the lead-in cabling to an outbuilding or to the main building where the electricity enclosure is located at a detached building or structure

(a) Lead-in cabling path for the supply of a separate telecommunications service to the outbuilding

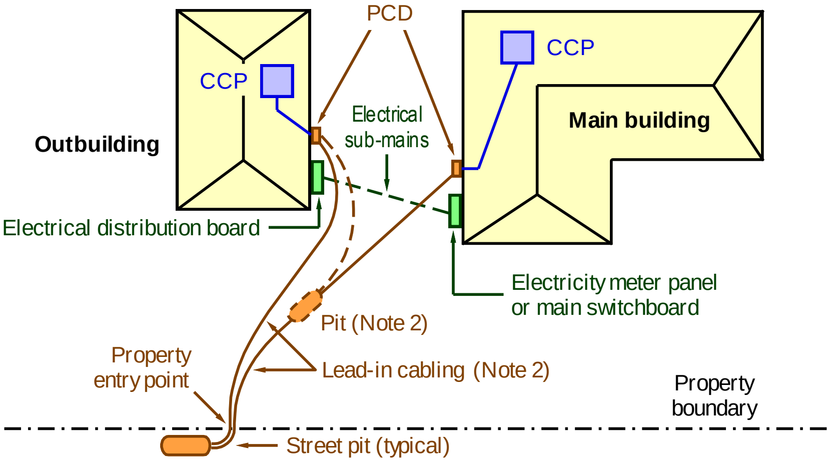
(b) Lead-in cabling path where the electricity enclosure is located at a detached building or structure



Notes:

1. Any customer cabling required between the main building and the outbuilding, e.g. for additional access points (telecommunications outlets) as shown in arrangement (a), must be separate and distinct from the lead-in cabling, i.e. it must use separate cable and conduit to the lead-in cable and conduit.
2. The PCD at the main building may be used as a branching point for the lead-in cabling to the outbuilding. Unrestricted access to this PCD must be guaranteed; otherwise the arrangement shown in Figure 32 must be used.
3. The detached structure at which the electricity enclosure is located may be a garage, shed, pole or fence. Arrangement (b) may apply for copper lead-in cabling where this is required in accordance with the flow chart in Figure 34. For optical fibre lead-in cabling, arrangement (b) would normally only apply where the lead-in cabling needs to be installed in two sections due to site conditions (e.g. retaining walls) or because a separate telecommunications service is required in each building.
4. The lead-in cabling must **not** be run near any pole that carries a SWER (Single Wire Earth Return) transformer, e.g. rural properties. Refer to Figure 33 (b).

Figure 32 Lead-in cabling directly to an outbuilding

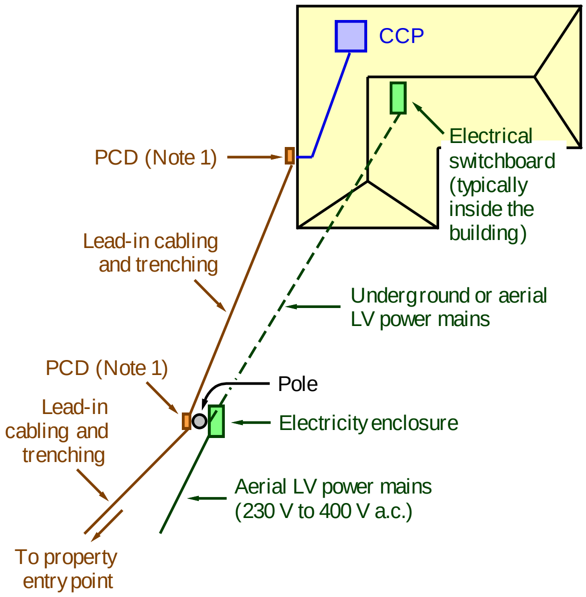


Notes:

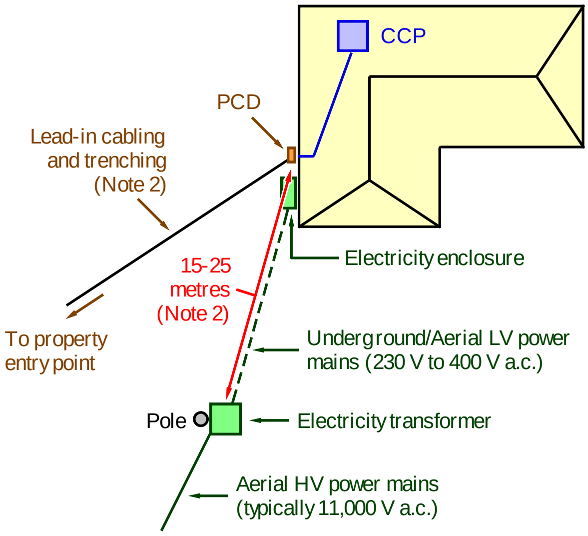
1. In some cases, the lead-in cabling may need to be provided via the main building for technical reasons. Refer to Figure 31 and, for copper lead-in cabling, the flow chart in Figure 34 to determine whether it may be appropriate to provide lead-in cabling via the main building rather than directly to the outbuilding.
2. Some lead-in trenching and conduit may be common, using a pit where the lead-in cables branch off.
3. Any customer cabling required between the buildings, e.g. for intercommunication between the buildings, must be separate to the lead-in cabling, i.e. using separate cable and conduit to the lead-in cable and conduit.

Figure 33 Typical path of the lead-in cabling where the power mains are fed from an electricity enclosure or a transformer located on a pole (acreage or rural properties)

(a) Low voltage (230 V to 400 V a.c.) power mains connected via an electricity enclosure on a pole



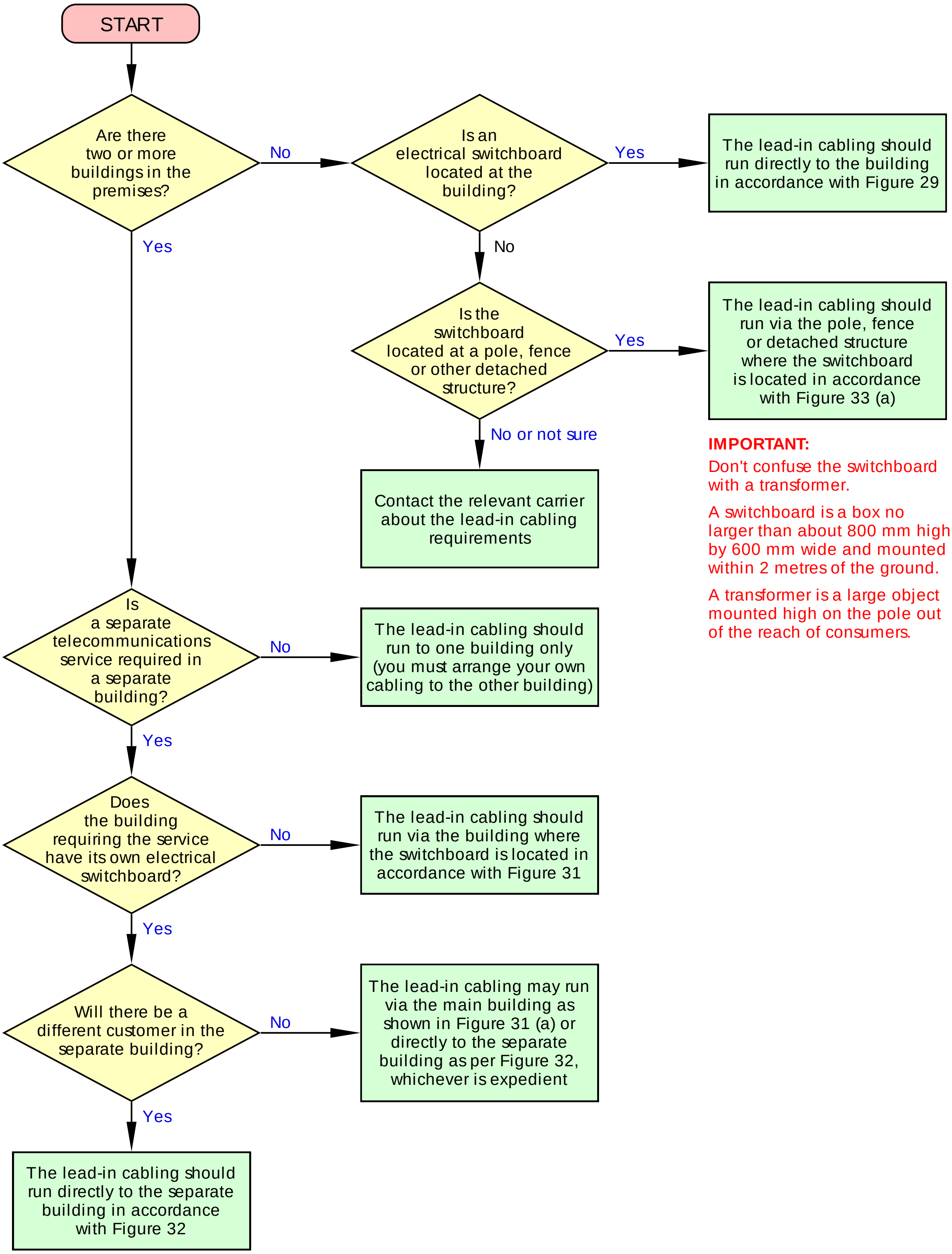
(b) High voltage (e.g. 11,000 V a.c.) power mains connected to a transformer on a pole



Notes:

1. In case (a), if copper lead-in cabling is to be installed, the carrier may need to install PCDs at both the pole and the building for lightning surge suppression purposes. In such cases, the PCD at the building should also be located on the external wall as close as possible to the electrical switchboard for effective earthing of lightning protectors.
2. In case (b), the carrier's PCD should be kept at least 25 m away from any pole carrying a SWER (Single Wire Earth Return) transformer or at least 15 m away from any other electricity transformer.

Figure 34 Determining the appropriate lead-in cabling route to a particular building (copper lead-in cabling)



Note: For optical fibre lead-in cables (e.g. Telstra or NBN Co FTTP estates), there is no need to use this flow chart. The lead-in cabling may run directly to the building where the service is required per Figure 29 or Figure 32.

5.2.4.5 Rural areas

In rural areas, NBN services are likely to be supplied using satellite or fixed wireless technologies. Where Telstra installs copper cabling to supply a standard telephone service, ADSL may be available.

In rural areas, Telstra normally buries the lead-in cable directly in the ground without conduit and marks the route at regular intervals with signs and marker posts. With directly buried cable there is no limitation on the number of bends in the cabling. However, the cable route should be as direct as possible between cable route markers to enable subsequent location of the cable for repairs and to reduce the risk of accidental damage to the cable during any digging or cultivation activities.

Where practicable the path of the lead-in cabling should follow established geographical features such as private roadways, tracks, right-of-ways, fence boundaries, etc. to minimise the risk of disturbance. Traversing of cultivated land or grazing paddocks should be avoided if possible. Where the cable runs beside a fence or property boundary, it must be spaced at least 1 m from the fence line (see also 5.2.5.6 on page 58 regarding proximity to power poles).

For long cable runs in rural areas, Telstra may opt to plough its lead-in cable directly into the ground instead of requiring the provision of an open trench. Nevertheless, even if the lead-in cable is to be ploughed in, the last section of lead-in cable to the building should be installed in conduit, so an open trench will be required for at least the last 3 m of lead-in cabling to the building. Advice should be sought from Telstra as to lead-in trenching and conduit requirements in rural areas.

5.2.4.6 Contacting Telstra about Telstra lead-in cabling

5.2.4.6.1 New lead-in cabling

Where it is necessary to contact Telstra for trenching advice for the installation of **new** lead-in cabling, please call the appropriate number listed below and follow the procedure listed.

Home 13 2200

Business 13 2000

- To the automated voice greeting, respond "**connections**", then "**fixed line phone**", and then your **telephone number** or "**I don't have one**", as applicable.
- Inform the Telstra consultant that you are calling about pre-provisioning of your premises.
- State the address to which the enquiry is related and, if requested, your name and contact number.
- Discuss your requirements with the Telstra consultant who will tell you the name and contact number of the Telstra contractor for your area.
- Call the Telstra contractor who will assist you with your enquiry.
- The Telstra consultant or the Telstra contractor may provide you with a reference number for any follow-up enquiries.

5.2.4.6.2 Existing lead-in cabling

If the lead-in trenching is for relocation of **existing** lead-in cabling (e.g. due to building renovations or land redevelopment), please call the following number:

Home or Business.. 1800 810 443

You will receive a brief automated voice greeting and then you will be switched through to the Telstra Network Integrity Team with which you may discuss your requirements.

You may be given a reference number for any follow-up enquiries.

5.2.5 Lead-in trench

5.2.5.1 Safety

5.2.5.1.1 General

For new buildings, all service cables, conduits and pipes are usually exposed at the time of installation of the lead-in cabling, minimising the hazards for the installer and the risk of damage to other services. Ideally, the lead-in cabling should be installed in the trench being dug for the electricity mains (see 5.2.5.8).

For established premises, the location of other underground services may be unknown. Accordingly, the trench should be dug by an experienced person who is familiar with underground service arrangements and who is suitably accredited or licensed where required by the relevant authority. Careless excavation work may result in personal injury (e.g. through contact with live underground power cables) or costly damage to underground conduits, pipes and cables. Service providers (including Telstra) may seek to recover their entire repair and associated costs in the event that any damage is caused to their assets.

5.2.5.1.2 Locating existing underground services

In order to avoid personal injury or damage to property, existing underground services should be located and identified by an experienced, suitably accredited or licensed person.

Methods for locating underground services include:

- Before any earth breaking activity is contemplated, contact the Dial Before You Dig (DBYD) “free call service”, by telephoning 1100 or by visiting the DBYD website at http://www.1100.com.au for information about any underground services that may be in the vicinity (note that while plans supplied by DBYD may contain information about underground services on public or adjoining land, you are not required to dig the trench outside the boundary of your premises, e.g. in public footways, roadways or in neighbouring premises).
- Review any property documentation (e.g. building plans, electrical specifications, plumbing plan).
- Visually inspect the site noting the location of conduits, pipes or cables emerging from the ground at buildings, sheds, swimming pools, fountains, electric barbecues, garden lights, external power outlets, etc.
- Visually inspect the footway and verge for the location of any power, water, gas, sanitation, stormwater, drainage or telecommunications facilities (e.g. pedestals, pits, poles, meters, kerb markers, drains, conduits/pipes, cables).
- Ascertain the likely path of underground services using the above indicators.
- Verify the location of services using a cable locator or similar equipment, if available (note that existing services may not have been installed in a straight line).
- Verify the presence or absence of underground services at appropriate points along the chosen trenching route by careful hand digging (see below).

Where there is evidence of underground services along the chosen trench route but their position cannot be verified with reasonable accuracy, look for a more suitable route or excavate by careful hand digging where uncertainty exists.

Apply the following precautions when digging the trench:

- Allow for at least one 1 m separation from any suspected underground service.
- Except where otherwise required by this document, e.g. if a PCD is to be installed on a pole as shown in Figure 33 (a), keep at least one 1 m away from any pole (to avoid disturbance of the pole footings and to allow for future replacement of the pole without disturbing the lead-in cabling that will be installed in the trench).
- When hand digging, use non-conductive tools (e.g. with wooden handles) and wear insulating (rubber) boots.
- Do not dig the trench any deeper than the recommended depth (see Table 3).

5.2.5.1.3 Service identification

As a guide only, the types of underground services that may be encountered on private property, and their typical characteristics, are as follows:

- Electrical power — power cables may be installed in orange conduit or covered by orange marker tape or cover strip. However, they may be incorrectly installed in galvanised iron pipe or grey conduit marked "ELECTRICAL" without an orange covering, so take care if you come across any such pipes or conduits.
- Garden lighting — cables for garden lighting operating directly from mains power (230 V a.c.) may be installed in the same way as electrical power cables described above. Cables for garden lighting that operate from a transformer (e.g. 12 V a.c.) are deemed to be non-hazardous and may be buried directly in the ground.
- Piped fuel gas — modern gas lines usually consist of yellow or yellow-ochre pipe (or a black pipe with a yellow stripe) or are covered by a yellowish marker tape, but earlier installations may have used copper or steel pipe.
- Water — potable water is usually supplied in copper, galvanised iron, black polyethylene or white plastic pipe.
- Grey water (recycled water) — pipes used for recycled water are likely to be black polyethylene (preferably with a violet stripe), white plastic or violet plastic pipe.
- Sanitation (sewerage/waste water) — modern sanitation pipes are generally white or light grey plastic, but earlier installations may have used earthenware (e.g. fired clay), concrete or asbestos cement pipes.
- Stormwater — modern stormwater pipes are generally light coloured plastic (e.g. white, grey, pink, blue) but earlier installations may have used earthenware (e.g. fired clay), concrete or asbestos cement pipes.
- Drainage (surface water or seepage drain) — pipes used for drainage of surface or seepage water are usually white plastic or black polyethylene with slots or holes cut in them, but earlier installations may have used earthenware or concrete pipes without seals, rubble (gravel) pits covered with sheeting and soil or a combination of these.

If you damage any underground service, do not attempt to fix it yourself. Get an expert to repair it.

5.2.5.2 Trench depth

The trench depth requirements are different for urban and rural areas. You may need to contact the relevant carrier for advice as to whether the carrier deems the area to be urban or rural.

To the extent that the terrain will reasonably allow, the conduit (or cable in rural areas where the cable is directly buried) must be installed in a uniform trench of the depth specified in Table 3 for the applicable conditions. The depth specified in Table 3 includes allowance for the depth of the conduit or cable itself.

In urban areas, if the length of the lead-in conduit will exceed 50 m, pits must be installed at intervals of no more than 50 m.

In rural areas where the cable is normally buried directly in the ground without conduit, pits will usually only be necessary for long cable runs to joint cables (in some areas, aboveground jointing posts may be used for this purpose instead of pits). The carrier (usually Telstra) will install any necessary cable jointing pits or posts as required.

Table 3 Trench depth required (Note 1)

<table>
<tr><td colspan="2" rowspan="2"></td><td>Urban area</td><td colspan="2">Rural area (cable directly buried without conduit)</td></tr>
<tr><td>For 23 mm ID conduit</td><td>Soil & non-continuous rock (Note 2)</td><td>Continuous rock (Note 3)</td></tr>
<tr><td rowspan="3">Non-trafficable area, driveway or private footway (Note 4)</td><td>Minimum</td><td>350 mm</td><td>500 mm (where deep cultivation ploughing is not likely)</td><td>250 mm</td></tr>
<tr><td>Maximum</td><td>550 mm</td><td>650 mm</td><td>650 mm</td></tr>
<tr><td>Recommended (Note 5)</td><td>400 mm</td><td>550 mm</td><td>300 mm</td></tr>
<tr><td>Private roadway (Note 4)</td><td>Minimum</td><td>500 mm under the lowest point</td><td colspan="2">500 mm under the lowest point (usually the gutter or kerb)</td></tr>
</table>

Notes:

1. If it is not possible to provide the required depth due to ground conditions, seek advice from the carrier.
2. “Soil” means sand, gravel, clay, loam or silt. “Non-continuous rock” means stones and boulders (“floaters”) set in soil.
3. “Continuous rock” means rock in continuous strata or prevailing on a massive scale. It can only be removed by blasting and ripping or by using a rock breaker or a rock saw.
4. Private footways and roadways are typically found in town-house/villa complexes, retirement villages, caravan parks, etc. Such complexes do not generally have clearly defined footways.
5. The recommended depth allows for fluctuations in ground conditions and for the use of bedding material, if required, to ensure that the minimum depth of cover above the conduit or cable is achieved.

5.2.5.3 Trench width

For 23 mm ID conduit or directly buried rural cables, the width of the trench should be no less than 100 mm and should follow the contour of the conduit/cable path as closely as possible (see 5.2.2.4 on page 41).

5.2.5.4 Bedding and backfill material

The installed conduit must be supported firmly and evenly on all sides using bedding sand or the excavated material as long as the material does not contain any metal, concrete, rocks or similarly hard material exceeding 50 mm in cross-section. The bedding and backfill material must be free of any timber or other fibrous material that may decompose or attract termites.

5.2.5.5 Retaining walls and embankments

Where there is, or will be, a retaining wall or embankment in the path of the lead-in cabling:

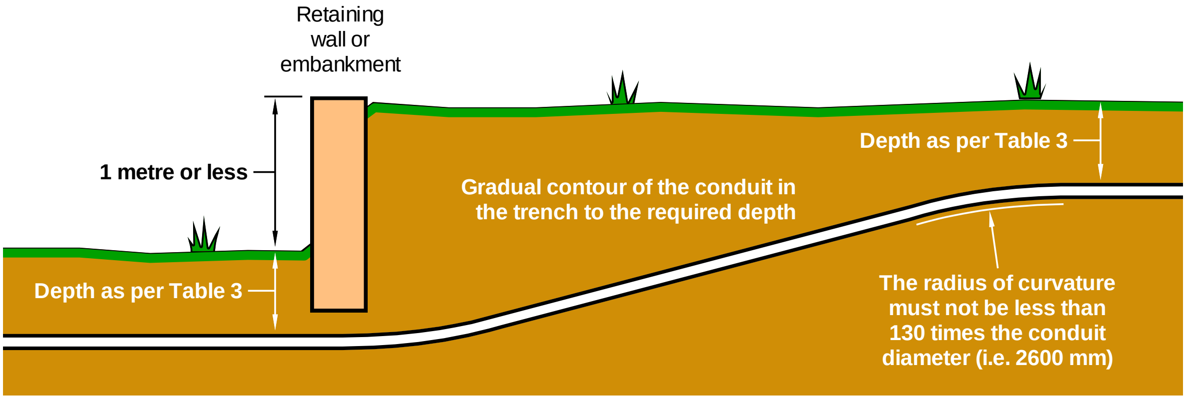
(a) If the vertical height of the retaining wall or embankment does not exceed 1 m, the trenching/conduit may continue under the wall or embankment at a gradual incline to resume the appropriate depth set out in Table 3 on the high side of the wall/embankment (see Figure 35). Alternatively, the technique described in (b) may be applied.

(b) If the vertical height of the retaining wall or embankment exceeds 1 m, the trenching/conduit must end at the foot of the retaining wall or embankment and recommence at the high side of the wall/embankment at the depth set out in Table 3 (see Figure 36).

(c) If the wall or embankment is at a gradual incline to the horizontal, the trenching/conduit should follow the incline as close as practicable to the appropriate depth set out in Table 3 (see Figure 37).

Note: If one side of the wall or embankment is on public property (such as a footway) or a neighbouring property, the trenching/conduit on that side of the wall/embankment is the carrier’s responsibility.

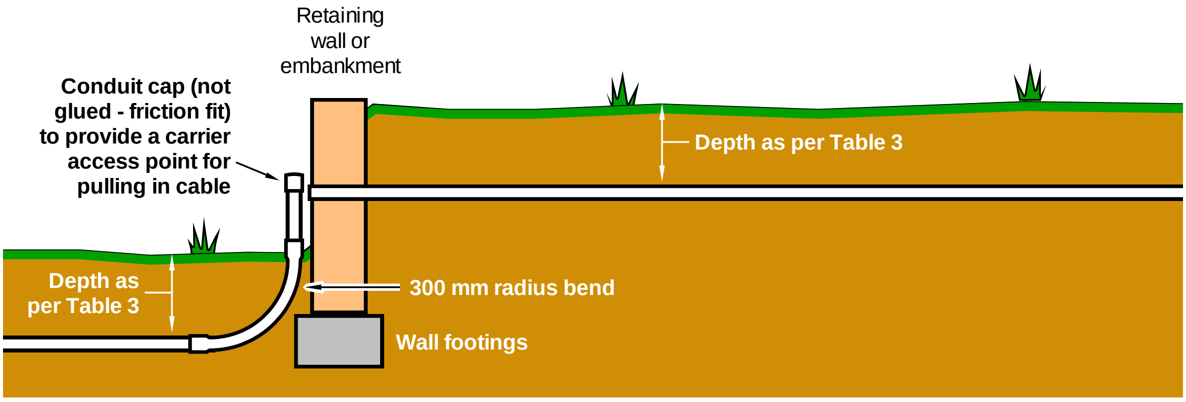
Figure 35 Lead-in conduit arrangement where a retaining wall or embankment does not exceed a vertical height of 1 m



Notes:

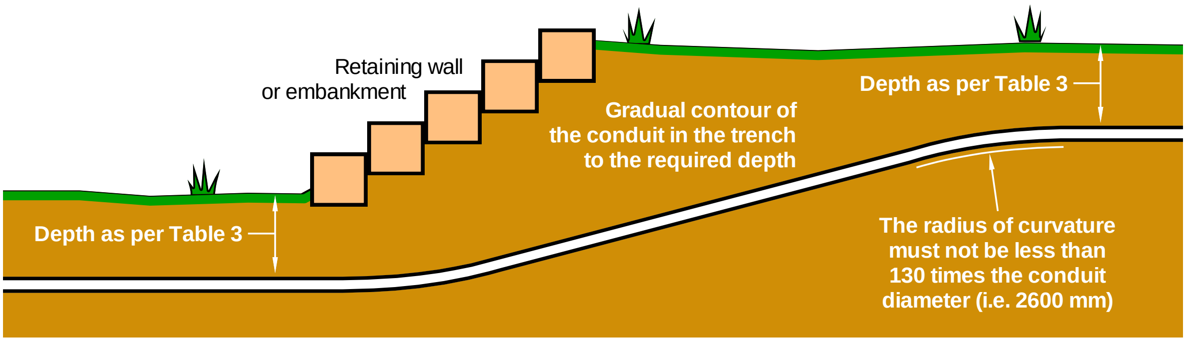
1. The technique may be applied either before or after the retaining wall is installed or an embankment is created.
2. For an existing retaining wall or embankment, the technique shown in Figure 36 may be applied.

Figure 36 Lead-in conduit arrangement where a retaining wall or embankment exceeds a vertical height of 1 m



Note: The carrier may install a metal cover strip over the conduit on the surface of the retaining wall as a mower guard.

Figure 37 Lead-in conduit arrangement for a gradually sloping retaining wall or embankment



Note: The trenching should follow the contour of the finished ground level within the curvature (flexing) constraints of the conduit.

5.2.5.6 Proximity to power poles

Lead-in trenching should be kept at least 1 m away from any power poles (including poles used for lighting) to allow for future replacement of the pole without disturbing the lead-in cabling — except in cases where the electricity enclosure is installed on the pole and it is necessary to run the lead-in cabling via a PCD on the pole supporting the electricity enclosure. Refer to Figure 33 (a) and Figure 34.

5.2.5.7 Trenching outside the premises

Your premises includes common property (e.g. controlled by a body corporate) or a private easement or right of way (e.g. for a driveway). You must obtain permission from the body corporate or owner of the easement or right of way before trenching through it.

Do not dig the trench outside the boundary of your premises, e.g. in a public footway, roadway or in neighbouring premises. Trenching outside your premises is subject to land access code requirements and is the carrier's responsibility.

5.2.5.8 Shared trench arrangements

For new building construction, lead-in cabling may be installed in a shared trench with another service (preferably the electricity mains) to reduce costs and minimise the width of the service corridor through the property. Trench sharing arrangements are illustrated in Figure 38 to Figure 40. Where the trench is shared with more than one other service, their respective separations must be maintained. Local authority requirements, or the requirements of the other utility, may preclude a shared trench with some services.

For **Telstra** lead-in cabling, no separation is required from the conduits or cables of another **telecommunications** service unless:

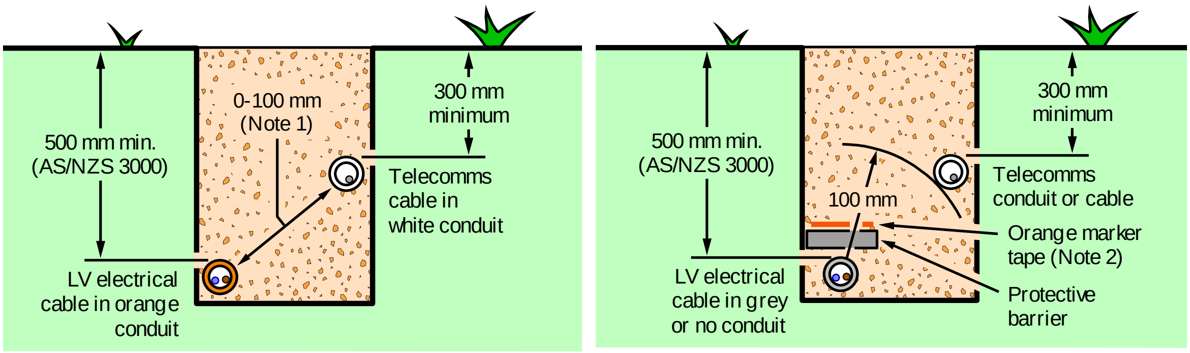
- separation is required by the owner of the other telecommunications service; or
- the other telecommunications service is a conduit or cable of **another carrier**, in which case a minimum radial clearance of **100 mm** is required in accordance with ACIF Industry Code C524, *External Telecommunication Cable Networks*.

Note: NBN Co may require other telecommunications conduits to be separated from their lead-in conduits.

Figure 38 Shared trench with LV (low voltage) electricity (e.g. normal domestic single-phase or three-phase power mains)

(a) Electrical cable in orange conduit

(b) Electrical cable physically protected by means other than orange conduit



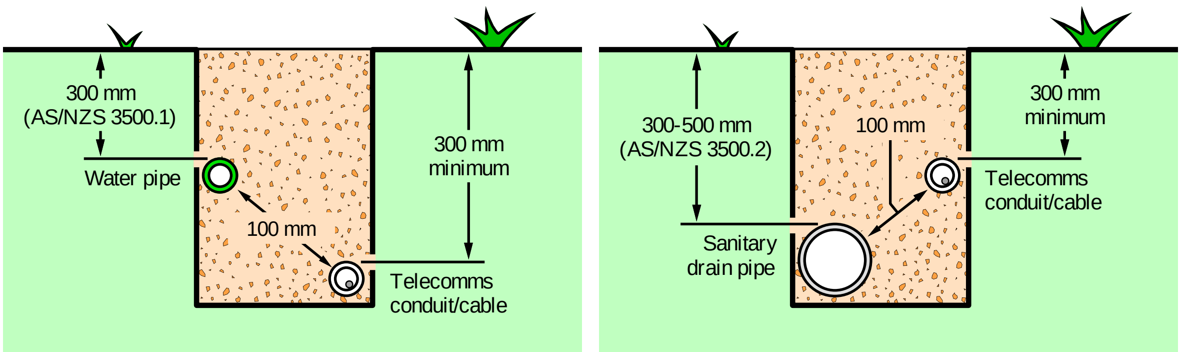
Notes:

1. No separation is required if the lead-in cable is installed in white conduit and the electrical cable is installed in orange conduit. At least 100 mm separation is required if the electrical cable is installed in orange conduit and the lead-in cable is directly buried without conduit (e.g. rural areas). The telecommunications conduit or cable should be installed above the electrical conduit.
2. Orange marker tape is required where the protective barrier is not orange in colour. The lead-in conduit must be installed above the electrical cable/conduit and separated from it by a minimum distance of 100 mm whether or not the lead-in cable is buried in conduit.
3. Lead-in cabling must **not** share a trench with unprotected electrical cable (e.g. not in orange conduit or not covered by concrete, approved bricks etc.) or electrical cable that is not identified by orange conduit, orange cover strip or orange marker tape. In such cases the lead-in cable must be installed in a separate trench.
4. In some rural areas, Telstra installs a guard wire above the cable to provide additional protection against lightning ground strikes. However, this does not affect the trench depth requirements or the separation distances required from other services.
5. Lead-in cabling must **not** be installed in a shared trench with HV (high voltage) electricity cabling (i.e. cable carrying a voltage exceeding 1000 V a.c.).

Figure 39 Shared trench with water and sanitary pipes

(a) Water service pipe

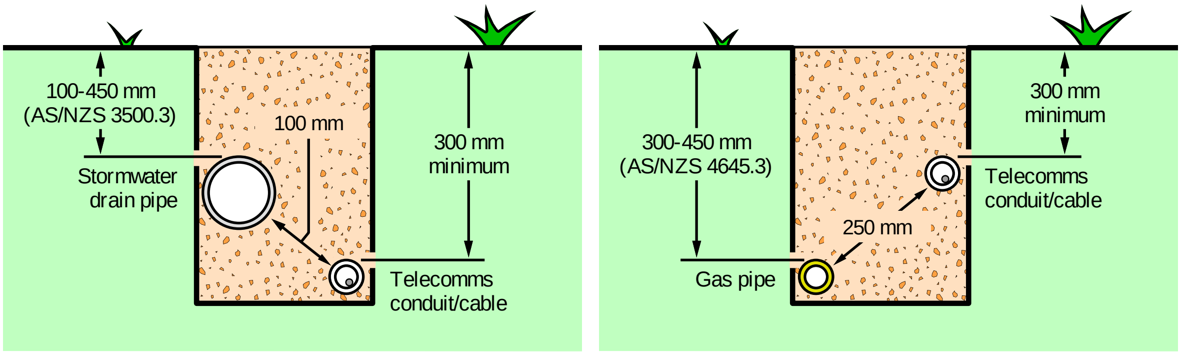
(b) Sanitary plumbing/drainage pipe



Note: The depths shown for water pipe and sanitary plumbing/drainage pipe are provided for guidance. The depths stated are the minimum specified in the relevant standards for burial of the pipe on private property. The required minimum depth may vary according to exposure of the location to vehicular traffic or the type of pipe used.

Figure 40 Shared trench with stormwater and gas pipes

(a) Stormwater drainage pipe **(b) Gas service pipe**



Notes:

1. The lead-in conduit/cable must **not** be installed above the stormwater drainage pipe (this is a requirement of AS/NZS 3500.3).
2. The depths shown for stormwater pipe and gas pipe are provided for guidance. The depths stated are the minimum specified in the relevant standards for burial of the pipe on private property. The required minimum depth may vary according to exposure of the location to vehicular traffic, the type of pipe used or, in the case of gas pipe, the service pressure.

5.2.5.9 Exclusive (separate) trench

Where it is not possible to use a shared trench with another service, the lead-in cabling must be installed in an exclusive (separate) trench.

For parallel runs with services other than electrical cables, the minimum separation from these services must be in accordance with 5.2.5.8. For parallel runs with electrical cables, the minimum separation between the lead-in cable or conduit and the electrical cable/conduit must be in accordance with Table 4 and Figure 41.

Where the Telstra conduit crosses the path of another service, the crossover must comply with 5.2.5.10.

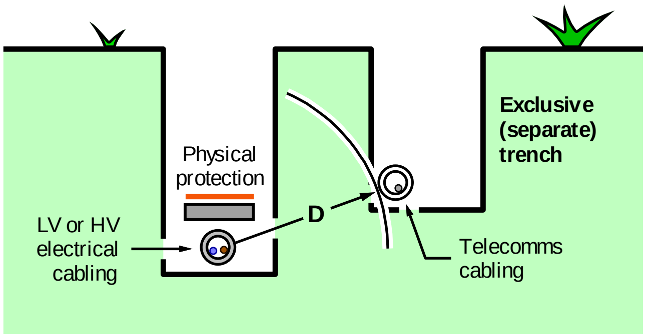
Table 4 Separation from electricity — exclusive trench

	LV (Note 1)		**HV** (Note 2)	
	With protective covering (Note 3)	**Without protective covering** (Note 4)	**With protective covering** (Note 3)	**Without protective covering** (Note 4)
Minimum separation distance "D" (see Figure 41)	100 mm	300 mm	300 mm	450 mm

Notes:

1. LV (Low Voltage) is typically used for electricity mains supply to single dwellings (i.e. 230 V a.c. single-phase power or 400 V a.c. three-phase power).
2. HV (High Voltage) is typically used for electricity mains supply to large multi-residential or large commercial premises (e.g. 11,000 V a.c. power to an HV transformer).
3. For an exclusive trench, try to keep at least 300 mm away from LV and 450 mm from HV whether or not the electricity has a protective covering. Where there is any doubt as to whether the electricity is, or will be, physically protected in accordance with AS/NZS 3000, a minimum separation distance of 300 mm from LV or 450 mm from HV must be maintained.
4. Installation of underground electrical cable in customer premises without a protective covering is not allowable under the electrical wiring rules (AS/NZS 3000). However, there may be cases where AS/NZS 3000 doesn't apply or unprotected cable is incorrectly installed.

Figure 41 Separation from electrical conduit or cable — exclusive trench



Note: The trench must be located such that distance "D" (refer to Table 4) is maintained between the electrical conduit or cable and the lead-in conduit/cable. This distance may be measured radially in any direction from the electrical conduit/cable.

5.2.5.10 Crossovers with other services

Where the lead-in cabling crosses another service, separation from the other service at the crossover must be in accordance with Table 5.

Table 5 Separation at crossovers with other services within customer premises

Other service	Lead-in separation requirements
LV electrical cable with a protective covering	The lead-in cabling must be separated from the electrical cable by at least 100 mm at the crossover, and should cross **above** the electrical cable (see Figure 42). The lead-in cabling may only cross under the electrical cable if a concrete protective covering is installed above the electrical cable at the crossover in accordance with Figure 45.
LV electrical cable **without** a protective covering (Note 1)	The lead-in cabling must cross at least 300 mm **above** the electrical cable (see Figure 43) unless a protective covering of concrete is provided over the electrical cable 600 mm each side of the crossing as shown in Figure 44, in which case a 100 mm separation is allowable. If it is necessary for the lead-in cabling to cross under the electrical cable: • it should only be installed by boring; • a concrete protective covering must be installed above the electrical cable at the crossover in accordance with Figure 45; and • a minimum separation distance of 300 mm must be maintained from the electrical cable at the crossover.
HV electrical cable with a protective covering	The lead-in cabling must be separated from the electrical cable by at least 300 mm at the crossover, and should cross **above** the electrical cable (see Figure 42). The lead-in cabling may only cross under the electrical cable if a concrete protective covering is installed above the electrical cable at the crossover in accordance with Figure 45.
HV electrical cable **without** a protective covering (Note 1)	The lead-in cabling must cross at least 450 mm **above** the electrical cable (see Figure 43) unless a protective covering of concrete is provided over the electrical cable 600 mm each side of the crossing as shown in Figure 44, in which case a 300 mm separation is allowable. If it is necessary for the lead-in cabling to cross under the electrical cable: • it should only be installed by boring; • a concrete protective covering must be installed above the electrical cable at the crossover in accordance with Figure 45; and • a minimum separation distance of 300 mm must be maintained from the electrical cable at the crossover.
Water service pipe	The lead-in cabling must cross at least 100 mm **below** the water pipe at an angle not less than 45° and should be covered by white marker tape complying with AS/NZS 2648.1 laid 150 mm above the lead-in cabling for at least 1 m either side of the crossing (Note 2).
Sanitary plumbing/ drainage pipe	The lead-in cabling must cross at least 100 mm **above** the pipe at an angle not less than 45° and should be covered by white marker tape complying with AS/NZS 2648.1 laid 150 mm above the lead-in cabling for at least 1 m either side of the crossing (Note 2).
Stormwater drainage pipe	The lead-in cabling must cross at least 100 mm **below** the pipe at an angle not less than 45° and should be covered by white marker tape complying with AS/NZS 2648.1 laid 150 mm above the lead-in cabling for at least 1 m either side of the crossing (Note 2).
Gas service pipe	The lead-in cabling must cross at least 100 mm **above** the pipe at an angle not less than 45° and should be covered by white marker tape complying with AS/NZS 2648.1 laid 150 mm above the lead-in cabling for at least 1 m either side of the crossing (Note 2).
Telecommunications	The lead-in cabling must cross at least 100 mm **above or below** (whichever is expedient) the other telecommunications conduit or cable and should be covered by white marker tape complying with AS/NZS 2648.1 laid 150 mm above the lead-in cabling for at least 1 m either side of the crossing (Note 2).

Notes:

1. Installation of underground electrical cable in customer premises without a protective covering is not allowable under the electrical wiring rules (AS/NZS 3000). However, there may be cases where AS/NZS 3000 doesn't apply or unprotected cable is incorrectly installed.
2. Marker tape that complies with Australian Standard AS/NZS 2648.1, *Underground marking tape Part 1: Non-detectable tape*, is required to be at least 75 mm wide (preferably 100 mm or 150 mm wide) with black block lettering at least 25 mm high. The text should contain "COMMUNICATION" or "TELECOMMUNICATION" to identify the service. The text must be repeated at intervals of 1 m or less.

Figure 42 Crossing above electrical cable with a protective covering that complies with AS/NZS 3000 requirements

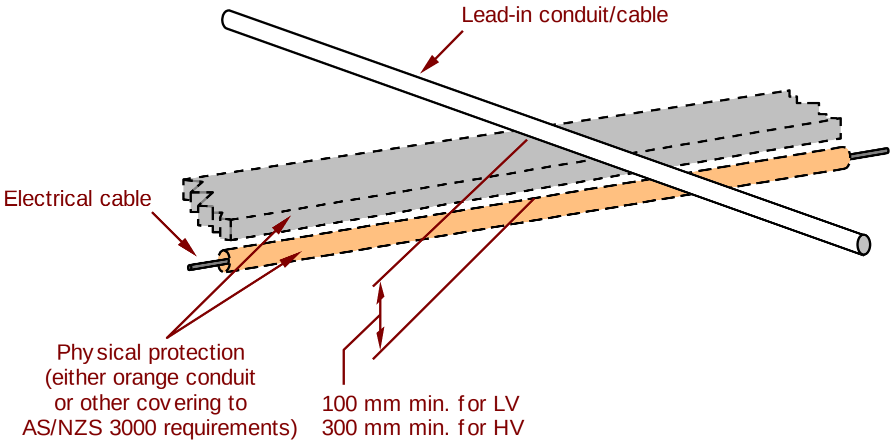
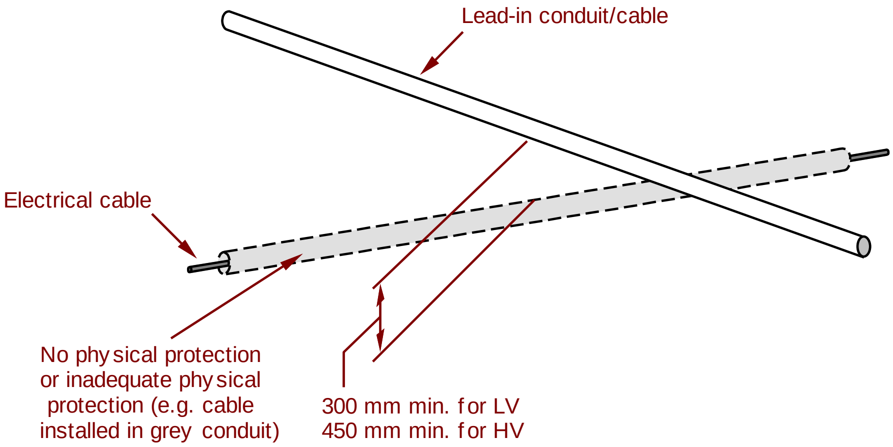
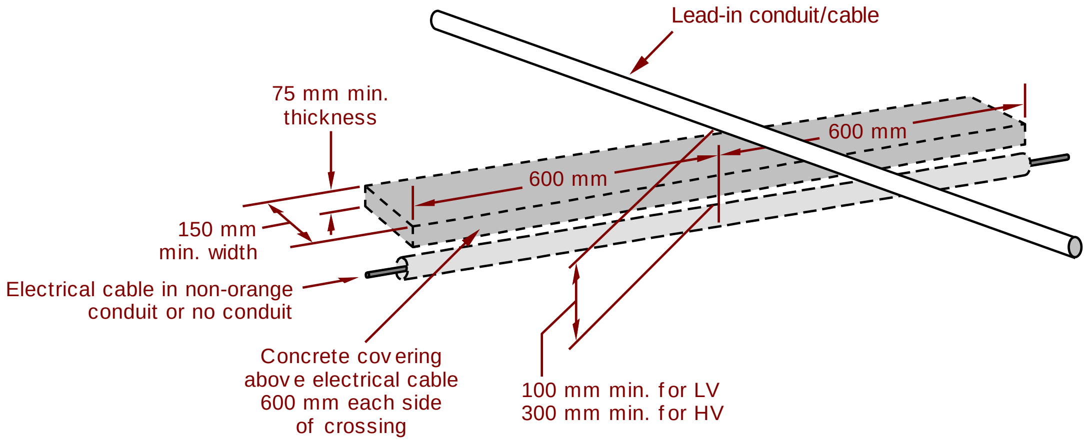


Figure 43 Crossing above electrical cable with NO protective covering



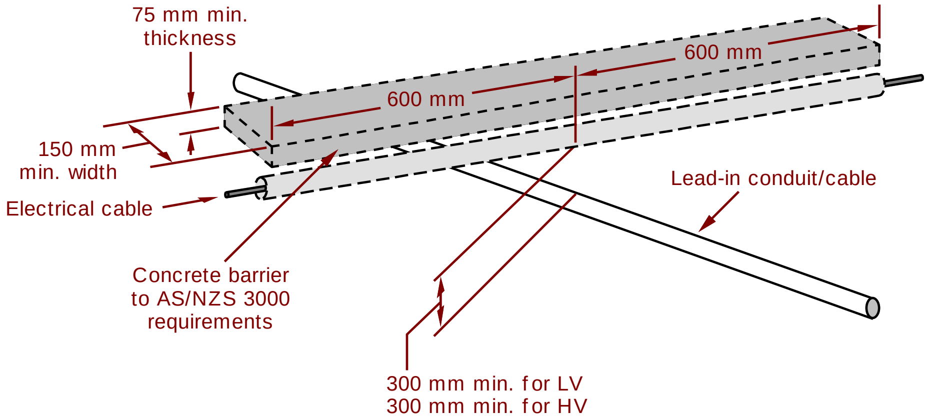
Note: Installation of underground electrical cable in customer premises without a protective covering is not allowable under the electrical wiring rules (AS/NZS 3000). However, there may be cases where AS/NZS 3000 doesn't apply or unprotected cable is incorrectly installed.

Figure 44 Crossing above electrical cable with a concrete protective covering that complies with AS/NZS 3000 requirements installed at the crossing



Note: The concrete covering is to protect against accidental contact with the electrical cable if excavating along the path of the lead-in cabling subsequent to its initial installation.

Figure 45 Crossing under electrical cable



Notes:

1. Lead-in cabling should only be installed under electrical cable during boring. If a concrete protective covering to AS/NZS 3000 requirements has not been provided above the electrical cable, a concrete strip at least 150 mm wide and 75 mm thick must be provided 600 mm each side of the crossing.
2. The concrete covering is to protect against accidental contact with the electrical cable if excavating along the path of the lead-in cabling subsequent to its initial installation.

5.2.6 Lead-in cable

The carrier will supply, install and connect the lead-in cable. The customer's cabler must **not** pull the lead-in cable through the conduit or connect it to the PCD.

Note: Lead-in cabling must **not** be used for customer cabling purposes. Customer cabling must be separate and distinct from lead-in cabling.

5.3 Aerial lead-in cabling

5.3.1 General

Where aerial lead-in cabling is to be installed for connection to the Telstra network to supply a Telstra service, the customer is required to pay the cost of erection, by Telstra, of any Telstra poles that are required within the confines of the customer's premises, including clearing of land along the cabling route, digging of the pole holes and reinstatement of the land after the poles are installed (such poles are normally only required with acreage or rural properties). The supply of the poles and the cable, and the installation of the cable on the poles, is included in the basic telephone new service connection charge.

Telstra will not permit the customer or a third party (e.g. a contractor of the customer's choosing) to install the Telstra poles but the customer may reduce Telstra's pole installation charges by arranging clearing of the land, digging the holes and backfilling them under Telstra direction and supervision.

5.3.2 Lead-in cabling route

The route of the lead-in cabling will be determined by Telstra in accordance with the principles set out in 5.2.4.1 to 5.2.4.4 (pages 47 to 52). This information may be used to determine the likely PCD location.

5.3.3 Private poles and trees

For safety reasons, Telstra will not use trees or customer-owned poles to support new aerial Telstra lead-in cabling. This includes any poles installed by the customer to support the power mains.

5.3.4 Power utility poles

Telstra may agree to use poles owned by a power utility (subject to the agreement of the power utility) because they are regularly inspected and properly maintained by the power utility. However, the use of such poles is at Telstra's discretion.

5.3.5 Inspection and maintenance of poles

Telstra regularly inspects Telstra-owned poles and replaces any defective poles at Telstra's cost.

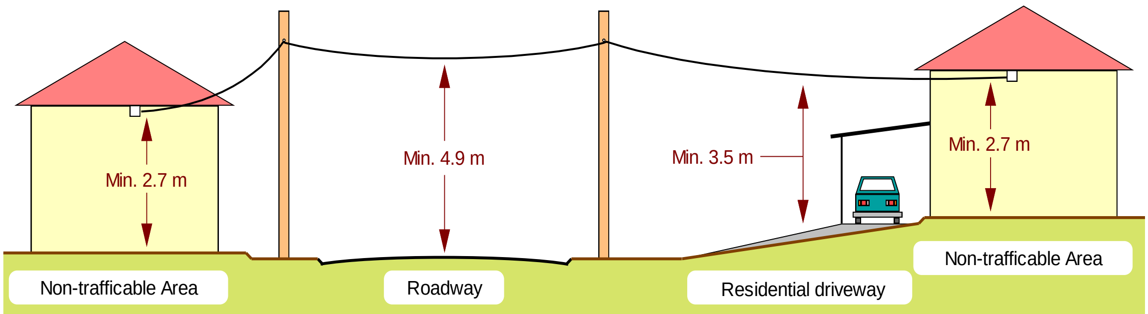
5.3.6 Clearance of aerial lines from the ground

The minimum ground clearances required for aerial lead-in cabling in residential areas are as follows (see Figure 46):

- over any private land not traversable by road vehicles 2.7 m
- over any residential driveway 3.5 m
- over any commercial/industrial driveway or private roadway 4.9 m.

Note: This information is provided for guidance only in determining whether a raiser pole may be required at the building (see Figure 49 and Figure 50). The lead-in cable will be installed by the relevant carrier.

Figure 46 Minimum ground clearances for residential aerial lead-in cabling



Note: At least 5.5 m clearance (or as specified by the relevant transport authority) is normally required above any part of a freeway, primary arterial or collector road or highway.

5.3.7 Clearance from other services

5.3.7.1 At poles and in-span

The minimum separation distances required from low voltage (230 V AC single-phase or 400 V AC three-phase) power mains, associated fittings and terminations on poles or in-span are set out in 5.3.8 (h).

5.3.7.2 At the building

Sufficient separation must be provided at the building between the lead-in cable attachment point and any insulated low voltage power service lead such that **600 mm** can be maintained between the power cables and fittings and the **body of a person working on the lead-in cabling**. This means that if the telecommunications worker cannot safely access the lead-in cable or attachment on the side of the cable or attachment furthest from the power cables and fittings, a separation of at least 1200 mm will be required between the power cables and fittings and the lead-in cables and fittings at the building.

5.3.8 Use of Telstra poles for power mains

While Telstra will not use any poles installed by the customer to support the LV power mains, Telstra will allow Telstra-owned lead-in poles to be used to support the customer's low voltage (LV) power mains (i.e. 230 V AC single-phase or 400 V AC three-phase) under the following conditions:

(a) Only poles erected at the customer's cost (as described in 5.3.1) may be used, i.e. poles installed in accordance with the standard terms and conditions for the supply of a Telstra telephone service as set out in Telstra's "Our Customer Terms" available online at www.telstra.com.au/customer-terms/ (the poles are supplied at Telstra's cost but are erected at the customer's cost).

(b) Telstra must be notified of this requirement **prior** to the commencement of pole installation.

(c) The customer must pay any additional cost incurred to meet this requirement (e.g. any extra pole height required to accommodate the power mains).

(d) The customer must arrange and pay for the installation and maintenance of the power mains on the Telstra poles, including transfer of the power mains to any poles subsequently replaced by Telstra.

(e) Only Telstra poles located within the boundaries of the customer's premises may be used. Telstra poles located outside the customer's real property boundary must **not** be used to support the customer's power mains.

(f) High voltage power lines (exceeding 1000 V AC) must **not** be installed on the Telstra poles.

(g) The power mains must be installed **above** the aerial Telstra cable at a height that, taking into account the required separation distances described in (h), would enable the following minimum ground clearances to be maintained for the Telstra aerial cabling (see 5.3.6):

(i)	Over any private land not traversable by road vehicles	2.7 m
(ii)	Over any residential driveway	3.5 m
(iii)	Over any commercial/industrial driveway or private roadway	4.9 m

(h) The power mains, associated fittings and terminations must be separated from the aerial Telstra cabling, associated fittings and terminations by the following minimum distances:

(i)	Insulated power mains	At the pole In span	600 mm 600 mm
(ii)	Uninsulated power mains	At the pole In span	1200 mm 600 mm
(iii)	Light fitting, stay fitting or power conduit	At the pole	50 mm

5.3.9 Use of Telstra poles for customer cabling

Telstra will allow Telstra-owned lead-in poles to be used to support customer cabling under the following conditions:

(a) Only poles erected at the customer's cost (as described in 5.3.1) may be used, i.e. poles installed in accordance with the standard terms and conditions for the supply of a Telstra telephone service as set out in Telstra's "Our Customer Terms" available online at www.telstra.com.au/customer-terms/ (the poles are supplied at Telstra's cost but are erected at the customer's cost).

(b) Only Telstra poles located within the boundaries of the customer's premises may be used. Telstra poles located outside the customer's property boundary must **not** be used for customer cabling.

(c) The poles must be of sufficient height and the Telstra lead-in cable must be installed on the poles at sufficient height to allow installation of the customer cabling in accordance with (d), (e), (f) and (g).

(d) The customer cabling must be installed below the aerial Telstra cabling.

(e) The customer cable and associated pole fittings must be separated from the Telstra cable and associated pole fittings by at least 300 mm at the pole.

(f) The customer cable must be separated in-span from the Telstra cable by at least 300 mm.

(g) The customer cabling must be installed in accordance with the relevant requirements of the ACMA wiring rules including minimum ground clearances (currently the same as described in 5.3.6).

(h) The customer cable must not be installed within any Telstra underground conduit or pit or within any Telstra conduit installed on the pole.

5.3.10 Aerial cable attachment at the building

The cable attachment point should be as close as possible to the building electricity enclosure to facilitate location of the PCD in accordance with section 6. The location and height of the point of attachment to the building or other structure must allow a route from the pole to the building that:

- does not cross any adjacent property;
- is unobstructed by existing trees or foliage; and
- is capable of maintaining the specified ground clearances and separation from power cables described in 5.3.6 and 5.3.7.

Note: The location of the cable attachment point must also take into account any planned structural additions to the premises, future tree growth or prospective planting of any trees along the proposed cable path.

The cable attachment point at the building must be within reach of a standard one-person extension ladder that is able to be safely erected and secured at the site. The attachment must be made at the perimeter of the building (e.g. fascia, bargeboard or external wall) and not at any point on the roof.

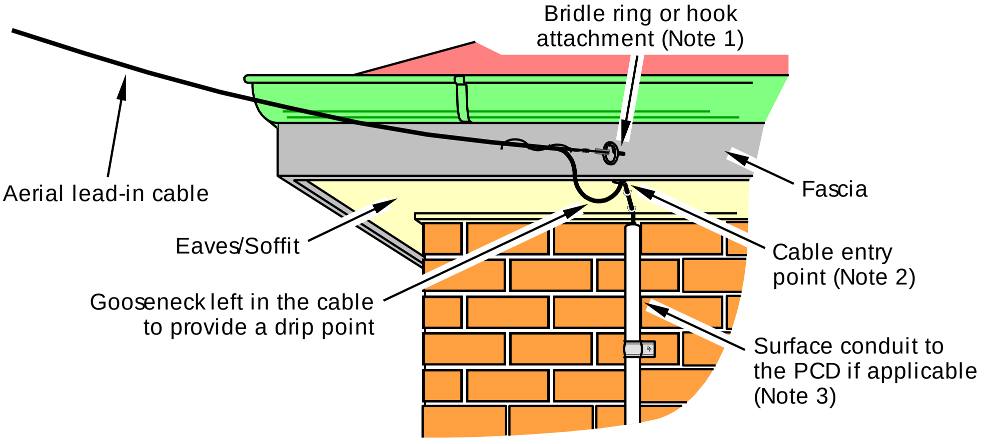
The preferred means of attachment of aerial lead-in cable to the building is to a solid timber fascia or bargeboard or a metal fascia/bargeboard backed by structural timber. The structural member into which the attachment is made must be of sufficient strength to withstand a tension of 2000 Newtons (approximately 200 kgf).

The proposed point of cable attachment with the required structural integrity should be marked on the building plan or the building itself by the builder. Up to three cables of the following description (in any combination) may be attached to the same attachment point:

- 2-pair lead-in cable with integral bearer (ALIC — Aerial Lead-In Cable)
- RG6 or RG11 coaxial "messenger" cable (i.e. with integral bearer)
- single-core optical fibre cable with integral strengthener(s).

The various means of attaching aerial telecommunications cables to buildings are illustrated in Figure 47 to Figure 50.

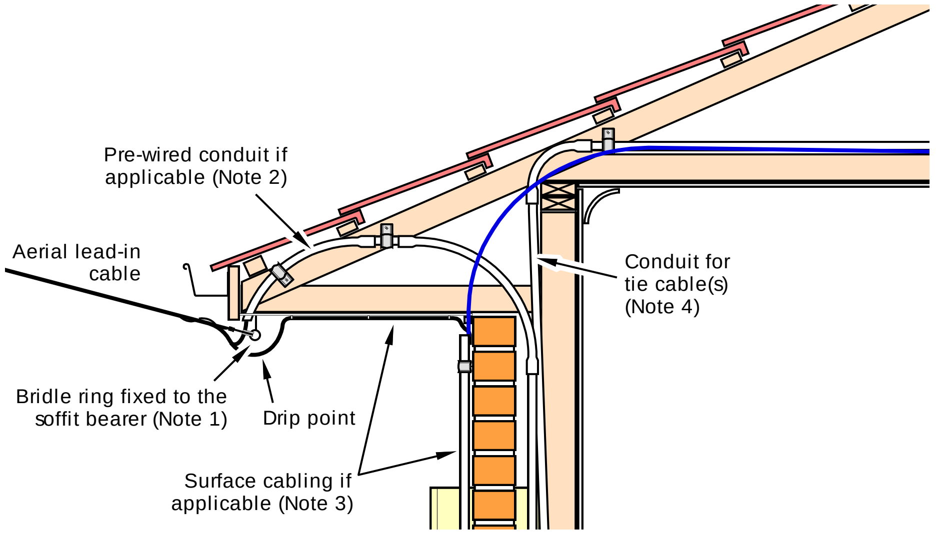
Figure 47 Attachment of aerial cable to the fascia



Notes:

1. This is the preferred means of attachment to the building if the fascia has sufficient structural integrity and the aerial cable will have sufficient ground clearance.
2. If the building has been prepared in accordance with 7.4.4 (page 84) or 7.5.4 (page 87), the lead-in cable may be pulled through the concealed conduit to the CUE or PCD.
3. For an established building, the lead-in cable will usually be extended to the PCD via conduit fixed to the external surface of the building.

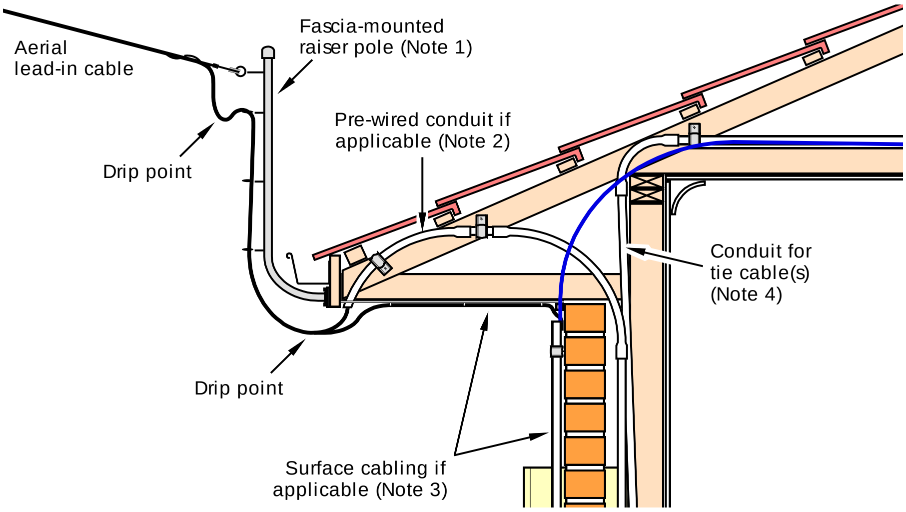
Figure 48 Attachment of aerial cable to the soffit bearer



Notes:

1. This method of attachment may be used if the fascia has insufficient strength to support the aerial cable attachment — as long as the cable will not rub against the fascia or gutter and there will be sufficient ground clearance if this method is used.
2. If the building has been prepared in accordance with 7.4.4 (page 84) or 7.5.4 (page 87), the lead-in cable may be pulled through the concealed conduit to the CUE or PCD.
3. For an established building, the lead-in cable will usually be extended to the PCD via conduit fixed to the external surface of the building.
4. If the building has been prepared in accordance with 7.4.4 or 7.5.4, the tie cable(s) may be pulled through the concealed conduit to the CCP. Otherwise, the tie cable(s) may need to be run via surface-run conduit.

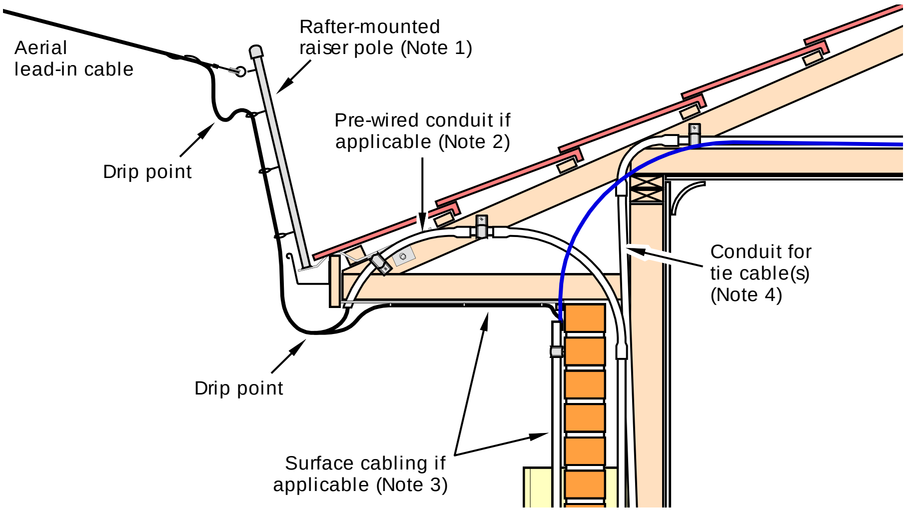
Figure 49 Attachment of aerial cable to a raiser pole attached to the fascia



Notes:

1. A raiser pole must be used where insufficient ground clearance can be obtained by attaching the aerial cable directly to the fascia. The raiser pole may be attached to the fascia as shown above if it has sufficient structural integrity to support the pole. The length of the raiser pole will not exceed 1200 mm and is installed by the carrier.
2. If the building has been prepared in accordance with 7.4.4 (page 84) or 7.5.4 (page 87), the lead-in cable may be pulled through the concealed conduit to the CUE or PCD.
3. For an established building, the lead-in cable will usually be extended to the PCD via conduit fixed to the external surface of the building.
4. If the building has been prepared in accordance with 7.4.4 or 7.5.4, the tie cable(s) may be pulled through the concealed conduit to the CCP. Otherwise, the tie cable(s) may need to be run via surface-run conduit.

Figure 50 Attachment of aerial cable to a raiser pole attached to the rafter/truss



Notes:

1. A raiser pole must be used where insufficient ground clearance can be obtained by attaching the aerial cable directly to the fascia. Where the fascia does not have sufficient structural integrity to support the pole, the pole must be attached to the roof rafter or truss as shown above. The length of the raiser pole will not exceed 1200 mm and is installed by the carrier.
2. If the building has been prepared in accordance with 7.4.4 (page 84) or 7.5.4 (page 87), the lead-in cable may be pulled through the concealed conduit to the CUE or PCD.
3. For an established building, the lead-in cable will usually be extended to the PCD via conduit fixed to the external surface of the building.
4. If the building has been prepared in accordance with 7.4.4 or 7.5.4, the tie cable(s) may be pulled through the concealed conduit to the CCP. Otherwise, the tie cable(s) may need to be run via surface-run conduit.

6 PREMISES CONNECTION DEVICE (PCD)

6.1 Description

The premises connection device (PCD) facilitates the transition from outdoor (underground or aerial) cabling to indoor cabling. No matter what wireline telecommunications network technology is used to supply the telecommunications services, the lead-in cabling will be connected to a PCD at the external wall of the building and will be interconnected to the indoor termination equipment via one or more indoor “tie” cable(s). The PCD may or may not be the network boundary and may vary in form and function depending on the telecommunications network technology used.

Typical PCDs are shown in Figure 51 and Figure 52.

Figure 51 Typical PCDs that are not the network boundary

Telstra FTTP (optical fibre) splice box

This box is 260 H x 250 W x 72 D

NBN Co FTTP (optical fibre) splice box

This box is 210 H x 175 W x 75 D

Standard Telstra HFC (coaxial) isolation box

This box is 215 H x 136 W x 63 D

Larger Telstra HFC (coaxial) isolation box

This box is 250 H x 270 W x 85 D

Notes:

1. The above devices are shown in relative size. These devices are not NTDs and do not require an earth. They are installed by the carrier.
2. The larger Telstra isolation box may be used for housing an RF amplifier (e.g. for more than 3 coaxial outlets).
3. At least 150 mm of clear space is generally required on all sides of all PCDs for cabling and access purposes. This clearance distance may be reduced for a PCD housed in a combined utilities enclosure (see 6.2) or between two PCDs located on the same wall (refer to 7.5.6.3 on page 95 for an example).

Figure 52 Typical network boundary PCDs (NTDs)

Telstra ADSL NTD for twisted pair lead-in cable	Telstra FTTP NTD for optical fibre lead-in cable
	
This NTD is 260 H x 250 W x 72 D	This NTD is 345 H x 305 W x 110 D

Notes:

1. The above NTDs are shown in relative size. They require a hard-wired communications earth (see section 11).
2. The NTD on the left may be installed by the builder's or customer's registered cabler. Refer to Telstra Document No. 012688, *Telstra Network Termination Device — Information for Cabling Providers*.
3. The NTD on the right is installed by Telstra. Telstra will cease using these NTDs for new installations in late 2013 and will use indoor NTDs instead. Refer to 9.6 (page 113) for details.
4. At least 150 mm of clear space is generally required on all sides of the NTD for cabling and access purposes. This clearance distance may be reduced for an NTD housed in a combined utilities enclosure (see 6.2) or between the NTD and another PCD located on the same wall (refer to 7.5.6.3 on page 95 for an example).

6.2 External combined utilities enclosure (CUE)

6.2.1 Description

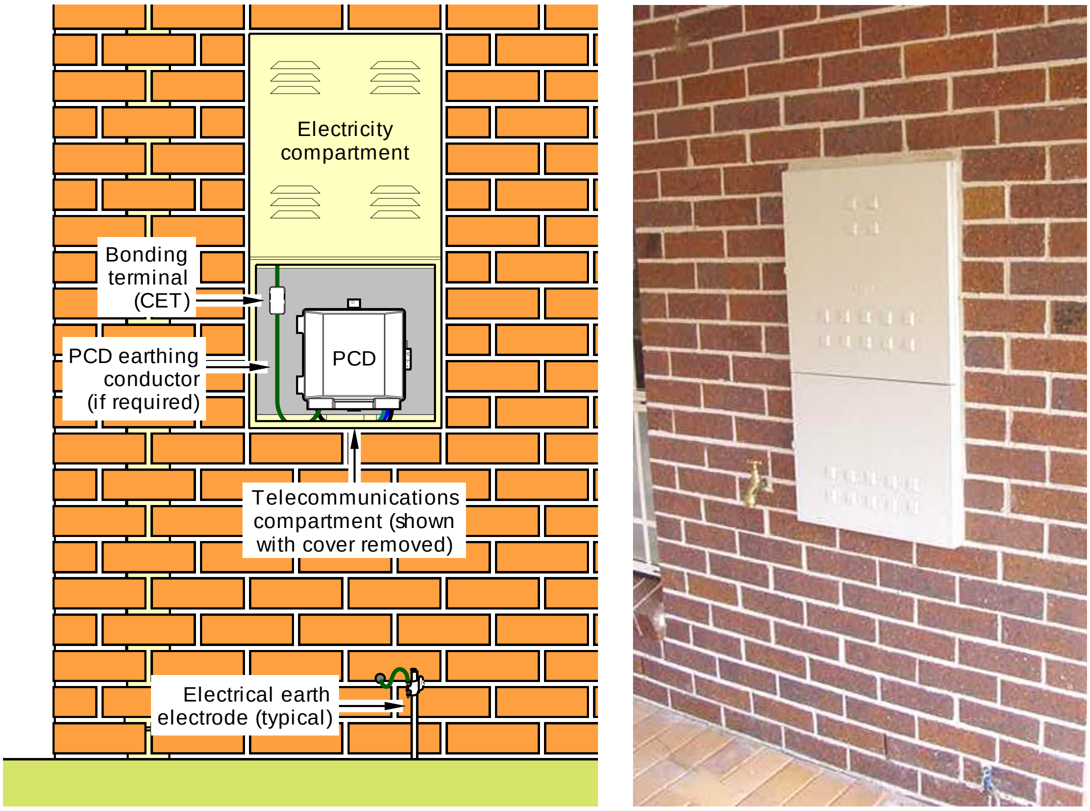
With new homes, it is preferable for the builder or electrician to provide a Combined Utilities Enclosure (CUE) for termination of the building entry conduit and housing of the PCD. Refer to Figure 53.

The CUE allows the cabling and equipment for various utilities such as electricity, telecommunications and, optionally, gas or water, to be housed in a single, compartmentalised enclosure. A CUE:

- improves the overall appearance of the building;
- simplifies the conduit and cabling arrangements, especially where the telecommunications network technology is unknown or is likely to change;
- provides convenient storage space for slack telecommunications cables (i.e. within the CUE);
- avoids problems with mounting PCDs on low-density cladding materials such as polystyrene;
- provides additional protection for the PCD and associated cables from the weather, hosing or impact from garden tools, balls, toys, etc.;
- facilitates effective earthing of the PCD, where required;
- improves accessibility by service personnel; and
- assists in implementing standardised installation practices.

The CUE must be installed by the electrician as part of the electrical installation.

Figure 53 Combined electricity and telecommunications enclosure (installed by the electrician)



Note: The equipotential bonding conductor for the CET (Communications Earth Terminal) must be installed by the electrician. The CET may be installed by either the electrician or the telecommunications installer. See section 11 for details.

6.2.2 CUE requirements

Telstra's requirements for CUEs are set out in Telstra Specification 010062, *Combined Utilities Enclosures* (Issue 4). The essential Telstra requirements for CUEs are as follows:

(a) The minimum internal dimensions of the space in which the PCD is to be housed must be 480W x 415H x 140D (in mm). The depth ("D") is measured between the face of the backboard described in (c) and the inside surface of the door.

(b) The telecommunications compartment door aperture must be at least 375W x 375H (in mm).

(c) A backboard of insulating material (e.g. timber) that is at least 400 mm wide and 18 mm thick must be provided for mounting of the PCD and must extend at least 350 mm below the horizontal plane of the top edge of the door aperture.

(d) A sturdy metal plate must be provided over any electrical conduits or cables that run behind the telecommunications backboard described in (c). A minimum clearance of 20 mm must be provided between the metal plate and the rear of the backboard for the passage of cables.

(e) Suitable cable entry facilities or knock-outs must be provided and must be accessible within the telecommunications compartment.

B&R Enclosures (http://www.brenclosures.com.au/nbn-enclosure.htm) manufactures a range of CUEs complying with Telstra Specification 010062, and these are available through electrical suppliers. Suitable enclosures are as follows:

State	Model No.	Description	Height (mm)	Width (mm)	Depth (mm)
NSW	CSN0401	Houses electrical meters & comms	934	482	255
	CSN042201	Houses electrical meters, switchboard & comms	1105	482	255
NT	CSQ0401	Houses electrical meters & comms	934	482	255
	CSQ042201	Houses electrical meters, switchboard & comms	1106	482	255
QLD	CSQ0401	Houses electrical meters & comms	934	482	255
	CSQ042201	Houses electrical meters, switchboard & comms	1106	482	255
TAS	CST022102	Houses electrical meters, switchboard & comms	1105	482	255
VIC	CSV022102	Houses electrical meters, switchboard & comms	1105	482	255

Where a CUE has been provided and meets the carrier's requirements, the PCD will be mounted inside the CUE as shown in Figure 53.

6.3 Where an external combined utilities enclosure (CUE) is not provided

6.3.1 General

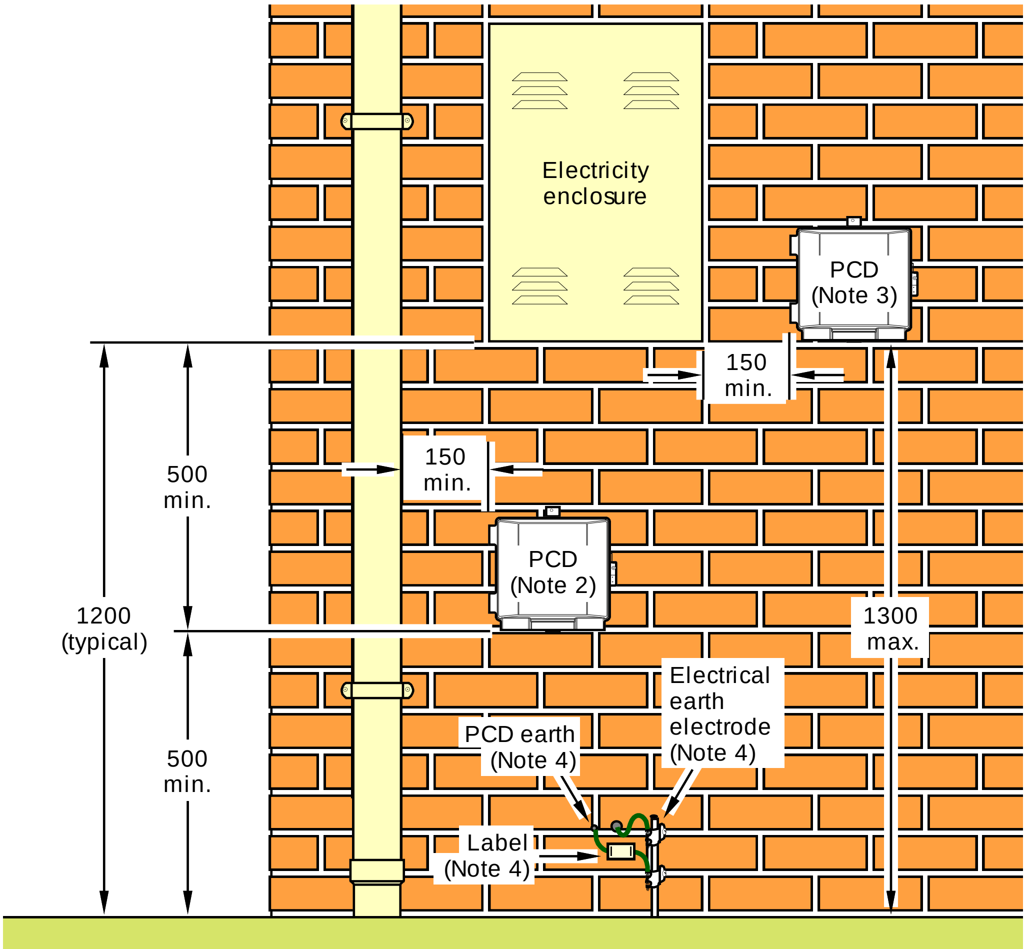
Where a CUE has not been provided, the PCD must be installed separately on the external wall.

The PCD must be installed:

- at a minimum height of 500 mm and a maximum height of 1300 mm from finished ground level, measured to the bottom of the lowest part of the PCD;
- at a minimum distance of 150 mm from the electricity enclosure or any other building fixture, measured to any part of the PCD with the cover closed; and
- outside any gas exclusion zone described in 6.3.3.1 (page 75).

These requirements are summarised in Figure 54.

Figure 54 PCD installation for new buildings where a CUE is not provided



Notes:

1. All measurements are in mm.
2. In areas that do not have a reticulated gas service (including homes where cylinder gas will be used), the preferred location for the PCD for new buildings under construction is below the electricity enclosure at a height of 500 mm to 600 mm above finished ground level. Locating the PCD below the electricity enclosure minimises the risk of obstruction by such things as downpipes, windows, doors, adjoining fences/gates and gas cylinders.
3. In areas that have a reticulated gas service, the gas meter is usually installed in the space below the electricity enclosure, in which case the preferred location for the PCD is at least 150 mm to the left or right of the electricity enclosure and at the same height as the electricity enclosure (usually about 1200 mm from finished ground level). In pre-wiring situations, if the PCD is to be located beside the electricity enclosure it will be necessary to ascertain the location of downpipes, doors, windows, adjoining fences, etc. from the building plan to determine which side of the electricity enclosure to install the PCD and the building entry conduits.
4. If the PCD requires an earth connection (see Table 1 on page 29 and Figure 52), this should be made directly to the electrical earth electrode if it is accessible; otherwise, a suitable bonding conductor must be provided by the electrician from the main earthing bar of the electrical switchboard in accordance with section 11.
5. Where more than one PCD is installed (e.g. one for twisted pair lead-in cable and one for coaxial lead-in cable), they should be positioned at least 50 mm apart (measured between the nearest part of each PCD with the cover closed) even if the same lead-in conduit will be used to pull in the separate lead-in cables (see Figure 71 on page 96 for an example).

6.3.2 Low-density wall cladding (e.g. polystyrene)

If low-density cladding such as polystyrene is to be used, suitable backing board must be provided by the builder behind the cladding at the PCD location to support the PCD. In such cases, the intended position for the PCD should be marked on the building plan or the actual building by the builder.

6.3.3 PCD positioning

6.3.3.1 Separation from gas facilities

The PCD must be positioned:

- at least 500 mm above or 1000 mm to the side of any gas meter or associated fitting in accordance with Figure 55
- outside the conical exclusion zone around any gas cylinder as shown in Figure 56.

Lead-in conduit/cabling and tie conduit/cabling running to/from the PCD must be separated from any gas pipe, meter, cylinder or associated fitting by a minimum distance of 150 mm (see 10.9.4.3 on page 232).

Figure 55 Exclusion zone for gas meters

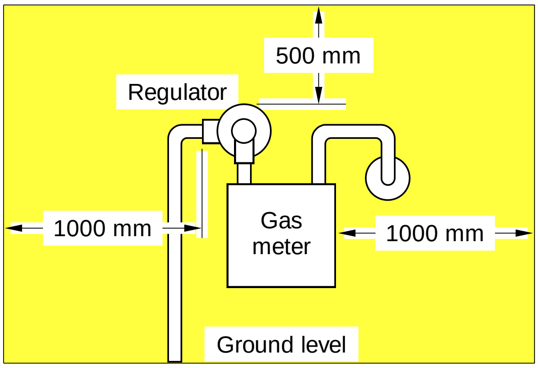
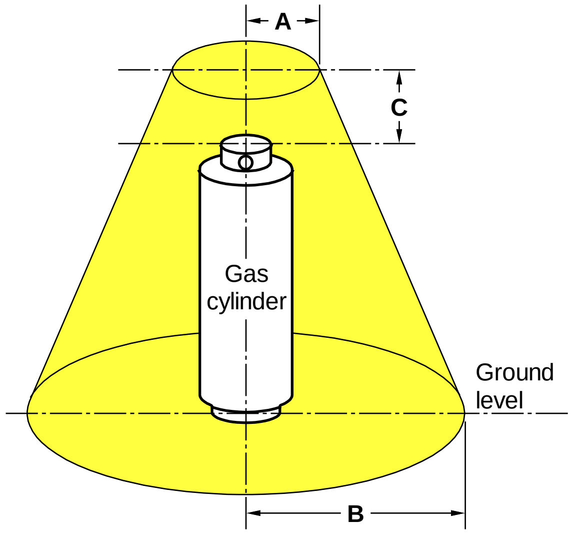


Figure 56 Exclusion zone for gas cylinders



	Exchange cylinder	In-situ fill cylinder
A	500 mm	1500 mm
B	1500 mm	3500 mm
C	500 mm	500 mm

6.3.3.2 Separation from water services

The PCD must be positioned at least **300 mm** in any direction from a **water meter** or **water tap**.

Lead-in conduit/cabling and tie conduit/cabling running to/from the PCD should be separated from any water pipe, water meter or associated fitting by a minimum distance of 50 mm (see 10.9.4.3 on page 232).

6.3.3.3 New buildings

6.3.3.3.1 Areas with reticulated gas

In areas that have a reticulated gas service, the gas meter is usually installed in the space below the electricity enclosure (meter panel or switchboard). In such areas, the preferred location for the PCD is at least 150 mm to the **left or right of the electricity enclosure** and at the **same height as the electricity enclosure** (usually about 1200 mm from finished ground level). In pre-wiring situations, if the PCD is to be located beside the electricity enclosure it will be necessary to ascertain the location of downpipes, doors, windows, adjoining fences, etc. from the building plan to determine which side of the electricity enclosure to install the PCD and the building entry conduits.

6.3.3.3.2 Areas without reticulated gas

In areas that do not have a reticulated gas service (including a home where cylinder gas will be used), the preferred PCD location for new buildings under construction is **below the electricity enclosure** at a height of 500 mm to 600 mm above finished ground level. Locating the PCD below the electricity enclosure reduces the risk of obstruction by downpipes, windows, doors, adjoining fences/gates, gas cylinders, etc.

6.3.3.3.3 PCD location away from the electricity enclosure

Where the electricity enclosure is on the opposite side of the building to the side where the property entry point is located and the lead-in underground or aerial cable cannot be run across to this side of the building (e.g. due to difficult terrain, extensive landscaping, retaining wall, paved driveway, swimming pool, trees, etc.), the PCD may be located at the side of the building nearest to the property entry point as long as the builder, electrician or customer provides a suitable earthing conductor at the PCD location if an earth is required (see Figure 52 and section 11). In such cases, care must be taken to avoid gas cylinders (see 6.3.3.1) which are normally located away from the electricity enclosure. Also, if the premises is in a defined lightning risk situation and will be connected to a copper network, there may be a need to install a PCD on each side of the building joined by “lead-in extension” cabling (see Figure 30 on page 49).

For optical (FTTP) networks, the PCD may be located on the opposite side of the building to the electricity enclosure if this is expedient — as long as the builder, electrician or customer provides a suitable earthing conductor at the PCD location if an earth is required and care is taken to avoid gas cylinders. Refer to Figure 52 and section 11 for details.

Note: Even though optical fibre is not electrically conductive, optical PCDs must be separated from gas facilities in accordance with 6.3.3.1 in case fusion splicing of fibres needs to be carried out at the PCD.

6.3.3.4 Established buildings

For established buildings (e.g. building reconstruction or renovation), it will normally be necessary for the PCD to be located beside (not below) the electricity enclosure or, in some cases, near the existing building entry point which may not be near the electricity enclosure. In all cases, the PCD must be installed within the height limitations shown in Figure 54 and must be separated from gas and water services in accordance with 6.3.3.1 and 6.3.3.2.

A suitable earthing/bonding conductor must be provided for connection to the PCD, if required (see Table 1 on page 29 and Figure 52 on page 71).

7 BUILDING ENTRY CONDUITS

7.1 Description

Building entry conduits are the conduits that provide for the penetration of the telecommunications cables into the building. The conduits must allow cables to be pulled through them while preventing the entry of water or vapour into the building or the covert entry of termites.

For some types of building construction (e.g. brick veneer), conduits may be partially concealed inside the wall cavity; otherwise they may be fastened to the surface of the external wall. Each method has its advantages and disadvantages. Concealed conduits produce a neater result — as long as the conduits are positioned correctly.

The integrity of the building entry conduits is very important to ensure that cables can be pulled through them without stress or damage.

In particular, the conduits and bends must be capable of allowing an optical fibre cable with a factory-fitted connector within a protective boot or hauling sock to pass through them (see 5.2.2.6 on page 42). Pre-formed bends **must** be used — conduit must **not** be bent on site whether or not this is done by the application of heat or using a bending tool.

The use of some form of Premises Connection Device (PCD) on the external wall of the home is an essential part of the building entry facilities.

The PCD:

- provides a transition from outdoor type cable to indoor type cable;
- supports mitigation against the entry of water and termites to the building via the lead-in conduit;
- facilitates future repair or replacement of the telecommunications lead-in cabling or tie cabling; and
- provides an external access point for testing of cables or services at the building.

If it is not possible to use an external PCD for some reason, the relevant carrier must be consulted.

Under no circumstances should underground lead-in conduit terminate inside the building unless a “drainage pit” is used at the external wall of the building to reduce the risk of entry of water and termites to the building via the conduit. Refer to 7.6 (page 99).

7.2 Lead-in entry conduit

7.2.1 Conduit type

For homes, **white**, **rigid** (UPVC) plastic conduit and fittings with an **inside diameter (ID) of 23 mm** that complies with 5.2.2.2 and 5.2.2.3 (page 41) is used for installation of the lead-in cable(s) between the property entry point and the PCD. No more than the equivalent of **two 90° bends** is permissible **at the building**, comprising:

- one **300 mm radius** bend (or equivalent where composite bends are used over the footings) in the **underground** portion; and
- one **100 mm radius** bend in the **aboveground** portion (e.g. within the wall cavity).

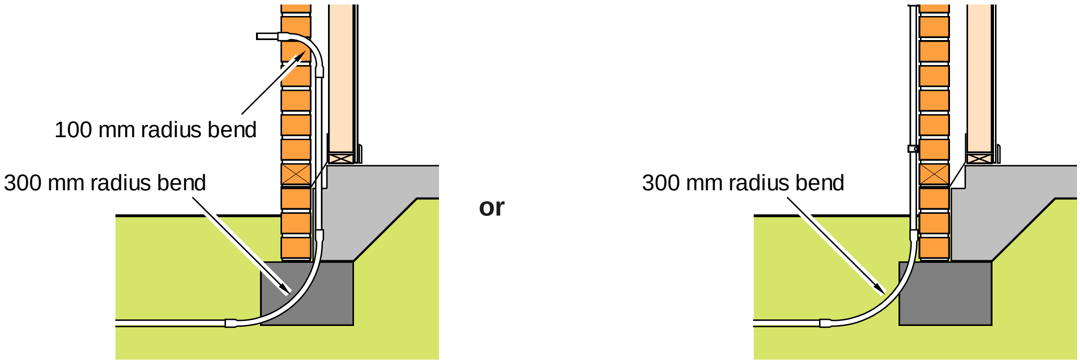
Refer to Figure 57.

Note: Another 300 mm radius bend may be used at the street pit, making a total of three bends (the maximum permissible) between cable access points (see Figure 24 on page 43).

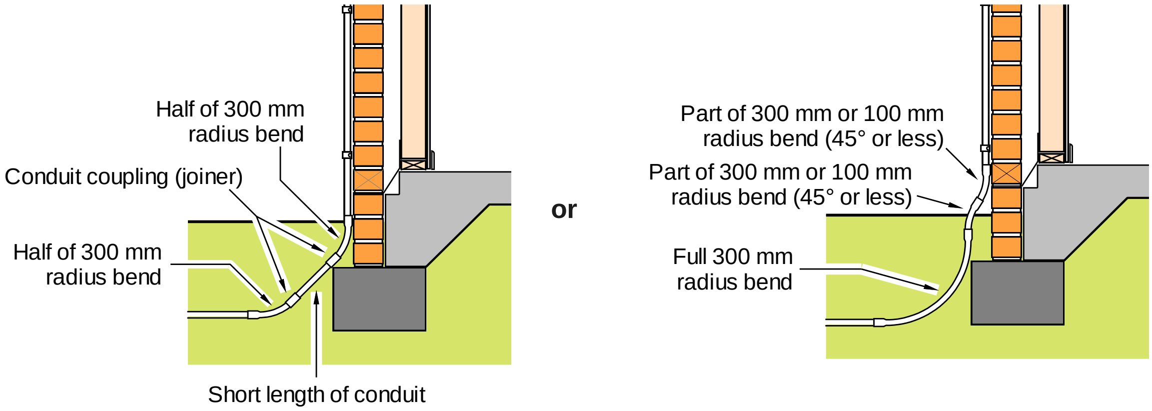
Flexible conduit with a minimum outside diameter (OD) of 25 mm may be used on the **external wall** to protect the cable between the point where the rigid conduit terminates on the external wall and the PCD, as long as the flexible conduit can be separated from the rigid conduit for future access. **This is for information only** — the **carrier** will install any flexible lead-in conduit that is required on the external wall.

Figure 57 Lead-in conduit and bends at the building

(a) Conduit installed in the building footings



(b) Conduit installed over the building footings



Notes:

1. No more than the equivalent of two 90° bends, comprising one **300 mm radius** bend **underground** and one **100 mm radius** bend **aboveground**, are permissible at the building. Another 300 mm radius bend may be used at the street pit, making a total of three bends (the maximum permissible) between cable access points (see Figure 24 on page 43).
2. Only **pre-formed bends** may be used. Conduit must **not** be bent on site (e.g. by application of heat or using a bending tool). Flexible/corrugated conduit must not be used for this purpose.

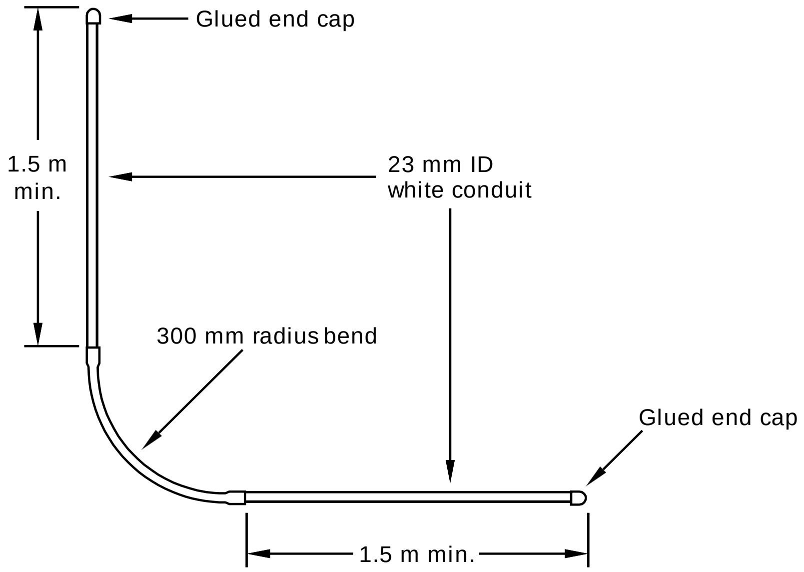
7.2.2 Lead-in conduit positioning in the building foundations

Conduit for underground lead-in cabling should be installed in the building footings before the concrete is poured. A conduit/bend assembly should be located in the building footings in accordance with Figure 58. Otherwise, the conduit will need to be installed over the footings later, but it may protrude from the wall as shown in Figure 57 (b).

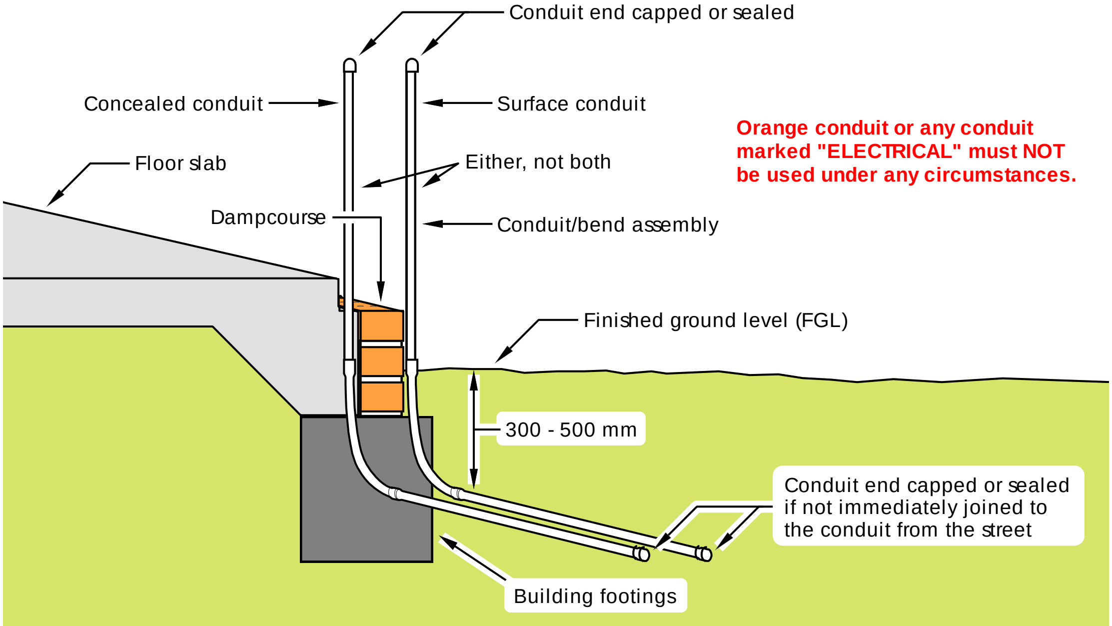
Any conduit installed in the building footings must comply with 7.2.1. Suitable lengths of conduit must be glued to the bend using solvent conduit cement. Conduit of any other size (whether it has a larger or smaller diameter) may not be useable by the carrier.

Figure 58 Lead-in building entry conduit installation

(a) Conduit and bend assembly (Note 1)



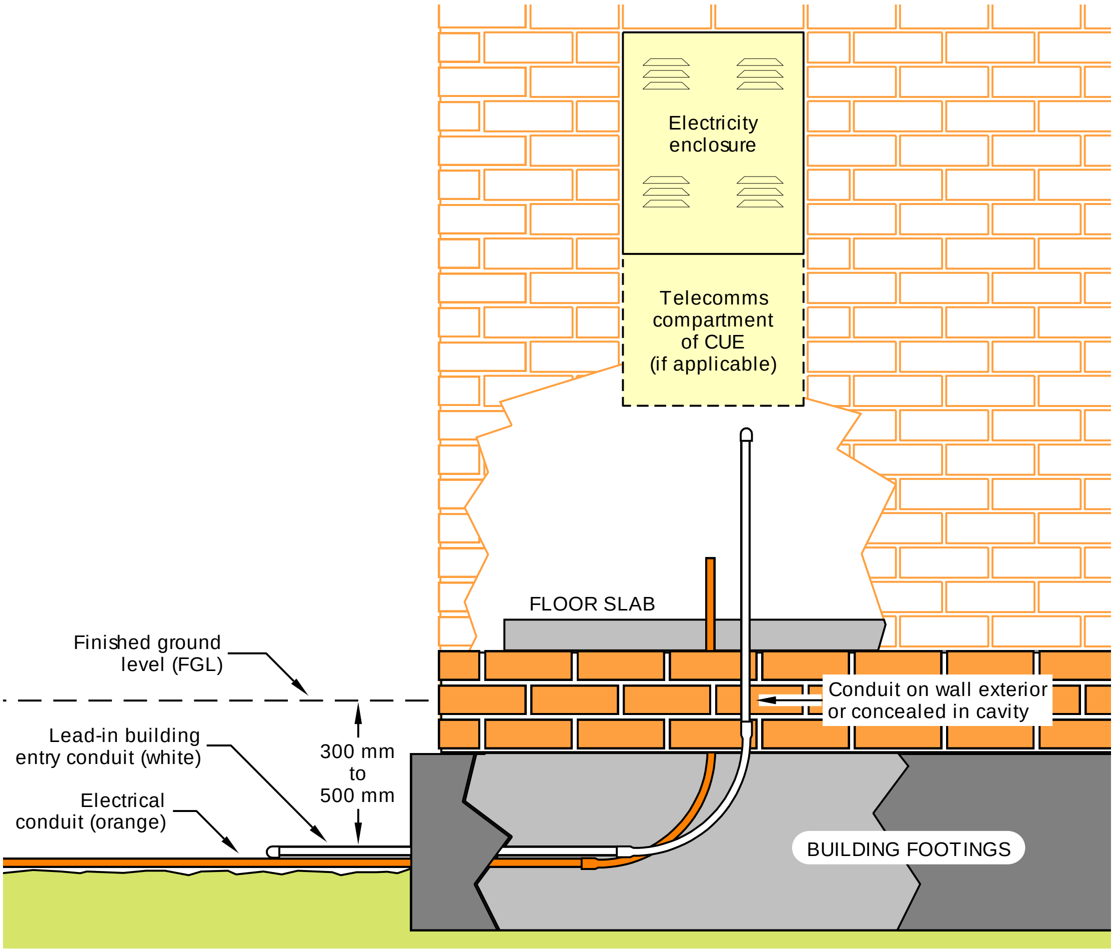
(b) Positioning of the lead-in conduit/bend assembly in the building footings



Notes:

1. The conduit/bend assembly must be made from suitable lengths of **white, 23 mm ID, UPVC conduit** complying with 7.2.1 glued to a **300 mm radius** bend using solvent conduit cement. For Telstra lead-in cabling, the conduits and bends may be marked “Telstra” or “NBN”. Conduits or bends of the same inside diameter but marked “Communications” may also be used — however, any conduit or bend marked as “20 mm” or “25 mm” and including “2053” in the markings (i.e. manufactured to Australian Standard AS/NZS 2053) is physically incompatible with Telstra and NBN Co networks and is **not suitable** for lead-in building entry conduit.
2. The end of the conduit/bend assembly should be capped to:
   - prevent the entry of debris or silt into the conduit during building construction; and
   - as a safeguard in case it is never used to ensure that it does not provide a corridor for the entry of water or termites into the wall cavity (the cap should be glued to any conduit laid in a trench or positioned in the wall cavity — to be cut away later when jointing the lead-in conduit or the bend in the wall cavity).

Figure 59 Building entry conduit positioning relative to the electricity enclosure



Notes:

1. The conduit may enter the building footings from any direction as long as it is pointed in the general direction of the carrier's property entry point (if it is not already joined to the lead-in conduit from the property entry point).
2. Where a CUE is not, or will not be, provided, the vertical section of the lead-in conduit must be correctly positioned in relation to the intended PCD location, as the use of flexible conduit or more than one bend within the wall cavity is not permitted for the lead-in cabling.

7.2.3 Termite barriers

Virtually all buildings in mainland Australia require a termite barrier to be installed around the perimeter of the building or on isolated piers, posts or stumps used to support the building or such things as verandas and staircases. The purpose of the barrier is to impede termite entry to the building and to ensure that any shelter tubes constructed by termites over the barrier are visible.

Common termite barriers consist of exposed slab edge, stainless steel mesh, metal capping, graded stone or chemically treated soil. Whatever method is used, the lead-in conduit will bridge or breach the termite barrier where the conduit enters the building. Termites can build a shelter tube around some barriers but they are then in the open where they can be detected more readily during regular inspections by a competent person. Bridging or breaching of these termite barriers by such things as conduits and cables may defeat the protection measures taken.

For new building construction, it is important that any underground lead-in conduit be installed at the building footings before the termite barrier is installed so that the conduit is treated appropriately by the termite barrier installer.

For established buildings, any new underground lead-in conduit installed will either bridge or breach the existing termite barrier. Where the conduit penetrates the termite barrier (e.g. graded stone, chemically treated soil), the barrier must be reinstated at the penetration point by a qualified termite barrier installer. Where the conduit bridges the termite barrier (e.g. exposed slab edge, stainless steel mesh or metal capping), the conduit must be installed in a way that does not impede clear visual inspection of the termite barrier where it is bridged (e.g. it must not be fixed into a corner against two adjoining walls or against another conduit or pipe). Additionally, the conduit must not cover any weepholes.

7.3 Conduit for the tie cabling

At least one 23 mm ID conduit should be provided between the PCD and the CCP or, if this is not possible, between the PCD and a suitable access point for pulling in the tie cable(s).

Note: Where the PCD is likely to be an outdoor FTTP NTD or if two PCDs will be installed, the provision of a **second conduit** may be required **for coaxial cabling** (see Table 1 on page 29).

The conduit for the tie cabling will:

- provide a pathway between the PCD and the CCP for the installation of the tie cable(s) either before or after building completion and for replacement of the cable(s) at some future time to accommodate any change in telecommunications network technology;
- protect the cable(s) from damage during construction activities;
- help to ensure that the cable(s) is/are not dislocated or entombed in the external wall cavity during construction;
- ensure that any required cable separation requirements of the telecommunications and electrical wiring rules are met;
- where a CUE is not used, correctly position the cable(s) at the PCD location; and
- protect the cable from possible rodent damage after construction (optical fibre cables in particular may be susceptible to damage by rodents due to the absence of an electric field around the cable).

The requirements for this conduit are set out in 8.2.2 (page 101).

7.4 Conduit arrangements where a combined utilities enclosure (CUE) is used

7.4.1 General

Underground lead-in cabling is used in virtually all new developments. Aerial lead-in cabling may be used in established areas or in new developments where the ground conditions preclude underground cabling construction.

Rigid conduit must be used all the way to the telecommunications compartment of the CUE. **All conduit joints and fittings must be glued.** The use of flexible conduit within building cavities is prohibited due to the difficulty of pulling cables through flexible conduit.

7.4.2 Tie cabling

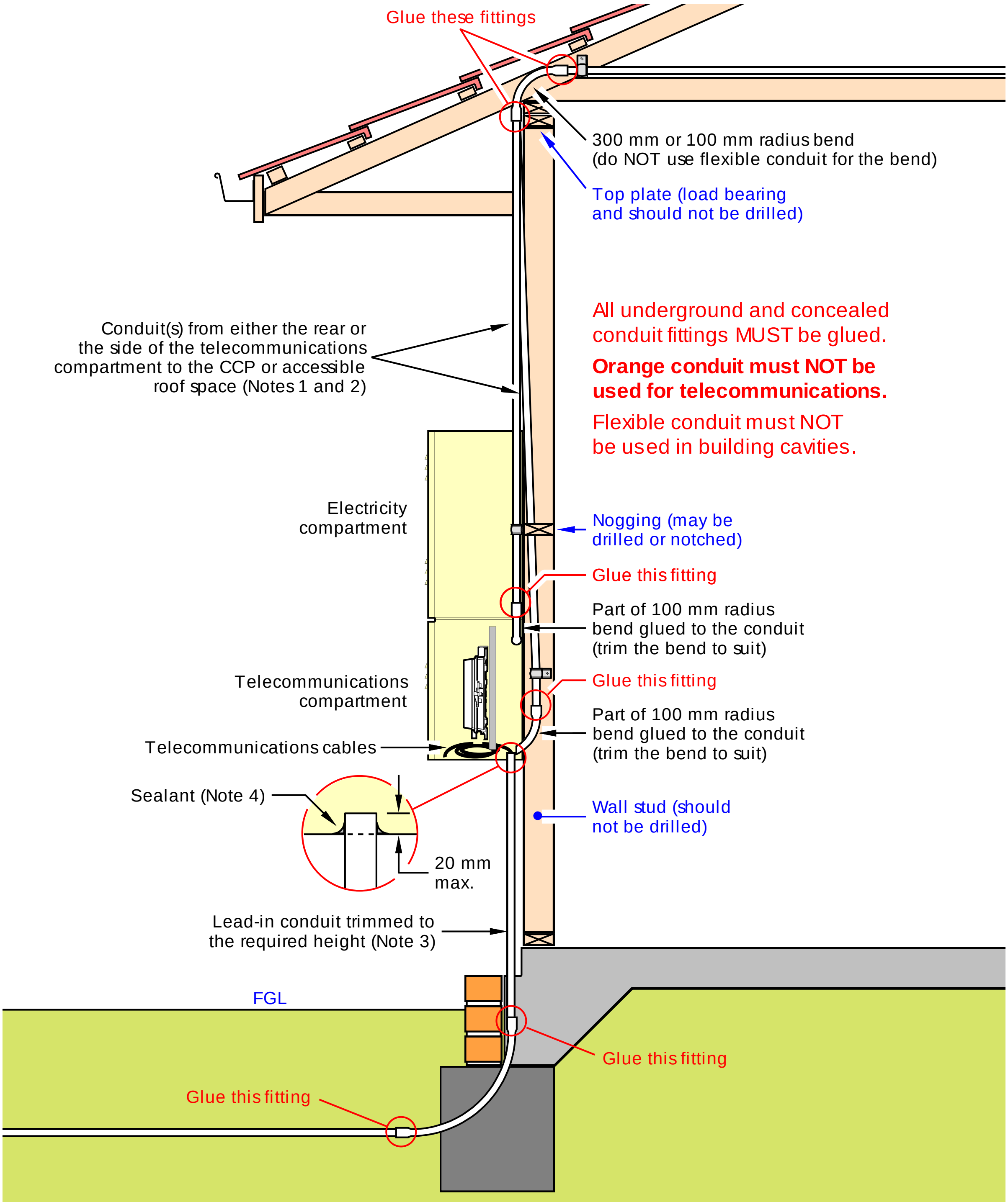
Conduit(s) for the tie cabling will terminate in the CUE as shown in Figure 60 to Figure 63. Refer to 8.2.2 on page 101 for more information about tie cabling conduits.

7.4.3 Underground lead-in cabling

Underground lead-in conduit will terminate within the CUE, which should be designed to allow any water emitting from the end of the conduit to drain to the bottom, front edge of the door opening. To ensure that such water does not drain back into the wall cavity, the outer surface of the conduit should be sealed where it penetrates the CUE (e.g. using an ant-resistant, flexible sealant). The end of the conduit should terminate no more than 20 mm above the penetration to the CUE to ensure that it is visible for inspection under the backboard for termite activity.

Figure 60 and Figure 61 show typical conduit arrangements for cavity wall (e.g. brick veneer and timber or metal framed) buildings. For buildings of solid masonry or double-brick construction, refer to 8.2.2.4 (page 102) for typical tie cabling conduit arrangements.

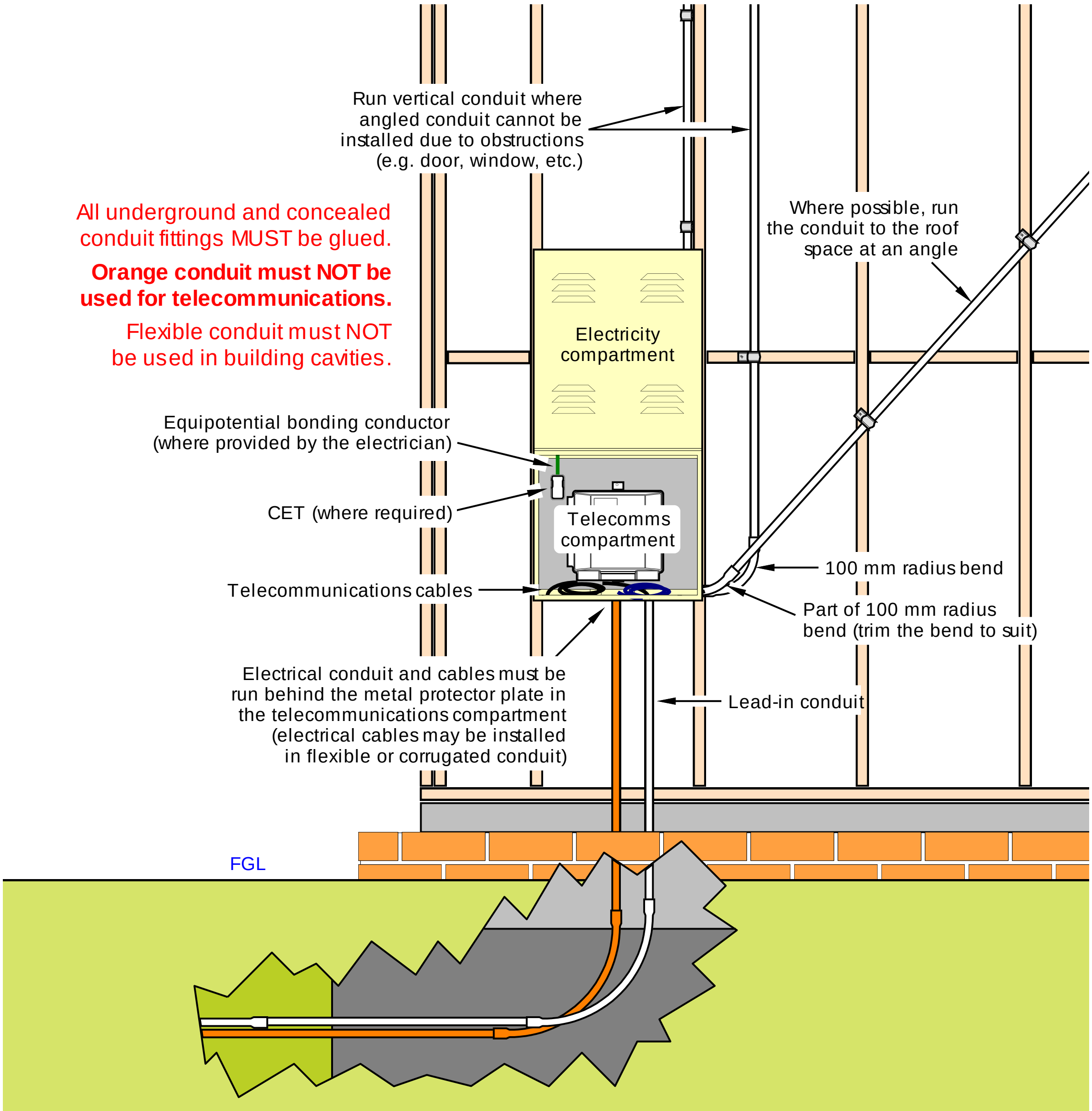
Figure 60 Conduit arrangements for a CUE installation on a cavity wall — side view



Notes:

1. Run the conduit for the tie cabling to either the side or the rear of the telecommunications compartment, as appropriate. Where the conduit runs behind the enclosure, run it between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2.
2. Secure the conduit to the wall studs and/or noggings with conduit saddles or half-saddles. Glue all conduit and bend joints so that the fittings will not come apart when cables are being pulled through them.
3. The lead-in conduit must not be drilled under any circumstances, as this may allow the covert entry of water or termites to the wall cavity via the underground lead-in conduit.
4. The lead-in conduit should be sealed where it enters the CUE to prevent any water emitting from the conduit from draining into the wall cavity.

Figure 61 Conduit arrangements for a CUE installation on a cavity wall — front view



Notes:

1. If possible, run the conduit to the roof space at an angle so that:
   - the conduit bend at the top will fit comfortably between the top plate and the roof battens; and
   - the cabling will be clear of the power cables running from the electricity compartment in the roof space.

   Alternatively, the conduit may run directly to the CCP if it is to be located on the internal side of the same wall on which the CUE is located.
2. Where it is not possible to run the conduit at an angle, run it vertically beside the enclosure or between the wall studs behind it. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2.

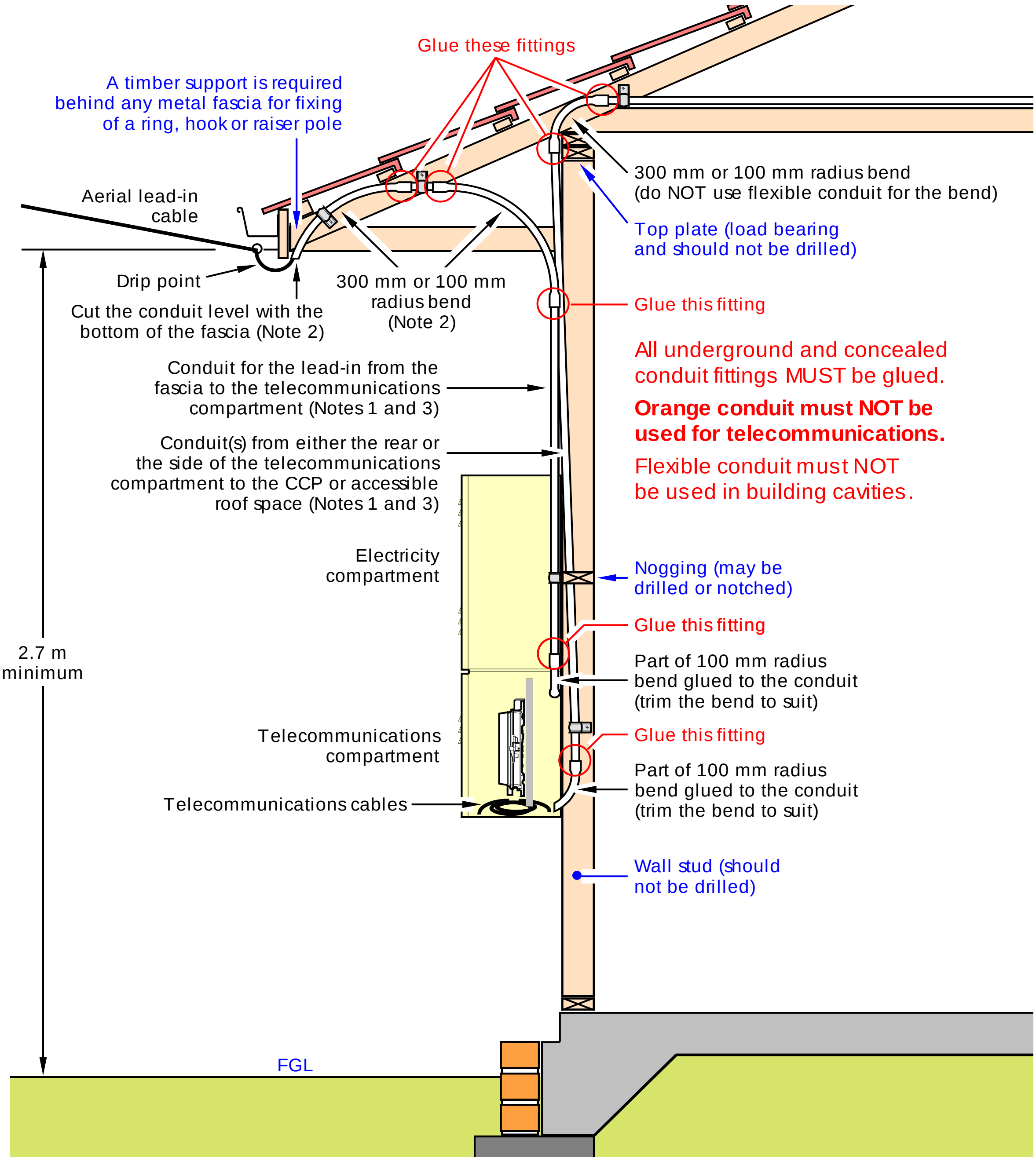
7.4.4 Aerial lead-in cabling

Aerial lead-in cabling is normally only used in established suburbs or in rural areas where the nature of the terrain precludes underground cabling.

Aerial lead-in conduit will terminate within the CUE, which should be designed to allow any rainwater that gets into the conduit at the fascia to drain to the bottom, front edge of the CUE door opening. With aerial lead-in cabling, there is no need to worry about inspection of the end of the conduit for termite activity.

Figure 62 and Figure 63 illustrate typical conduit arrangements for cavity wall (e.g. brick veneer and timber/metal framed) buildings. For buildings of solid masonry or double-brick construction, refer to 8.2.2.4 (page 102).

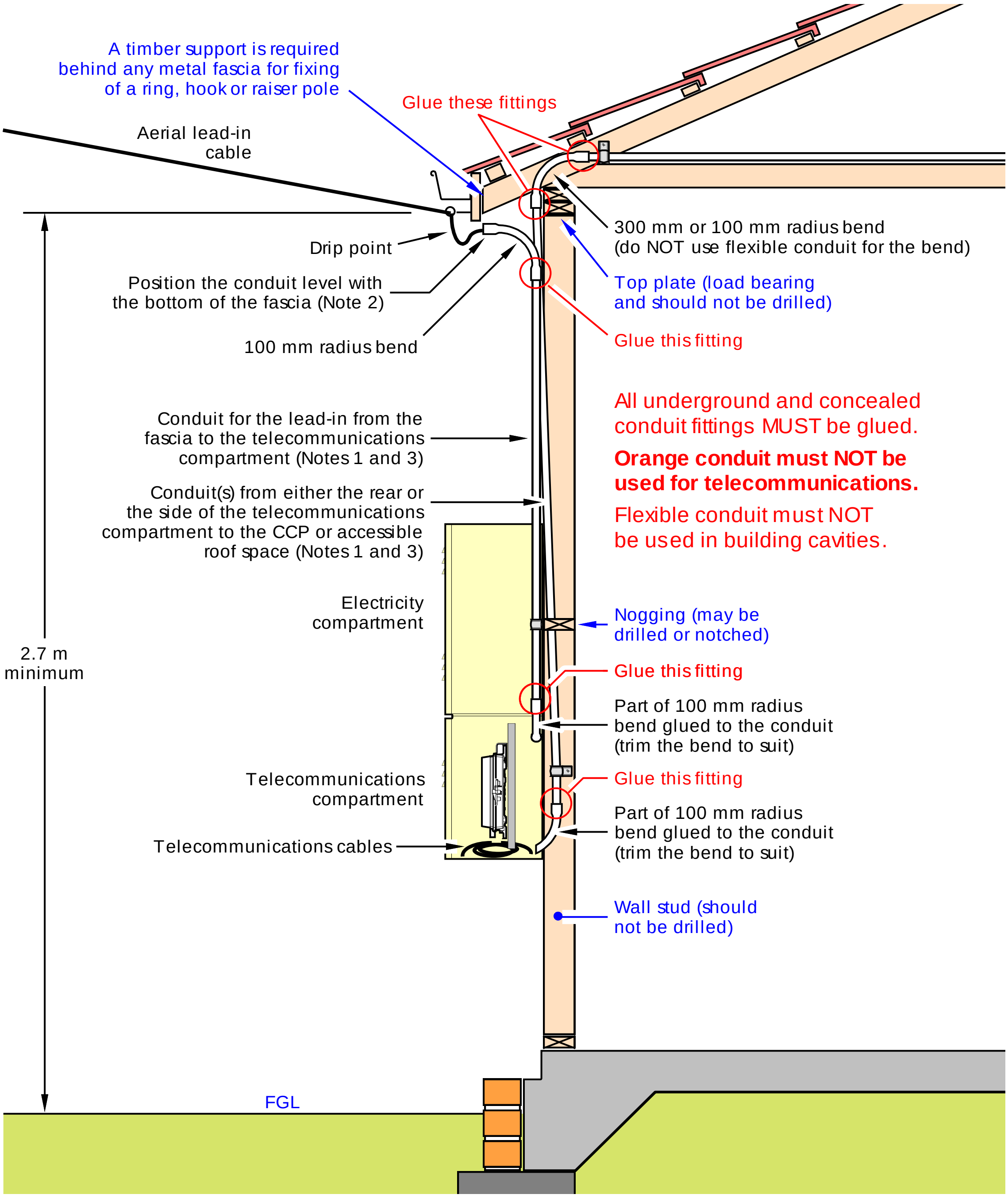
Figure 62 Conduit arrangements for a CUE installation on a cavity wall — building with 450 mm to 600 mm eaves



Notes:

1. Run the conduits for the lead-in cabling and tie cabling to either the side or the rear of the telecommunications compartment, as appropriate. Where the conduits run behind the enclosure, run them between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2.
2. Fix the bends firmly to the eaves truss as shown such that the conduit is hard up against the inside of the fascia. 100 mm radius bends may be used where 300 mm radius bends won't fit. Cut the conduit flush with the bottom of the fascia. All bends must be glued to the conduit.
3. Secure the conduits to the wall studs and/or noggings with conduit saddles or half-saddles. Glue all conduit and bend joints so that the fittings will not come apart when cables are being pulled through them.

Figure 63 Conduit arrangements for a CUE installation on a cavity wall — building with narrow or no eaves



Notes:

1. Run the conduits for the lead-in cabling and tie cabling to either the side or the rear of the telecommunications compartment, as appropriate. Where the conduits run behind the enclosure, run them between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2.
2. Fix the top bend as shown such that the top of the conduit is level with the bottom of the fascia. Cut the conduit flush with the inside face of the fascia. All bends must be glued to the conduit.
3. Secure the conduits to the wall studs and/or noggings with conduit saddles or half-saddles. Glue all conduit and bend joints so that the fittings will not come apart when cables are being pulled through them.

7.5 Conduit arrangements where a combined utilities enclosure (CUE) is NOT used

7.5.1 General

Underground lead-in cabling is used in virtually all new developments. Aerial lead-in cabling may be used in established areas or in new developments where the ground conditions preclude underground cabling construction.

Rigid conduit must be used all the way to the external wall of the building. **All rigid conduit joints and fittings must be glued.** Flexible conduit should not be used within building cavities due to the difficulty of pulling cables through flexible conduit. However, if necessary flexible conduit with a minimum outside diameter (OD) of 25 mm may be used on the **external surface** of the building as long as it can be separated from the rigid conduit for future access for pulling in cables (this is for information only — the carrier will install any flexible lead-in conduit that is required on the external wall).

7.5.2 Tie cabling

Conduit(s) for the tie cabling will terminate below the PCD as shown in Figure 64 to Figure 67. See 7.5.5 for details about positioning of the conduits at the PCD location. Refer to 8.2.2 on page 101 for more information about conduits for tie cabling.

7.5.3 Underground lead-in cabling

Underground lead-in conduit must terminate at the external wall of the building to allow any water or vapour emitting from the end of the conduit to drain harmlessly outside the building and to ensure that the conduit opening is visible to enable inspection for termite activity.

For new buildings under construction, the PCD should be located either under or beside the electricity enclosure in accordance with 6.3 (page 73). Where it is not possible to locate the PCD near the electricity enclosure, refer to 6.3.3.3.3 (page 76).

Figure 64 and Figure 65 illustrate typical conduit arrangements for cavity wall (e.g. brick veneer and timber/metal-framed) buildings. For buildings of solid masonry or double-brick construction, refer to 8.2.2.4 (page 102).

7.5.4 Aerial lead-in cabling

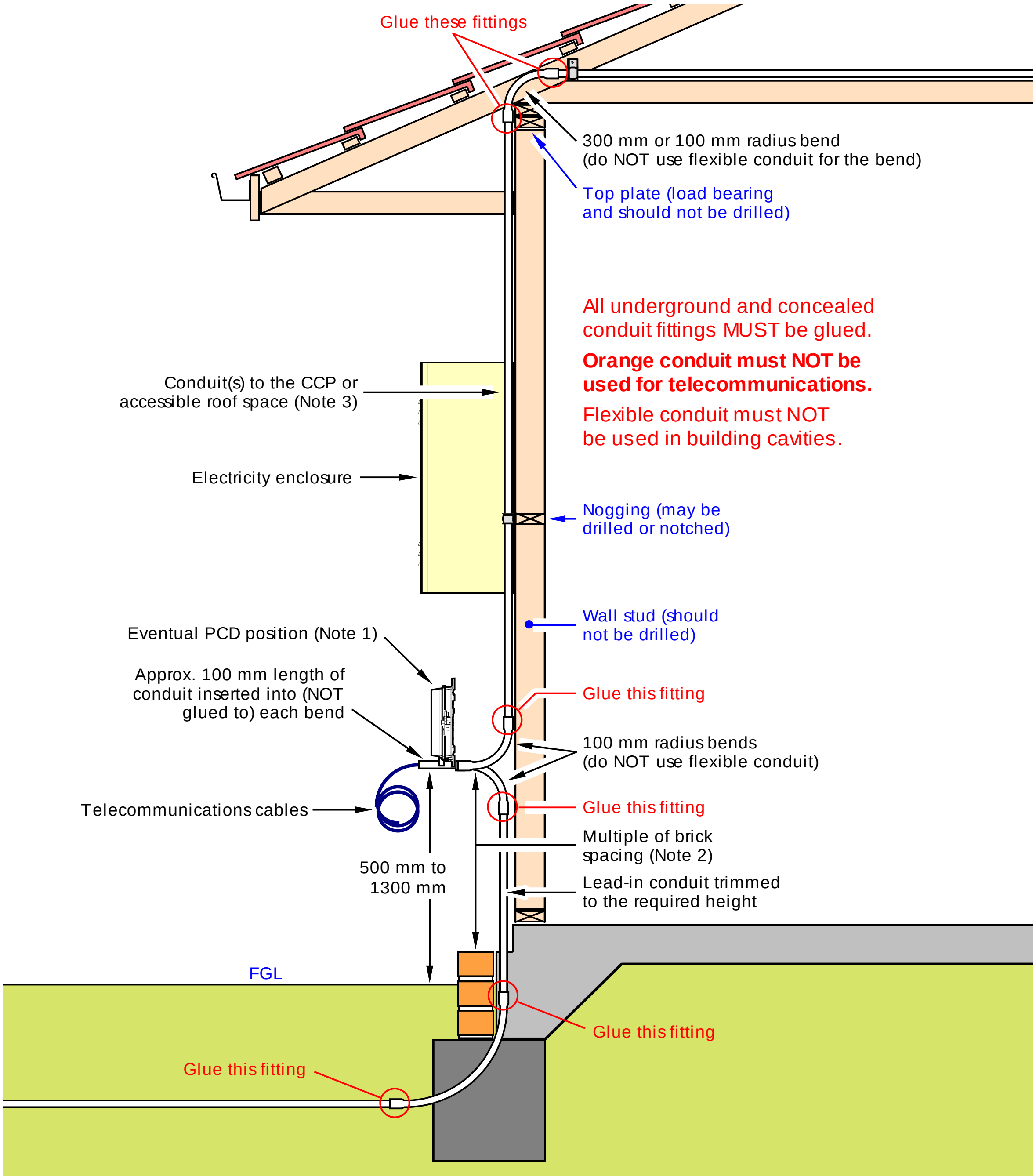
Aerial lead-in cabling is normally only used in established suburbs or in rural areas where the nature of the terrain precludes underground cabling.

For new buildings under construction in an area where aerial lead-in cabling is used, the PCD must be located either under or adjacent to the electricity enclosure so as to provide access to the PCD without the use of a ladder and to support the possible connection of underground lead-in cabling at some future time. Where it is not possible to locate the PCD near the electricity enclosure, it may be located below the point where the aerial cable attaches to the building as long as it is installed within the height limits described in Figure 54 on page 74. Refer to 6.3.3.3.3 on page 76 for other requirements and precautions.

Figure 66 and Figure 67 illustrate typical conduit arrangements for cavity wall (e.g. brick veneer and timber/metal-framed) buildings. For buildings of solid masonry or double-brick construction, refer to 8.2.2.4 (page 102).

IT'S HOW WE CONNECT

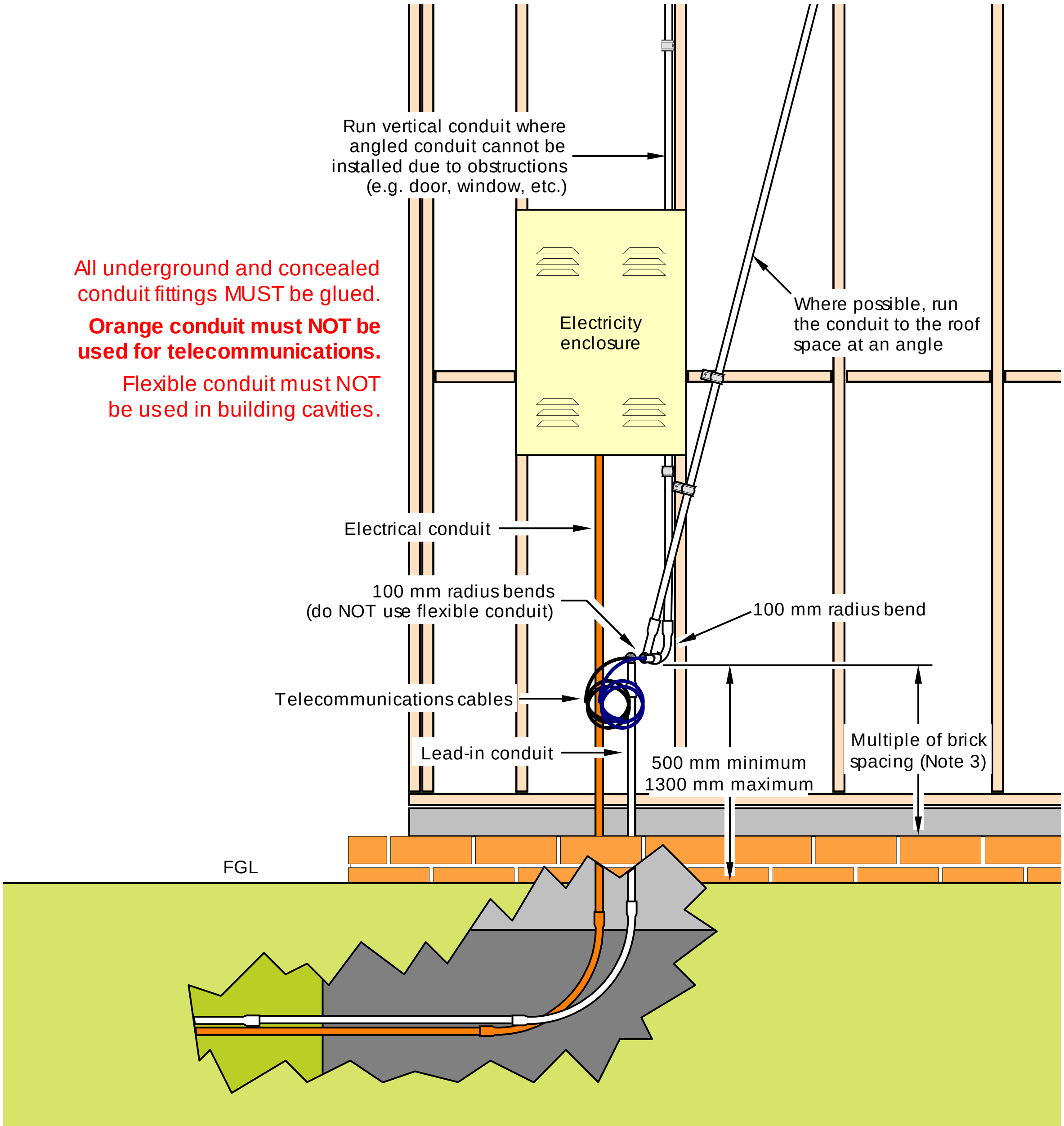
Figure 64 Conduit arrangements for a non-CUE installation on a cavity wall underground lead-in cabling — side view



Notes:

1. For new buildings under construction in an area that does not have a reticulated gas service (including homes where cylinder gas will be used), the PCD should be located below the electricity enclosure, as indicated above, to avoid obstruction by such things as downpipes, windows, doors, adjoining fences/gates and gas cylinders. Otherwise, the PCD should be located beside the electricity enclosure.
2. Fix the horizontal section of each bend a multiple of the brick spacing above the brick base. For standard 230 x 110 x 76 clay bricks, this will be a multiple of 86 mm, e.g. 7 bricks x 86 mm = 602 mm. In areas that have a reticulated gas service, locate the conduits to either side of, and level with the bottom of, the electricity enclosure (see Figure 54 on page 74 and 6.3.3.3 on page 75).
3. Where the conduit runs behind the electricity enclosure, run it between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2. Secure the conduit to the wall studs and/or noggings with conduit saddles or half-saddles. Glue all conduit and bend joints so that the fittings will not come apart when cables are being pulled through them.

Figure 65 Conduit arrangements for a non-CUE installation on a cavity wall underground lead-in cabling — front view

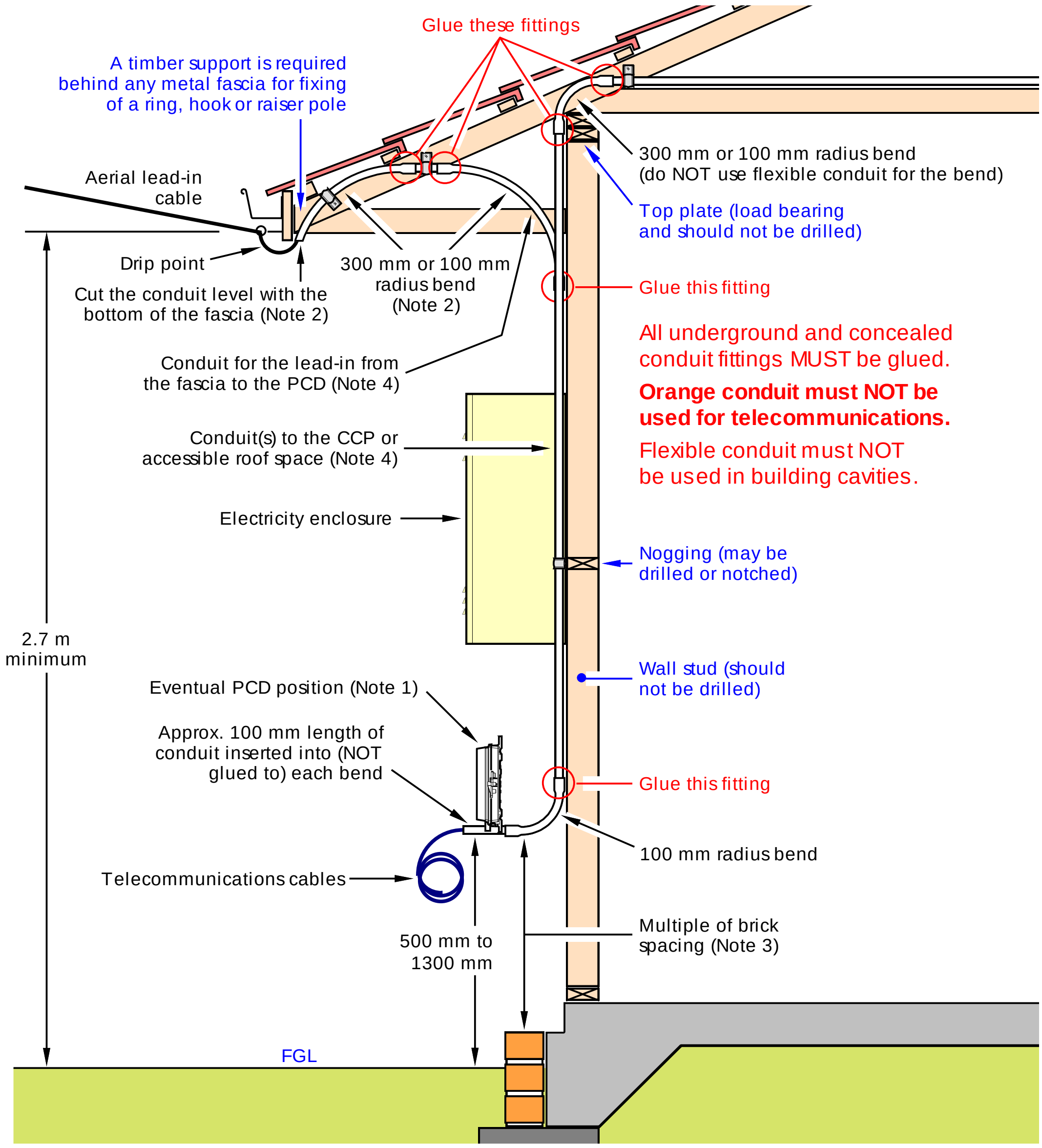


Notes:

1. If possible, run the conduit to the roof space at an angle so that:
   - the conduit bend at the top will fit comfortably between the top plate and the roof battens; and
   - the cabling will be clear of the power cables running from the electricity enclosure in the roof space.

   Alternatively, the conduit may run directly to the CCP if it is to be located on the internal side of the same wall on which the PCD is located.
2. Where it is not possible to run the conduit at an angle, run it vertically beside or behind the electricity enclosure. Where the conduit runs behind the enclosure, run it between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2.
3. Fix the horizontal section of each bend a multiple of the brick spacing above the brick base. For standard 230 x 110 x 76 clay bricks, this will be a multiple of 86 mm, e.g. 7 bricks x 86 mm = 602 mm. In areas that have a reticulated gas service, locate the conduits to either side of, and level with the bottom of, the electricity enclosure (see Figure 54 on page 74 and 6.3.3.3 on page 75).

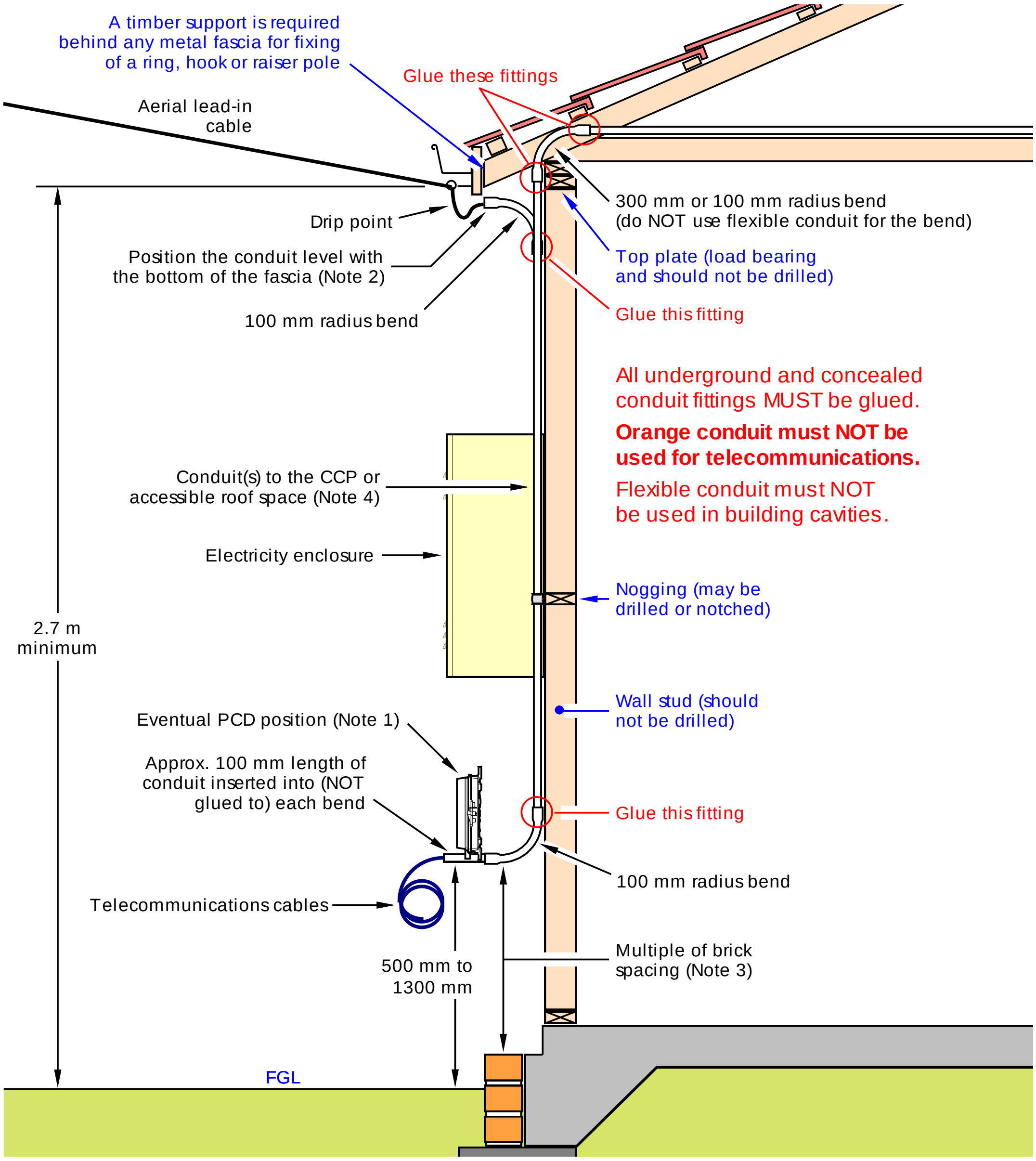
Figure 66 Conduit arrangements for a non-CUE installation on a cavity wall aerial lead-in cabling — building with 450 mm to 600 mm eaves



Notes:

1. For new buildings under construction in an area that does not have a reticulated gas service (including homes where cylinder gas will be used), the PCD should be located below the electricity enclosure, as indicated above, for safe and easy access, to avoid obstruction by such things as downpipes, windows, doors, adjoining fences and gas cylinders, and to facilitate future underground lead-in cabling. Otherwise, the PCD should be located beside the electricity enclosure.
2. Fix the bends firmly to the eaves truss as shown such that the conduit is hard up against the inside of the fascia. 100 mm radius bends may be used where 300 mm radius bends won't fit. Cut the conduit flush with the bottom of the fascia. All bends must be glued to the conduit.
3. Fix the horizontal section of each bend a multiple of the brick spacing above the brick base. For standard 230 x 110 x 76 clay bricks, this will be a multiple of 86 mm, e.g. 7 bricks x 86 mm = 602 mm. In areas that have a reticulated gas service, locate the conduits to either side of, and level with the bottom of, the electricity enclosure (see Figure 54 on page 74 and 6.3.3.3 on page 75).
4. Where the conduits run behind the electricity enclosure, run them between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2. Secure the conduits to the wall studs and/or noggings with conduit saddles or half-saddles. Glue all conduit and bend joints so that the fittings will not come apart when cables are being pulled through them.

Figure 67 Conduit arrangements for a non-CUE installation on a cavity wall aerial lead-in cabling — building with narrow or no eaves



Notes:

1. For new buildings under construction in an area that does not have a reticulated gas service (including homes where cylinder gas will be used), the PCD should be located below the electricity enclosure, as indicated above, for safe and easy access, to avoid obstruction by such things as downpipes, windows, doors, adjoining fences and gas cylinders, and to facilitate future underground lead-in cabling. Otherwise, the PCD should be located beside the electricity enclosure.
2. Fix the top bend as shown such that the top of the conduit is level with the bottom of the fascia. Cut the conduit flush with the inside face of the fascia. All bends must be glued to the conduit.
3. Fix the horizontal section of each bend a multiple of the brick spacing above the brick base. For standard 230 x 110 x 76 clay bricks, this will be a multiple of 86 mm, e.g. 7 bricks x 86 mm = 602 mm. In areas that have a reticulated gas service, locate the conduits to either side of, and level with the bottom of, the electricity enclosure (see Figure 54 on page 74 and 6.3.3.3 on page 75).
4. Where the conduits run behind the electricity enclosure, run them between the studs, not on the front of the studs. Ensure that the telecommunications cables are separated from the power cables in accordance with 10.9.4.2. Secure the conduits to the wall studs and/or noggings with conduit saddles or half-saddles. Glue all conduit and bend joints so that the fittings will not come apart when cables are being pulled through them.

7.5.5 Conduit positioning at the PCD location

Cables should enter the bottom of the PCD to ensure that water or vapour will not enter the device via the cable entry hole. Therefore, the conduit ends must be positioned at the bottom of the PCD. All Telstra PCDs are designed to allow cables to pass behind them. Any cables coming down the surface of the wall from above the PCD may pass behind a Telstra PCD and then loop up into the cable entry port to form a drip point.

The NBN Co PCD pictured in Figure 51 (page 70) is not designed to allow cables to pass behind it but it has a cable entry port at the top of the PCD, which may be used by NBN Co installers for cable entry.

However, cables must **not** enter the top, side or rear of a **Telstra PCD** under any circumstances.

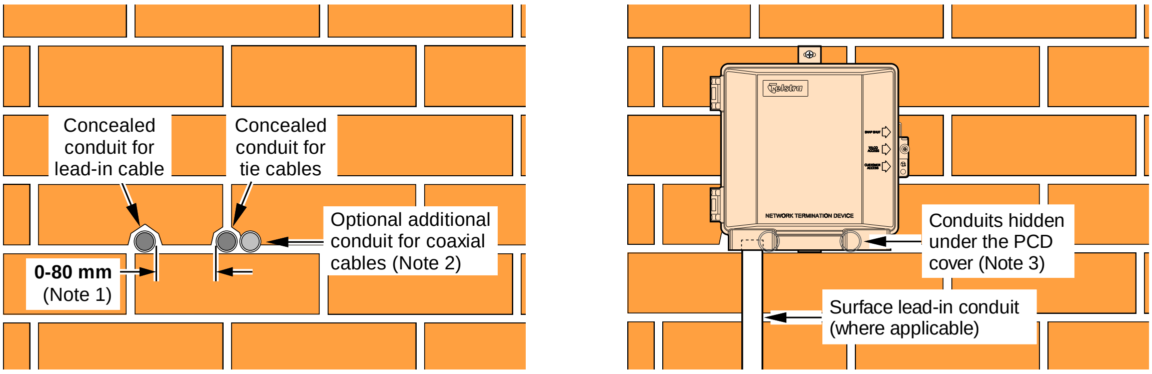
Refer to Figure 68 for correct conduit positioning on a cavity wall for **all** PCD types.

More detailed information is provided in 7.5.6 for various types of Telstra PCDs.

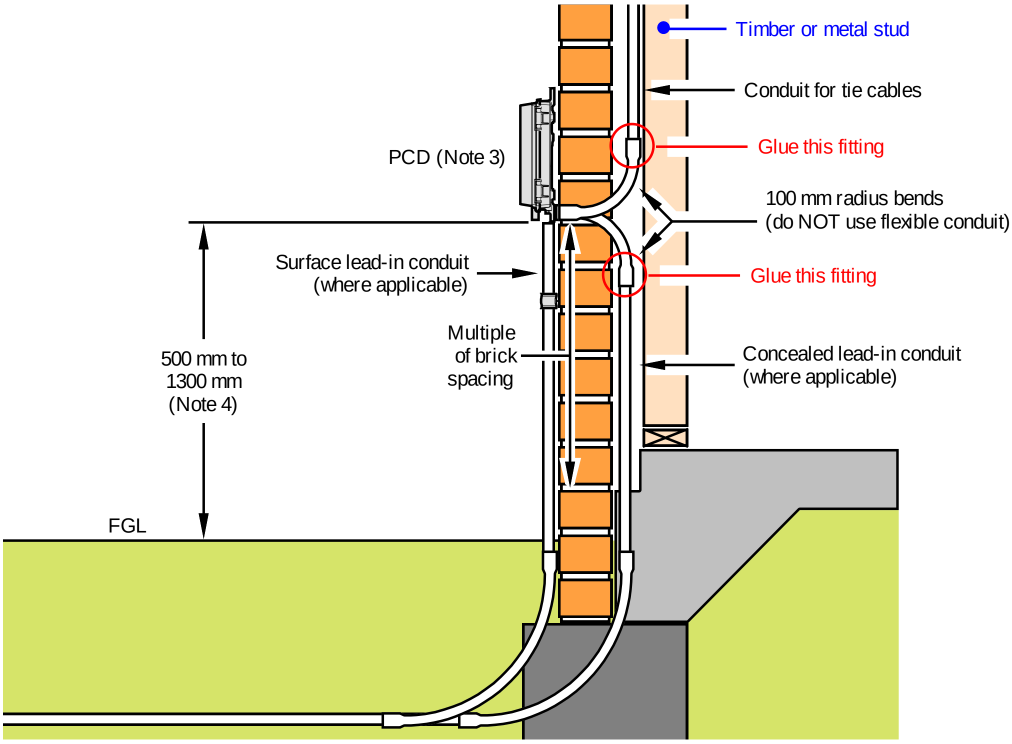
Figure 68 Conduit position for all PCDs on cavity walls where a CUE is not used

(a) Conduit spacing

(b) Front view of an installed Telstra PCD



(c) Side view of the completed PCD installation



Notes:

1. Optimal conduit positioning varies according to the type of PCD to be installed. Spacing the conduits between 0 mm and 80 mm will ensure compatibility with all PCDs.
2. The provision of a second conduit for the tie cabling is required where:
   - the PCD is likely to be an outdoor FTTP NTD as shown in Figure 52 on page 71 (in which case both conduits should be side by side as depicted in (a) above); or
   - a second PCD is to be installed, e.g. HFC isolation box for Cable internet or pay TV as shown in Figure 51 on page 70 (in which case the conduits should be spaced at least 180 mm apart — see 7.5.6.3 and Figure 71).
3. Telstra PCDs have a skirt on the cover to:
   - protect the cables from direct exposure to sunlight;
   - hide the ends of the conduits from general view while allowing water and vapour to escape from the lead-in conduit outside the PCD; and
   - enable the lead-in conduit opening to be readily inspected for termite activity by a pest inspector.
4. For pre-wiring in areas that do not have reticulated gas (including homes where cylinder gas will be used), locating the PCD below the electricity enclosure will minimise the risk of obstruction by such things as downpipes, fences, gas cylinders, etc. In such cases, positioning the conduits between 500 mm and 600 mm above finished ground level (FGL) will ensure there is sufficient clearance from the electricity enclosure while providing reasonable PCD height for access (see Figure 54 on page 74 and 6.3.3 on page 75).

7.5.6 PCD positioning over the conduits

7.5.6.1 General

Separate PCDs must be provided for twisted pair, coaxial and optical fibre lead-in cables. Where more than one PCD is required (e.g. one for a twisted pair lead-in cable and one for a coaxial lead-in cable), the PCDs should be separated by a minimum distance of 50 mm measured between the closest parts of each PCD with the cover closed. The same lead-in conduit may be used to pull in the separate lead-in cables, so at least one of the lead-in cables will be exposed before it enters the PCD (refer to 7.5.6.3 for an example).

A minimum clearance of 10 mm (20 mm preferred) must be maintained between the end of any underground conduit and the PCD cable entry to ensure that any water or vapour coming out of the conduit can escape externally and to enable any termite activity to be visible to a pest inspector. No minimum clearance is required for the end of any conduit provided for aerial cabling or indoor cabling.

7.5.6.2 ADSL NTD

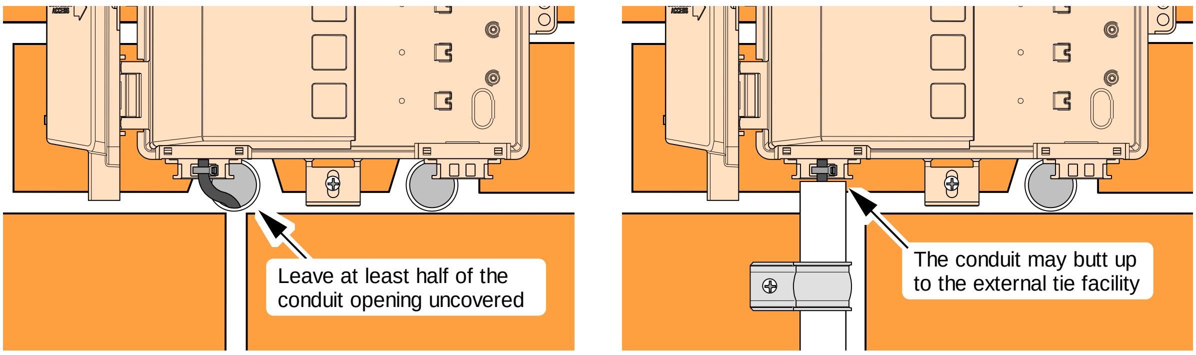
The Telstra NTD used for connection of twisted pair lead-in cables is coloured beige (light brown) and has a “Telco” (Telstra) side and a “customer” (cabler) side. The cable entry ports are spaced at 140 mm centres. Lead-in cable and the earthing conductor must enter the left-hand cable entry port and customer cables must enter the right-hand cable entry port. These cable entry arrangements cannot be reversed. However, flexibility is provided by the ability to pass cables behind and underneath the NTD without being exposed (see Figure 70).

Optimal positioning of the NTD over conduits spaced at 80 mm is shown in Figure 69. Typical positioning of the NTD over conduits located side-by-side is shown in Figure 70.

The NTD is normally supplied and installed by Telstra at no charge for the connection of a generic cabling system if the NTD is requested before the time of installation. Alternatively, a registered cabler may supply and install one, if expedient, in accordance with Telstra Specification 012688, *Telstra Network Termination Device — Information for Cabling Providers*.

Figure 69 Optimal Telstra ADSL NTD positioning over conduits spaced at 80 mm

(a) Concealed lead-in conduit (Note 1) **(b) Surface lead-in conduit** (Note 2)

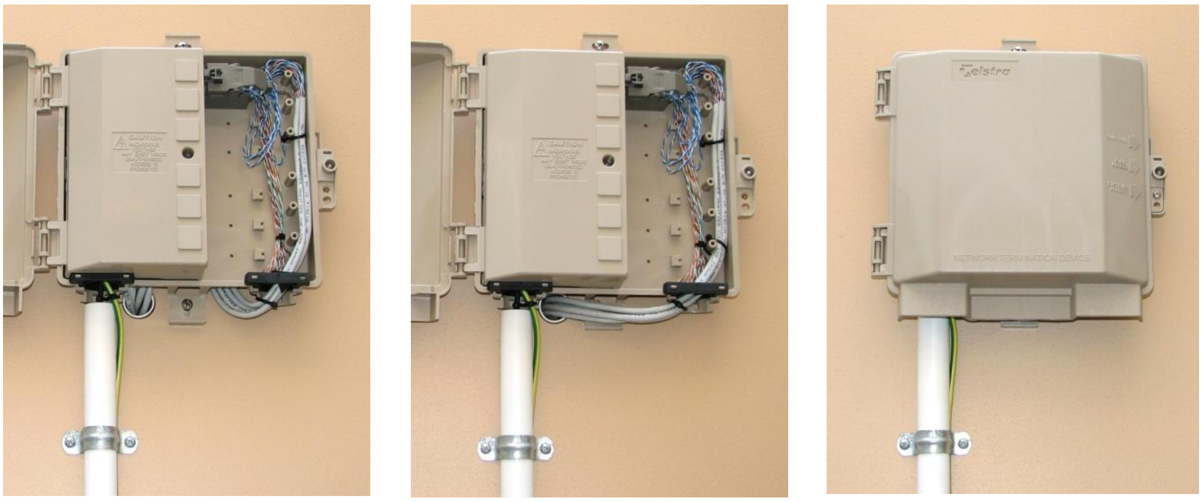


Notes:

1. **The end of any concealed lead-in conduit must not be covered by the base of the NTD** to ensure that any water or vapour coming out of the conduit can escape externally and to enable any termite activity to be visible to a pest inspector.
2. **Surface lead-in conduit must terminate 10 mm to 20 mm short of the cable entry hole.** In the case of the ADSL NTD, this will be achieved if the lead-in conduit butts up to the external cable tie facility.

Figure 70 Running cable behind or below the Telstra NTD to the cable entry port (conduits spaced less than 80 mm apart)

Cables running behind the NTD | **Cables running below the NTD** | **Cables hidden by the cover**



Note: If the lead-in and customer conduits are adjacent to each other, either the lead-in cable or the tie cables may be run behind or below the NTD to the appropriate cable entry port, as in the examples shown above. Either way, the skirt on the NTD cover will hide the cables from general view and protect them from exposure to sunlight. Cables running down the wall to the top of the NTD may run behind the NTD to the bottom of the NTD and then loop up into the cable entry to form a drip point.

7.5.6.3 HFC isolation box

Where HFC is available and is to be installed at the premises, a separate HFC isolation box is required for connection of the coaxial cabling. The standard Telstra isolation box is coloured grey and has three closely spaced cable entry ports, each of which may be used for either the outdoor or indoor coaxial cable entry. An earthing conductor is not required for this box.

A larger isolation box may be used in some circumstances (e.g. to house an RF amplifier), in which case the underground or aerial coaxial lead-in cable normally enters the left-hand cable entry port and each indoor coaxial cable usually enters one of the right-hand cable entry ports.

The isolation box will usually be provided in addition to another PCD, so typical positioning in relation to a separate PCD and the conduits is shown in Figure 71.

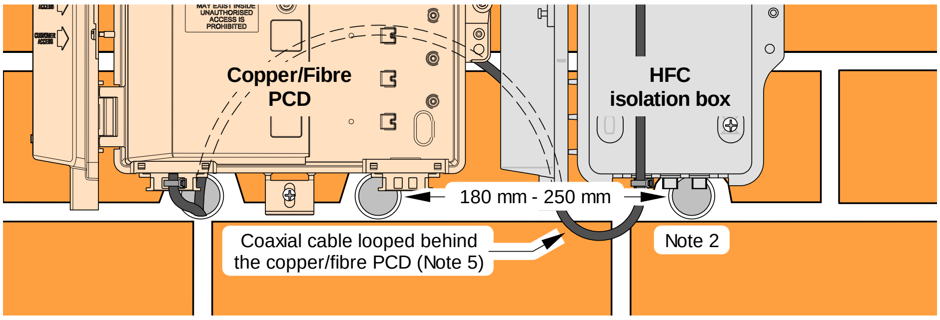
The isolation box is supplied and installed by Telstra (for cable internet) or FOXTEL (for pay TV), as applicable, as part of the HFC service. A registered cabler is not authorised to install the isolation box but may install the indoor coaxial cable (tie cable) to Telstra or FOXTEL specifications. Separate conduits are required for the coaxial cables running between the isolation box and the CCP (for cable internet) and between the isolation box and the wall plate at the entertainment point (for FOXTEL).

1. Telstra coaxial cabling specifications are provided in 10.8 (page 193).
2. It is not necessary to extend the conduit beyond accessible roof space for the FOXTEL cable(s) going to the entertainment point(s) because this would preclude branching of multiple cables to multiple points and, in any case, this cabling should never need upgrading. However, if a cable is damaged during or after building construction, the FOXTEL repairer is not obliged to conceal the replacement cable.

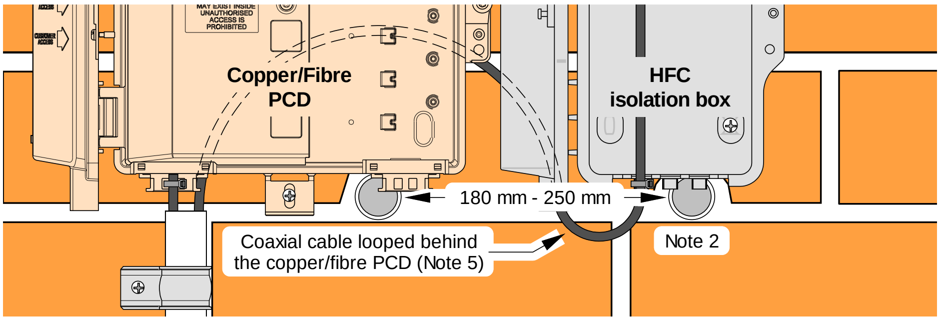
The box should be spaced at least 50 mm away from any other PCD and the conduits spaced 180 mm to 250 mm apart in accordance with Figure 71.

Figure 71 Optimal Telstra HFC isolation box spacing from the building entry conduits

(a) Concealed lead-in conduit



(b) Surface lead-in conduit



Notes:

1. The HFC isolation box should be spaced about 50 mm to the left or right of the other PCD, which means the conduits for the twisted pair and coaxial tie cables should be spaced between 180 mm and 250 mm apart, as shown above.
2. Separate tie cabling conduits will be required for the broadband internet cable and any pay TV (FOXTEL) cable because they will have different destinations (i.e. the internet cable goes to the CCP and the pay TV cable goes directly to the entertainment point).
3. **The end of any concealed lead-in conduit must not be covered by the base of the PCD** to ensure that any water or vapour coming out of the conduit can escape externally and to enable any termite activity to be visible to a pest inspector.
4. **Surface lead-in conduit must terminate 10 mm to 20 mm short of the cable entry hole.**
5. All Telstra PCDs have mounting feet that allow cables to pass behind the PCD.

7.5.6.4 Outdoor FTTP NTD

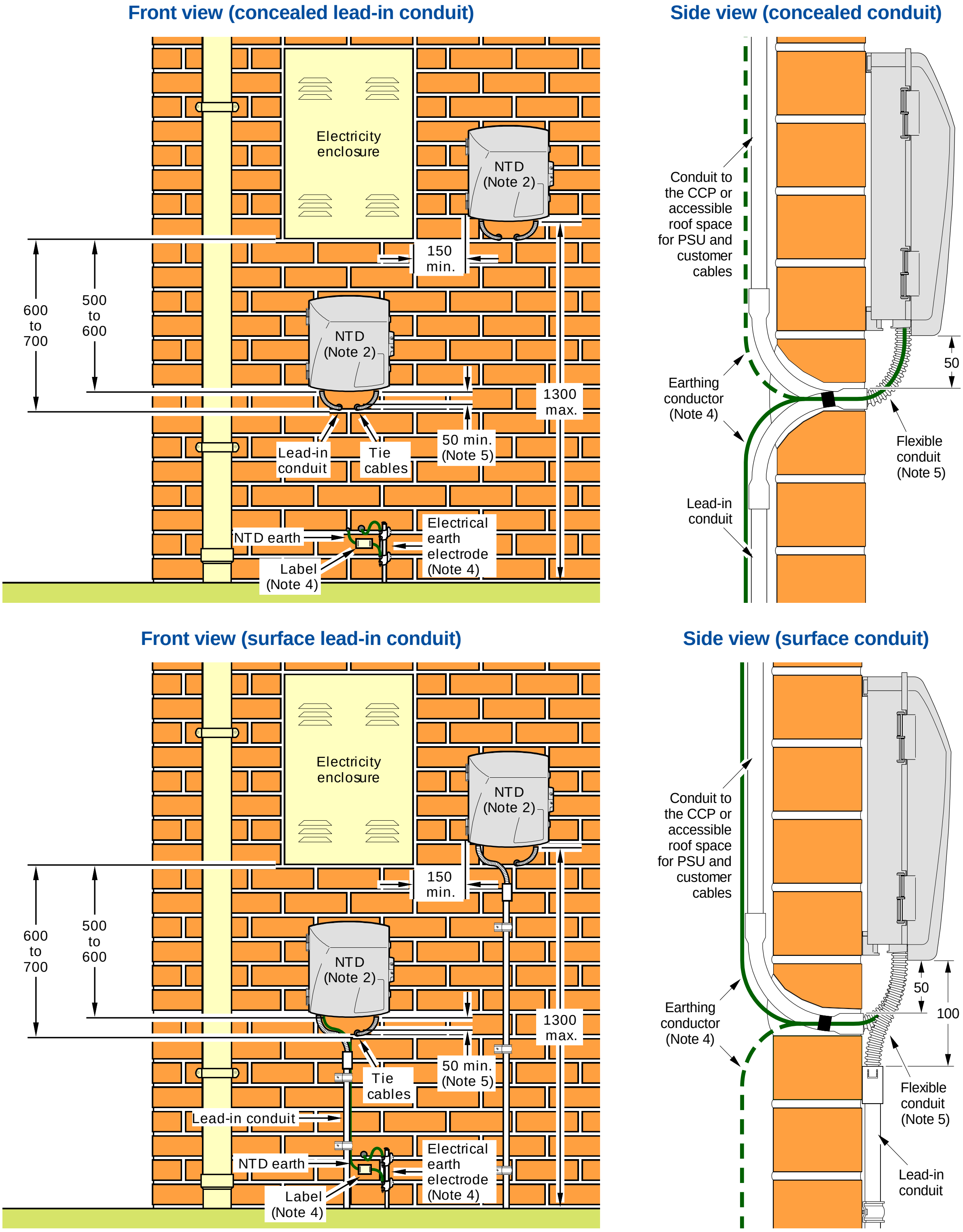
The outdoor Telstra FTTP NTD is coloured grey and has a “Telco” (Telstra) side and a “customer” (cabler) side. The cable entry ports are spaced at 180 mm centres. The lead-in cable must enter the left-hand cable entry port and customer cables must enter the right-hand cable entry port. These cable entry arrangements cannot be reversed. The earthing conductor should enter the left-hand cable entry port but may enter the right-hand cable entry port if necessary. There is a separate cable entry port for the PSU cable.

If RF TV (free-to-air TV or pay TV) is to be supplied from the NTD, two 23 mm ID conduits to Telstra or NBN Co. specification will be required between the NTD and the CCP (see Table 1 on page 29).

The NTD must be positioned 50 mm to 100 mm above the conduits to accommodate the minimum bend radius for the optical fibre lead-in cable, in which case flexible conduit must be used (by the NTD installer) between the rigid conduits and the cable entry ports. The NTD positioning within the height limits described in 6.3.1 on page 73 is shown in Figure 72. Optimal positioning of the NTD over conduits spaced at 80 mm is shown in Figure 73.

The NTD is supplied and installed by Telstra as part of the FTTP service and is normally installed at the time of service activation.

Figure 72 Outdoor Telstra FTTP NTD installation where a CUE is not used

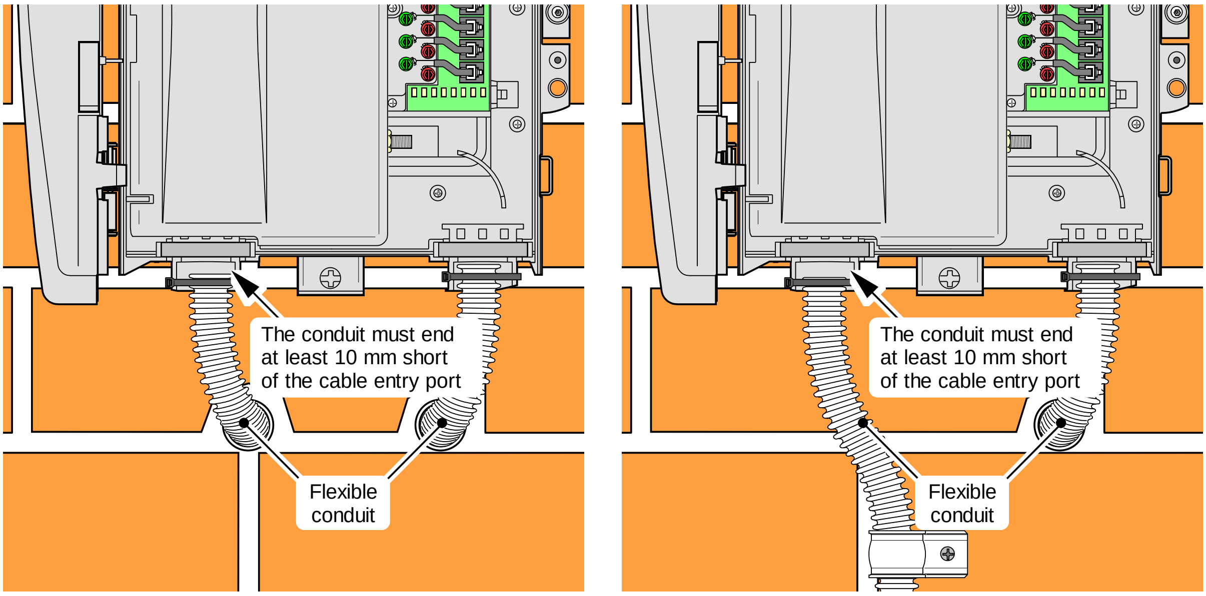


Notes:

1. All measurements are in mm.
2. For general PCD location requirements, refer to 6.3 on page 73.
3. For conduit positioning in the building footings, refer to 7.2.2 on page 78.
4. For NTD earthing requirements, refer to section 11 (page 248).
5. Spacing of 50 mm to 100 mm is required between the end of the lead-in conduit and the NTD to meet optical fibre lead-in cable bend requirements. Telstra will use flexible conduit to make the final conduit connection to the NTD.

Figure 73 Optimal outdoor Telstra FTTP NTD positioning over conduits spaced at 80 mm

(a) Concealed lead-in conduit **(b) Surface lead-in conduit**



Notes:

1. Flexible conduits are used by the NTD installer to join the rigid conduits to the NTD to protect the cables. The flexible conduit for the underground lead-in cable must terminate at least 10 mm short of the cable entry grommet to ensure that any water or vapour coming out of the conduit can escape externally and to enable any termite activity to be visible to a pest inspector.
2. The flexible conduit for the tie cables may butt up to the cable entry grommet.
3. If the conduits are spaced less than 80 mm apart, the NTD will be positioned over the conduits so as to ensure that the minimum optical fibre cable bend radius is maintained.

7.5.6.5 FTTP PCD

7.5.6.5.1 General

Where an indoor FTTP NTD is to be provided, an outdoor PCD (optical fibre splice box) will be installed on the external wall to connect the underground or aerial optical fibre lead-in cable to the indoor optical fibre lead-in cable.

7.5.6.5.2 Telstra PCD

The Telstra FTTP PCD (for an indoor NTD) is coloured grey and uses similar casing to the ADSL NTD described in 7.5.6.2 on page 94 but it only has a single access cover. The requirements for positioning the PCD above the conduits are essentially the same as described in 7.5.6.2. However:

- The PCD may need to be positioned a bit higher above any concealed lead-in conduit to accommodate the minimum bend radius for the optical fibre lead-in cable.
- Either cable entry port may be used for either the underground/aerial optical fibre lead-in cable or the indoor optical fibre lead-in cable — or both cables may enter the same (either) cable entry port.

An earthing conductor is not required for this PCD.

Optimal positioning of the PCD over conduits spaced at 80 mm is shown in Figure 69 on page 94. Typical positioning of the NTD over conduits located side-by-side is shown in Figure 70 (page 95).

The PCD is supplied and installed by Telstra as part of the FTTP service and is normally installed at the time of service activation.

7.5.6.5.3 NBN Co PCD

The NBN Co PCD pictured in Figure 51 on page 70 (for an indoor NTD) is coloured light grey and has a single cover. It does not have a cover skirt to hide the cables entering the bottom of the PCD, so it is assumed that underground lead-in cable entering the PCD will be unprotected to ensure compliance with 7.5.6.1 (page 94). It is also assumed that the tie cable entering the PCD will be unprotected because the PCD has no facility for securing flexible conduit to the PCD (unless it enters the left-hand cable entry port, in which case the underground/aerial lead-in cable must enter one of the other cable entry ports).

Cables cannot pass behind the NBN Co PCD, so cables running down the surface of the wall from above the PCD will either enter the cable entry port at the top of the PCD or run beside the PCD and loop up into a bottom cable entry port.

At the time of writing, NBN Co's practices for installation and connection of the PCD were unclear. The installation of a CUE as described in 6.2 on page 71 would resolve the uncertainty and is strongly recommended for new homes.

7.5.7 PCD fastenings

Impact fasteners should **not** be used to affix the PCD to the wall because these may be too difficult to remove later. The PCD needs to be easily removable to allow future removal and replacement of the PCD for repair or upgrade.

Note: This is for general information only — the Telstra ADSL NTD is the only PCD that may be installed by anyone other than the carrier.

7.6 Drainage pit

7.6.1 Description

A drainage pit is usually only installed in commercial premises or multi-storey apartment buildings where external PCDs are not used. It is mainly used when the lands falls to the building from the property entry point but can also be used to provide a cable/conduit access point immediately before the conduit enters the building. For single dwellings, a drainage pit may be required if the PCD cannot be installed on the external wall and the lead-in conduit cannot terminate at the external wall (e.g. due to extensive glazing). In such cases, the main purpose of the pit is to provide an external access point for sealing the conduit against the entry of water or termites immediately before the conduit enters the building.

Note: While it is possible to seal the conduit at the pit in the street, if the lead-in conduit is damaged in the ground between the pit and the building, there will be a risk of water and termite entry at the point of damage. The risk is minimised if the pit is located adjacent to the building.

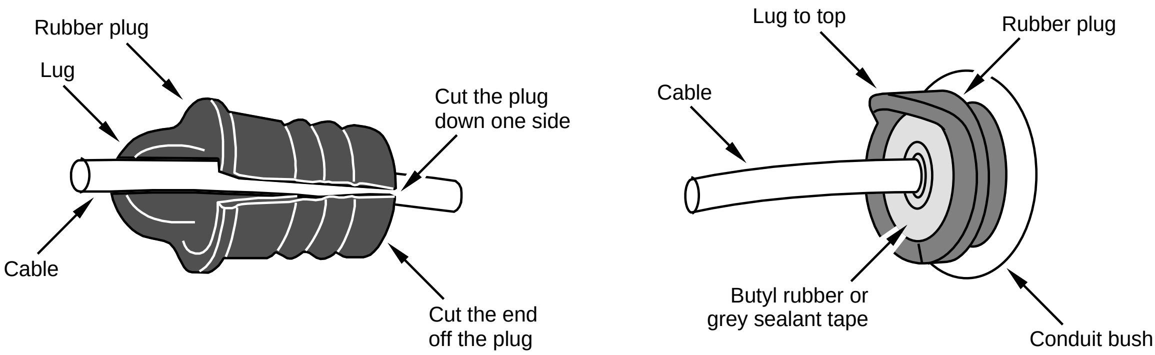
7.6.2 Plugging/Sealing of conduits

For 23 mm ID conduit that runs to a building or that runs downhill into a customer's property, a rubber plug (see Figure 74) is normally used by the carrier to plug the conduit in the pit to minimise water and insect entry to the premises via the conduit.

Figure 74 Typical rubber plug for 23 mm ID conduit

When the lead-in cable is installed in the conduit, the plug must be modified (by the carrier) as shown in Figure 75. If the underground conduit terminates inside a building as shown in Figure 76, the cavity of the plug must be filled with butyl rubber putty or grey sealant tape so as to make the seal watertight and to prevent the entry of insects (especially termites) to the building via the conduit.

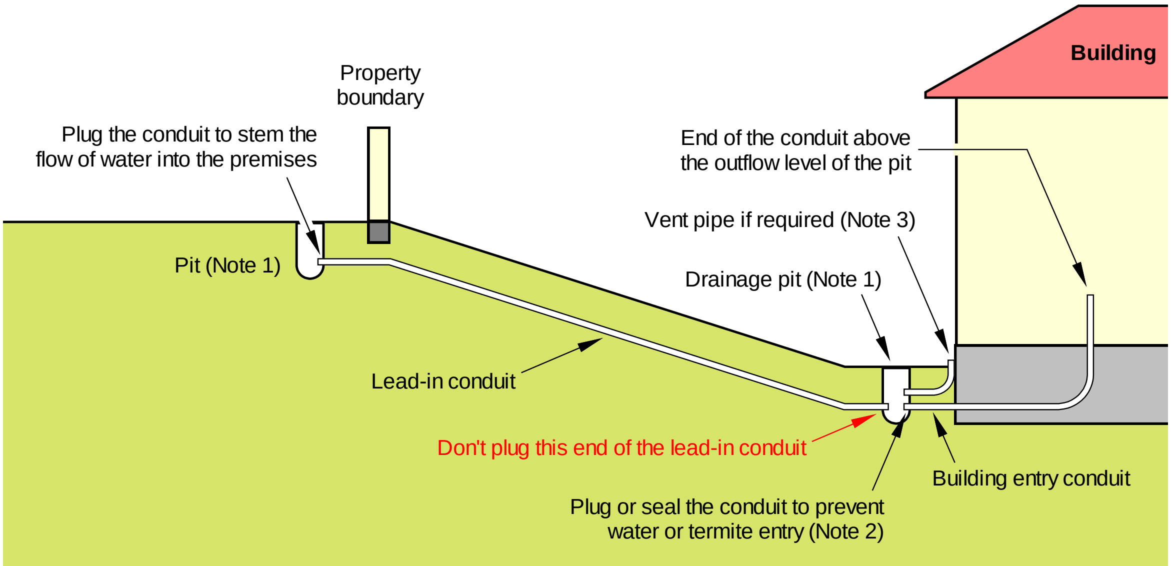
Figure 75 Modification of the rubber plug in the pit for installed cable



Notes:

1. When cable is installed in the conduit, the rubber plug is modified and wrapped around the cable as shown above left and pushed into the end of the conduit as shown above right. If the underground conduit terminates inside a building as shown in Figure 76, the cavity of the plug must be filled with butyl rubber putty or grey sealant tape so as to make the seal watertight and to prevent the entry of insects (especially termites) to the building via the conduit.
2. **This is provided for information only.** Any plugs in the pits must be fitted by the relevant carrier.

Figure 76 Use of a drainage pit



Notes:

1. Conduits must enter the end of the pit (see Figure 25 on page 44).
2. The "network" end of the lead-in and building entry conduits must be plugged or sealed in each pit using a rubber plug (see Figure 74) which must be modified (by the carrier) in accordance with Figure 75 when the lead-in cable is installed.
3. The drainage pit must be drained (or vented using a vent pipe as shown), and would normally sit below the level of the floor of the building. Any drainage or vent pipe must be at least the same size as the lead-in conduit.
4. A drainage pit is not normally required where the lead-in conduit terminates at the external wall of the building (e.g. to connect a PCD). In such cases, any water that trickles down the lead-in conduit should escape harmlessly outside the building and the end of the conduit is also visible for inspection for termite activity.

8 TIE CABLING

8.1 Description

Tie cabling is the cabling between the PCD and the CCP. It may consist of customer cabling, multi-core DC power cabling, extension of the carrier's lead-in cabling, or a combination of these (refer to Table 1 on page 29).

8.2 Cabling pathways and spaces

8.2.1 General

A cabling **pathway** is a conduit, duct, trunking or clear corridor within a building cavity that may be used for pulling in cable.

A cabling **space** is a cupboard, closet, enclosure or suitable space in which to install equipment or to provide safe and convenient access to cabling pathways for pulling in cables.

For health and safety reasons, employees and contractors of some companies (including Telstra) may not be permitted to enter some roof spaces or underfloor spaces to install cabling. Therefore, it is strongly recommended that suitable concealed cable pathways and, where necessary, cable access spaces be provided for easy installation of the tie cabling **after** building completion to avoid the need for surface cabling that the occupant may regard as unsightly.

8.2.2 Conduit through building cavities for tie cabling

8.2.2.1 General

At least one contiguous conduit should be provided through building cavities for the tie cabling in accordance with Figure 80 or Figure 81, as applicable. A second conduit or pathway is required where an HFC PCD ("cabled" areas) or an outdoor FTTP NTD that supplies RF TV may be installed (refer to 7.5.6.3 and 7.5.6.4 on pages 95 and 96).

The purpose of the conduit is explained in 7.3 (page 81).

8.2.2.2 Conduit requirements

Conduit installed for pulling in the tie cabling is to comply with the following:

- **White, rigid (UPVC) plastic conduit** with a minimum **inside diameter (ID)** of **23 mm** must be used (e.g. Telstra or NBN "20 mm" conduit or 32 mm UPVC "Communications" conduit to AS/NZS 2053).

  Note: 32 mm (outside diameter) conduit won't fit in some external wall cavities (e.g. within double-brick walls or between bracing ply and brick veneer). Check with the builder or bricklayer before using 32 mm conduit.
- There must be **no more than 3 x 90° conduit bends** between cable pulling points.
- Each conduit bend must have an **inner bend radius of 100 mm or greater** (see Figure 77).

  Note: Do not confuse these bends with bends used in underground conduits, which must have an inner bend radius of 300 mm or greater. Cables used inside buildings (indoor type cables) are generally more pliable than cables used externally (outdoor type cables) and may be more readily pulled through 100 mm radius bends. Protective boots fitted over optical fibre connectors on pre-terminated indoor cables are also smaller than those used on pre-terminated underground optical fibre cables.
- The total length of the conduit and bends between the PCD and the CCP **should not exceed 25 m** unless it is certain that FTTP with an **indoor** NTD will be installed, in which case a **40 m** limit applies.

  Note: The 25 m limit is to ensure that any coaxial cabling for HFC ("Cable") internet or DC power supply cabling for an outdoor FTTP NTD will be within specified limits. The 40 m limit is an arbitrary limit that may be discussed with the relevant carrier if it is unachievable for a particular home.
- A 3 mm polypropylene, braided cord (or equivalent) must be threaded through the conduit and bends to be used as a **pull-cord** for the tie cable(s).
- All conduit and fittings **must be glued** to prevent them coming apart.
- The conduit **must be restrained along its length** to prevent movement while pulling cable in.
- Orange conduit, flexible conduit or any conduit marked "ELECTRICAL" **must not be used**.

8.2.2.3 Conduit installation

The conduit should be installed through the roof space (or through the floor space of the upper floor of a two-storey home). Arrange the conduit markings to be visible to any person working in the roof space after building completion.

For cavity walls, install a mounting bracket (see 10.9.2 on page 224) where the cable will exit the wall, and terminate the conduit within the wall cavity about 100 mm above the bracket, as shown in Figure 80. Alternatively, the conduit may directly enter the top of a CCP enclosure that is recessed into the wall between studs.

The conduit may be installed in the concrete slab but this carries a high risk of error in positioning the conduit at the internal wall (i.e. at the CCP) and the conduit being waterlogged due to rain during construction which may lead to premature failure of the internal tie cable(s).

Figure 77 100 mm radius conduit bend and pre-terminated indoor optical fibre cable

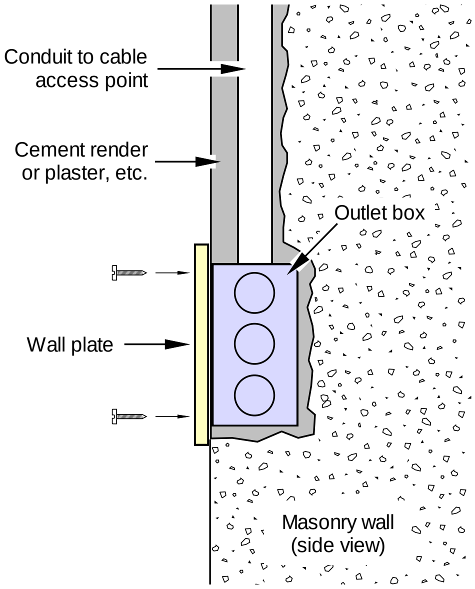
Note: The factory-fitted connector and protective boot of internal optical fibre cable may be up to 16 mm in diameter. A large-radius conduit bend is required for pulling such a cable through it.

8.2.2.4 Solid masonry or double-brick walls

With solid masonry or double-brick walls:

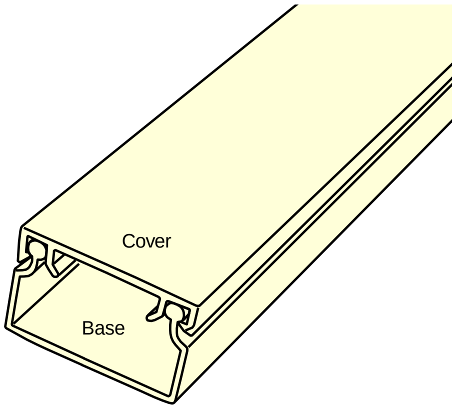
- unless surface-mounted conduit or trunking is acceptable to the customer, the conduit for the tie cabling will need to be chased into the wall and terminated into a **vertically orientated outlet box** (called a “wall box” in the electrical trade — refer to Figure 78 below and 10.9.3.1 on page 230); or
- accessible trunking (rectangular section duct with a removable cover along its entire length — see Figure 79) may be used on **internal** walls and interconnected by conduit that complies with 8.2.2.1 through the roof space or other inaccessible portion of the pathway, as illustrated in Figure 81.

Figure 78 Vertically orientated outlet box ("wall box")



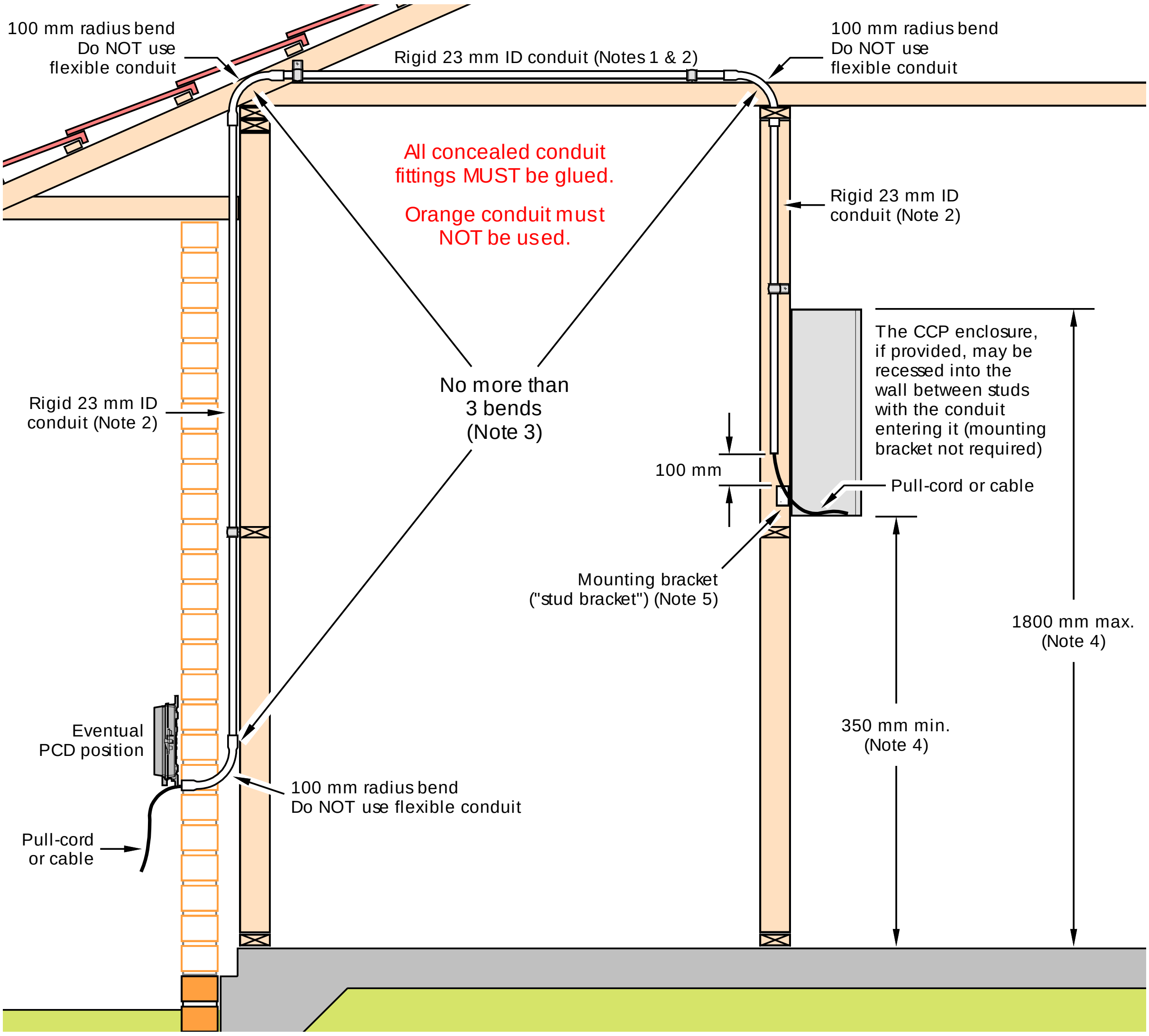
Note: Where conduit is run vertically to an outlet box, the outlet box should be vertically orientated to maximise the bend radius of the cable coming out of the conduit.

Figure 79 Typical cable trunking (also called "ducting")



Note: Trunking is available in various colours including white, grey and brown. 50 mm x 50 mm trunking will usually be required to accommodate the end of a 23 mm ID conduit or bend (see Figure 81).

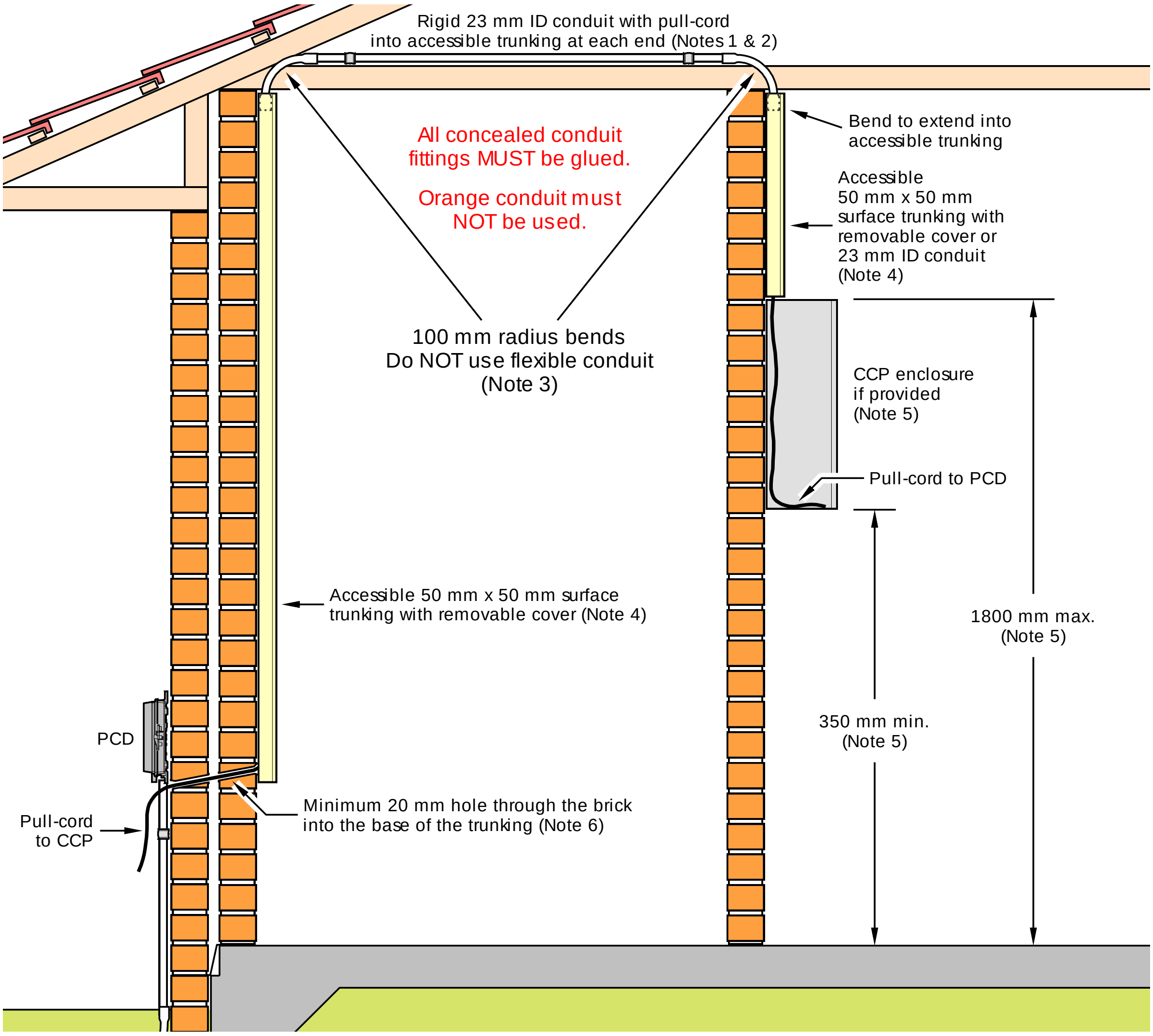
Figure 80 Typical conduit installation for tie cabling in cavity walls



Notes:

1. For a two-storey home, the conduit may pass between or through the bearers of the upper floor (subject to compliance with building codes) or through the roof space of the upper storey as long as the total length of cabling between the PCD and the CCP will not exceed **25 m** unless it is certain that an **indoor** FTTP NTD will be installed, in which case the length should not exceed **40 m** (see 8.2.2.2). The CCP may be located in the lower or upper floor, whichever is convenient. Where solid masonry or double-brick building construction is used, it may be necessary to chase the conduit into the walls unless surface-mounted conduit or trunking is acceptable to the customer (see Figure 81).
2. Use rigid conduit with a minimum inside diameter (ID) of 23 mm (e.g. Telstra or NBN "20 mm" UPVC conduit). Do **not** use orange conduit, flexible conduit or any conduit marked "ELECTRICAL". Extra conduit(s) may be required for any coaxial cables (see 7.5.6.3 and 7.5.6.4 on pages 95 and 96).
3. Use no more than 3 x 90° bends between cable pulling points. The inner bend radius of each bend must be 100 mm or greater. The conduit must be restrained along its length to prevent movement while pulling cable in.
4. Normally the CCP enclosure would be installed between wall studs above the nogging (about 1200 mm above the floor). If the CCP enclosure will be lower or higher, the bottom of the enclosure should be no less than 350 mm from the floor and the top of the enclosure should be no more than 1800 mm above the floor. Whether the powered electronic devices are to be located inside or outside the enclosure, they should be installed within the range of 350 mm to 1800 mm from the floor (i.e. no part of any device should be outside that range).
5. Where a CCP enclosure is not installed between the wall studs, install a mounting bracket 100 mm below the end of the conduit as a place marker for the tie cable.

Figure 81 Typical conduit/trunking installation for tie cabling on solid masonry or double-brick walls



Notes:

1. For a two-storey home, the conduit may pass between or through the bearers of the upper floor (subject to compliance with building codes) or through the roof space of the upper storey as long as the total length of cabling between the PCD and the CCP will not exceed **25 m** unless it is certain that an **indoor** FTTP NTD will be installed, in which case the length should not exceed **40 m** (see 8.2.2.2). The CCP may be located in the lower or upper floor, whichever is convenient.
2. Use rigid conduit with a minimum inside diameter (ID) of 23 mm (e.g. Telstra or NBN "20 mm" UPVC conduit). Do **not** use orange conduit, flexible conduit or any conduit marked "ELECTRICAL". Extra conduit(s) may be required for any coaxial cables (see 7.5.6.3 and 7.5.6.4 on pages 95 and 96).
3. Use no more than 3 x 90° bends between cable pulling points. The inner bend radius of each bend must be 100 mm or greater. The conduit must be restrained along its length to prevent movement while pulling cable in.
4. The trunking must be accessible for removal of the cover and insertion of the cable(s). The conduit and pull-cord must extend into an accessible part of the trunking. Conduit may be chased into the wall or run on the surface of the wall in preference to using surface-mounted trunking, as long as the conduit complies with 8.2.2.2.
5. The bottom of the CCP enclosure should be no less than 350 mm from the floor and the top of the CCP enclosure should be no more than 1800 mm above the floor. Whether the powered electronic devices are to be located inside or outside the enclosure, they should be installed within the range of 350 mm to 1800 mm from the floor (i.e. no part of any device should be outside that range).
6. A hole must be drilled through the external wall from the bottom of the PCD into the trunking at a slight upward angle. The hole must be at least 20 mm diameter to pass an optical fibre cable fitted with a connector. Extra hole(s) may be required for any coaxial cable(s) (see 7.5.6.3 and 7.5.6.4 on pages 95 and 96).

8.2.3 Tie cables for ADSL

Standard tie cabling for ADSL comprises at least two 4-pair data cables between the outdoor NTD and the CCP. One of these cables will be allocated for connection of the ADSL service and the other cable will be allocated for connection of up to four standard telephone services. This assumes that the central filter will be installed in the outdoor NTD. The central filter may alternatively be installed in the CCP but sufficient cables should be installed between the NTD and the CCP to support separate telephone and Ethernet data cabling from an outdoor FTTP NTD. For more information, refer to 10.4.7.2 (page 153).

Notes:

1. The Telstra ADSL NTD may be fitted with up to six line modules with integrated ADSL2+ central filters, which provides for up to six telephone services and six ADSL services. However, this does not mean that the NTD may be used to feed two or more units of an MDU — a separate NTD is required for each unit. Refer to Telstra Specification 012688 for more information. Where integrated DSL line modules are not used, for a list of certified splitters/filters for installation on the customer side of the NTD, go to http://www.telstra.com.au/adsl/equipmnt.htm.
2. While ADSL and telephone services are carried on the same pair within the telecommunications network up to the central filter, running an ADSL service and a filtered telephone service between the NTD and the CCP using separate pairs of the same cable is not recommended.

8.2.4 Tie cables for HFC

The same network and the same coaxial lead-in cable are used to supply Telstra BigPond Cable broadband services and FOXTEL pay TV services. Where both broadband internet and pay TV are required in the premises, a splitter is installed in the external isolation box and separate cables are provided for each type of service. The coaxial cable required for BigPond broadband internet is usually installed by Telstra while the coaxial cable required for pay TV is usually installed by FOXTEL. However, neither Telstra nor FOXTEL will pre-wire homes for HFC (coaxial) cabling, so such pre-wiring must be done by the builder's or customer's cabler, if required.

In general, no more than **three** coaxial cables may be cabled from the isolation box and the length of any cable between the isolation box and the modem/gateway or set top unit should not exceed **25 m**; otherwise an amplifier may need to be installed in the isolation box (extra charges apply).

A single Telstra-compliant coaxial cable is required between the external HFC isolation box and the CCP for connection of the cable broadband gateway. Any coaxial cable provided for a FOXTEL pay TV service must be run directly from the isolation box to the wall plate where the FOXTEL set top unit is to be connected and must **not** run to the CCP. This means a separate conduit must be provided from the isolation box to accessible roof space or other access point for the installation of the FOXTEL cable(s).

For more information, refer to 10.4.7.2 (page 153).

8.2.5 Tie cables for FTTP

8.2.5.1 Outdoor FTTP NTD

Tie cabling for an outdoor FTTP NTD will consist of:

- a special multi-core power cable, which must not exceed a length of **25 m**, between the NTD and the indoor Power Supply Unit (PSU) located at the CCP;
- a 4-pair data cable between the NTD and the CCP for the broadband (Ethernet) service;
- a second 4-pair data cable between the NTD and the CCP for up to four telephone services;
- an RG6 trishield or quadshield coaxial cable between the NTD and the TV cabling distribution point for the free-to-air TV and pay TV services (where available); and
- a 2.5 mm^2 green/yellow earthing conductor between the NTD and a CET or other earthing terminal at the CCP, e.g. where the NTD cannot be directly earthed to a nearby electrical earth electrode or CET (more information about earthing is provided in section 11).

Two conduits may be required for the tie cabling:

- one conduit for the two data cables, the PSU cable and, if required, the earthing conductor; and
- one conduit for a single coaxial cable, if required (i.e. where the NTD supplies FTA TV or pay TV).

For more information, refer to 10.4.7.2 (page 153).

8.2.5.2 Indoor FTTP NTD

Tie cabling for an indoor FTTP NTD will consist of a single optical fibre cable unless more than two telephone services are required, in which case two optical fibre cables may need to be installed for two NTDs (each NTD supplies up to two telephone services).

Only a single conduit is required to install one or two optical fibre cables between the PCD and the NTD at the CCP location. **No other cables are to be installed in this conduit.** A second conduit will be required if more than two optical fibre cables are to be installed. The total length of the conduit, including bends and curves, between the PCD and the NTD should not exceed **40 m**. Refer to 8.2.2.2 (page 101).

For more information, refer to 10.4.7.2 (page 153).

8.2.6 Tie cables for satellite broadband

8.2.6.1 General

Tie cabling for satellite broadband will consist of two coaxial cables between the satellite dish and two coaxial connectors on a wall plate at the CCP. The satellite dish will normally be mounted on a north-facing side of the building unless it will be larger than 120 cm, in which case it is likely to be mounted on a freestanding pole away from the building.

This cabling is normally installed by the service provider and the exact location of the satellite dish will be unknown until the service provider does an on-site assessment at the time of the broadband service installation. For pre-wiring purposes, sufficient coaxial cable should be provided to reach the furthest extremity of the northern side of the building plus an additional 4 m, and left coiled up in the roof space.

As explained in 4.12.5 (page 26), a different satellite dish is required for access to satellite TV, as this is provided via a different satellite. For more information about pre-wiring for satellite TV, refer to the relevant TV service provider’s web site.

Refer to 9.7 on page 117 for a description of the satellite gateway.

8.2.6.2 Additional Ethernet cabling

If the satellite gateway will be located distant from the CCP, two data cables should be provided between the gateway location and the CCP to provide for:

- connection of an Ethernet port from the gateway to the CCP; and
- connection of a telephone service (where provided) from the gateway to the CCP or back-feed from an Ethernet router or switch at the CCP to connect an Ethernet device adjacent to the gateway. This arrangement is the same as that illustrated in Figure 82 for 3G/4G wireless services.

8.2.7 Tie cables for Telstra 3G/4G wireless services

8.2.7.1 General

Telstra 3G/4G wireless networks may be used to supply broadband internet, telephone and fax services. The gateway used to provide all three services is different to the type that is used to supply a broadband internet service only. These are described separately below.

8.2.7.2 Telstra wireless broadband gateway

Telstra 3G/4G broadband modems or gateways may be in the form of:

- a USB device that plugs directly or via a short USB extension cord into the USB port of a personal computer (no permanent cabling is required for such a device)
- a standalone device capable of connecting to one or more personal computers or web-enabled (IP) devices via Wi-Fi (no cabling is required for such a device); or
- a shelf-mounted or wall-mounted device that has one or more Ethernet ports (and usually Wi-Fi capability) for wired (or Wi-Fi) connection to personal computers or other IP devices (read on).

For optimal data speed, the 3G/4G gateway should be located where the 3G/4G radio signal is the strongest. This location may be some distance from the CCP. There will be no detriment to internet performance (data speed) if the Ethernet port of the gateway is connected to the CCP by a length of data cable — the performance capability of the data cable will far exceed the performance capability of the 3G/4G communications.

Where 3G/4G technology will only be used to provide wireless broadband, at the pre-wiring stage (roof on, sarking or cladding installed on the external walls, and internal walls and ceiling ready for lining), an attempt may be made to determine where the 3G/4G signal is at its strongest within the home using a Telstra mobile phone or Telstra modem/gateway. Generally this will be at the perimeter of the home (i.e. near an external wall). Once the optimal location of the gateway has been determined by the above method, at least two data cables should be provided between the broadband gateway location and the CCP to provide for:

- connection of an Ethernet port from the gateway to the CCP; and
- connection of a VOIP port (where provided) from the gateway to the CCP or back-feed from an Ethernet router or switch at the CCP to connect an Ethernet device adjacent to the gateway (see Figure 82).

These cables are in addition to any cables provided for a TO in the room in accordance with 10.5 (see page 178).

Refer to 9.8.2 (page 118) for a more detailed description of a typical 3G/4G broadband gateway.

8.2.7.3 Tie cables for Next G™ Wireless Loop (NGWL)

8.2.7.3.1 Description

The Telstra Next G™ gateway used to supply NGWL services has three service ports:

- an 8P8C ("RJ45") Ethernet socket for the broadband data (internet) service
- a 6P ("RJ11") socket for the telephone service
- a 6P ("RJ11") socket for the fax service.

The telephone service does not support fax transmission, so if a fax is to be used, it must be connected to the fax port of the gateway. For this reason, it is recommended that any cabling between an NGWL gateway and the CCP (where the gateway is not located at the CCP) comprise at least three separate data cables if the location of the NGWL gateway is known. Nonetheless, two data cables will suffice if a "splitter" lead is used at each end for connection of the telephone and fax services using different pairs of the same data cable. For details of splitter leads, refer to 10.4.8.7 on page 176).

Refer to 9.8.3 (page 118) for a more detailed description of the NGWL gateway.

8.2.7.3.2 External NGWL antenna cables

It is not possible to pre-wire for NGWL antenna cabling, as the location of the external antenna will not be known until an on-site survey is performed by the Telstra installation technician. The NGWL gateway will need to be located within a cabling distance of 10 m from the external antenna and this also makes it difficult to pre-wire between the gateway location and the CCP.

If a faint Next G signal can be detected in any part of the home using a Next G mobile phone, it is possible that the external antenna will be installed above this location and a room in this part of the home should be nominated as the likely location of the gateway. The room may then be pre-wired in accordance with 8.2.7.3.1.

If a faint Next G signal **cannot** be detected in any part of the home using a mobile phone, it is not possible to determine the likely location of the antenna and, due to the 10 m antenna cabling limit described above, it may not be possible to locate the gateway at the CCP. However, if each room in the home is cabled in accordance with 8.2.7.3.1, the cabling in any of the rooms may be utilised to cable the Ethernet port (and the telephone and fax ports, if applicable) of the gateway back to the CCP.

8.2.7.3.3 Indoor NGWL gateway cables

If a reasonably strong Next G signal can be received on a Next G mobile phone at the home during construction, it is possible that an external antenna will not be necessary. At the pre-wiring stage (roof on, sarking or cladding installed on the external walls, and internal walls and ceiling ready for lining), an attempt may be made to determine where the Next G signal is at its strongest within the home. Generally this will be at the perimeter of the home (i.e. near an external wall).

Once the optimal location of the NGWL gateway has been determined by the above method, at least three data cables and TO sockets should be provided at the NGWL gateway location to provide for use as described in 8.2.7.3.1 (refer to Figure 82). These cables are in addition to any cables provided in the room in accordance with 10.3.4, 10.3.5 or 10.3.6 (pages 125 to 146).

8.2.8 Tie cables for NBN wireless services

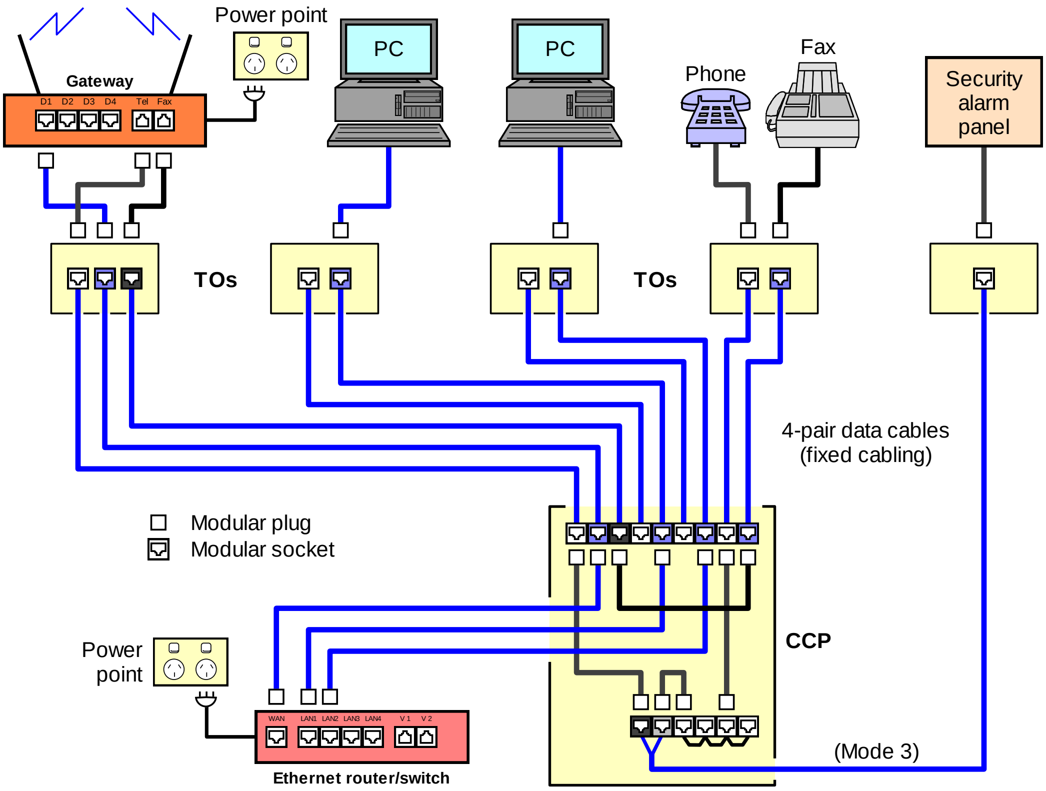
NBN fixed wireless networks are only used to supply broadband internet services, not telephone services. The external antenna is connected to an indoor NTD via a single Category 5 cable, which is supplied and installed by NBN Co.

The NBN wireless network is not used for mobile services, so it will not be possible to determine the direction of the NBN transmitter using a mobile phone. Therefore, it may not be possible to pre-wire for NBN wireless services, as the location of the external antenna may not be known until an on-site survey is performed by the NBN Co technician or until NBN Co notifies consumers of the locations of their wireless transmitters. It will be necessary to contact NBN Co to find out the likely optimal location for the external antenna.

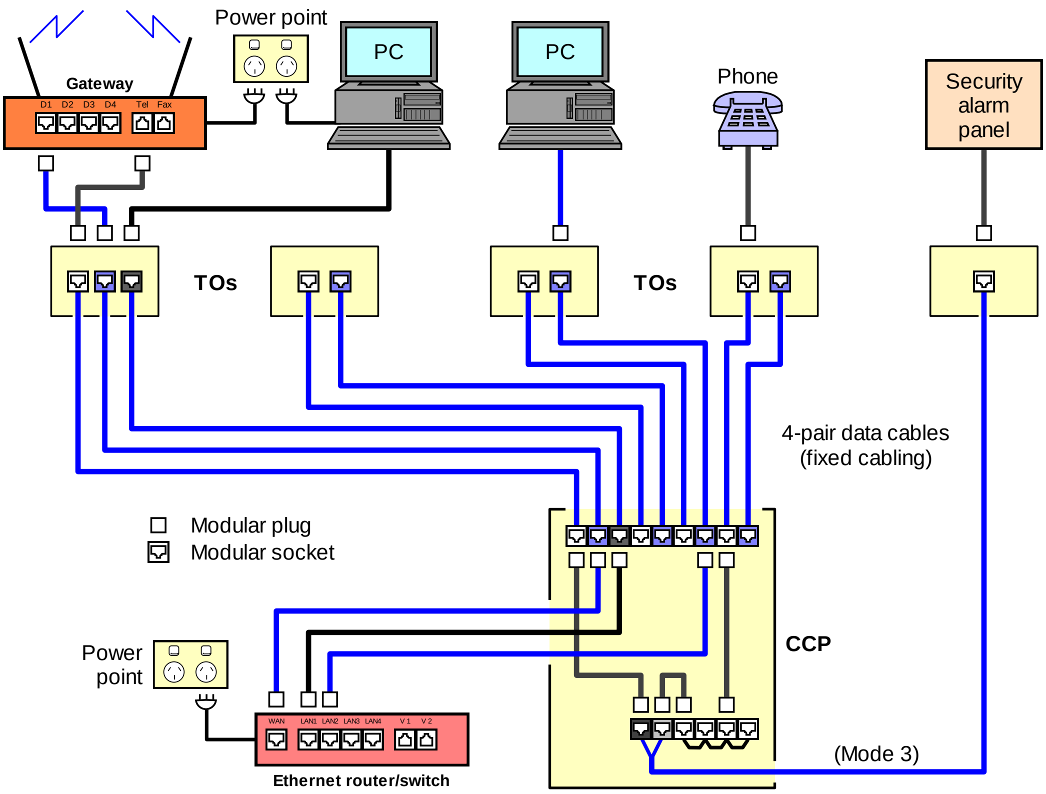
The NBN NTD may need to be located within a certain cabling distance of the external antenna and this also makes it difficult to pre-wire between the NTD location and the CCP. Refer to the NBN Co website www.nbnco.com.au for more information.

Figure 82 Connection of a 3G/4G gateway distant from the CCP

(a) Connection of Ethernet and, optionally, telephone and fax from the gateway to the CCP



(b) Connection of Ethernet and, optionally, telephone to the CCP and back-feed of Ethernet from a router/switch to another device



9 POWERED EQUIPMENT

9.1 General

Powered equipment at the CCP may include one or more of the following:

- modem/gateway
- wireless router (where this facility is not provided by the modem/gateway)
- Ethernet switch (where the number of Ethernet devices exceeds the capacity of the gateway/router)
- FTTP PSU (FTTP services only)
- Network-Attached Storage (NAS) device
- RF splitter/amplifier (for multiple TV access points)
- IR (infra-red) remote repeater (for a TV cabling distribution system).

It is possible that all of the above equipment may be required at the CCP, in which case **up to seven power sockets may be required**. Therefore, it is recommended that at least one (preferably two) double-socket power points be provided at the CCP and sufficient space be provided for an additional power board that will provide the capability to connect a total of seven power plugs (e.g. two double-socket power outlets and a four-socket power board or one double-socket power outlet and a six-socket power board) and that these are able to support at least one oversized plug pack.

Note: At the time of writing, NBN Co required the power supply for its NTD to be plugged directly into a power point and not via a power board or double adaptor.

9.2 Indoor equipment enclosure

An indoor enclosure should be provided at the CCP to house at least the multi-socket wall plate or patch panel and associated connecting cords to protect them from the ingress of dust and accidental damage.

Sufficient space should be provided at the CCP to accommodate the relevant equipment described in 9.1, either within or outside the CCP enclosure.

Any enclosure intended to house powered equipment should:

- be adequately ventilated to prevent overheating of the equipment; and
- if intended to house a wireless device, be of non-metallic construction.

For more information about the indoor enclosure, refer to 10.4.4 on page 149.

9.3 Equipment location

The equipment should not be located in a damp or dusty area or in any position exposed to direct sunlight. The equipment may be located within a robe or cupboard as long as adequate clearances are maintained around and in front of it for access and ventilation.

See also 10.4.2 for CCP location requirements.

9.4 ADSL equipment

Modern ADSL modems usually incorporate a 3-port or 4-port Ethernet router with 802.11 b/g/n Wi-Fi capability, in which case they are often referred to as a “gateway”. Some ADSL gateways also incorporate integrated VOIP and will have a “voice” or “telephone” port in addition to the LAN (Ethernet) and WAN (ADSL) ports.

While a modem or gateway is usually offered by the service provider, customers may opt to purchase their own modem/gateway to suit their needs. There is a multitude of these to choose from, offering varying levels of functionality. ADSL2+ modems and gateways are backwards compatible with ADSL2 and ADSL (“ADSL1”) but an ADSL1 or ADSL2 modem will not support ADSL2+.

Figure 83 Typical ADSL gateway

Notes:

1. This gateway is a modem with an integrated 4-port router and wireless capability.
2. A separate power supply (“plug pack”) is required to power this gateway and is not shown.

9.5 HFC (“cable”) internet and pay TV equipment

9.5.1 Cable internet

Modern “cable” modems may incorporate a 4-port Ethernet router with integrated 802.11 b/g/n Wi-Fi capability, in which case they are often referred to as a “gateway”.

The modem or gateway is usually supplied by the service provider as part of the service connection. In the case of Telstra BigPond Cable, the modem/gateway must be registered in Telstra’s database or it may not work. Therefore, the ability of customers to purchase their own cable modem/gateway from other sources is limited. In any case, unlike ADSL, the availability of cable modems and gateways is limited. If a customer wants more sophistication than is on offer from the service provider, it is advisable to opt for the supply of a basic cable modem from the service provider and separately purchase a router/gateway that provides the required functionality.

Figure 84 Typical cable gateway

Notes:

1. This gateway is a modem with an integrated 4-port router and wireless capability.
2. A separate power supply (“plug pack”) is required to power this gateway and is not shown.

9.5.2 Cable pay TV

Cable pay TV signals are transmitted on the same cable used to supply the cable internet service. Pay TV signals are encrypted and the programs are only accessible via a set top unit (STU) supplied by the service provider (e.g. FOXTEL) upon subscription to the service. The return path for the FOXTEL service (e.g. for interactive TV) is provided via an Ethernet connection to the customer's broadband service or, alternatively, via a standard telephone line. For this reason, it is always recommended that any wall plate with coaxial connectors installed for pay TV access should also contain a modular socket for connection of Ethernet or the telephone service to the FOXTEL STU.

Because pay TV and broadband internet are provided over the same cable, which is connected to a "common bus" system shared by the neighbourhood, any disturbance to the RF signals may feed back into the cable network and adversely affect the entire neighbourhood. For this reason, **the pay TV cable must not be combined with any other signals such antenna-fed TV or closed circuit TV**.

For more information about pay TV, refer to the relevant service provider's website.

Figure 85 Typical pay TV set top unit

9.6 FTTP equipment

9.6.1 Outdoor NTD

The outdoor FTTP NTD that Telstra currently uses in some FTTP networks is shown in Figure 86. This NTD can be, and has been, installed indoors if necessary (e.g. in residential apartments). However, Telstra currently uses a different FTTP NTD designed for indoor installation for MDU apartments (see 9.6.2). Telstra will use indoor FTTP NTDs for all new Telstra FTTP installations from late 2013.

At the time of writing, NBN Co did not use outdoor NTDs for their FTTP installations but indicated that it may use outdoor NTDs for some installations in future where necessary. Contact NBN Co for their current policy.

Whether the FTTP NTD is outdoor or indoor, the Power Supply Unit (PSU) needed for its operation must usually be installed inside the building, especially if it will contain a backup battery. **A Telstra FTTP PSU must not be located outdoors under any circumstances** even in a location protected from the weather (e.g. in an open veranda or external enclosure).

Some FTTP carriers may require the builder or owner to provide an external enclosure to house their NTD and, in some cases, the PSU (in which case an external power point will also be required). Refer to the relevant carrier's website for more information.

The NTD and associated PSU are supplied and installed by the relevant carrier.

Figure 86 Typical outdoor FTTP NTD

(a) Telstra FTTP NTD housed within a CUE

(b) Standalone Telstra FTTP NTD

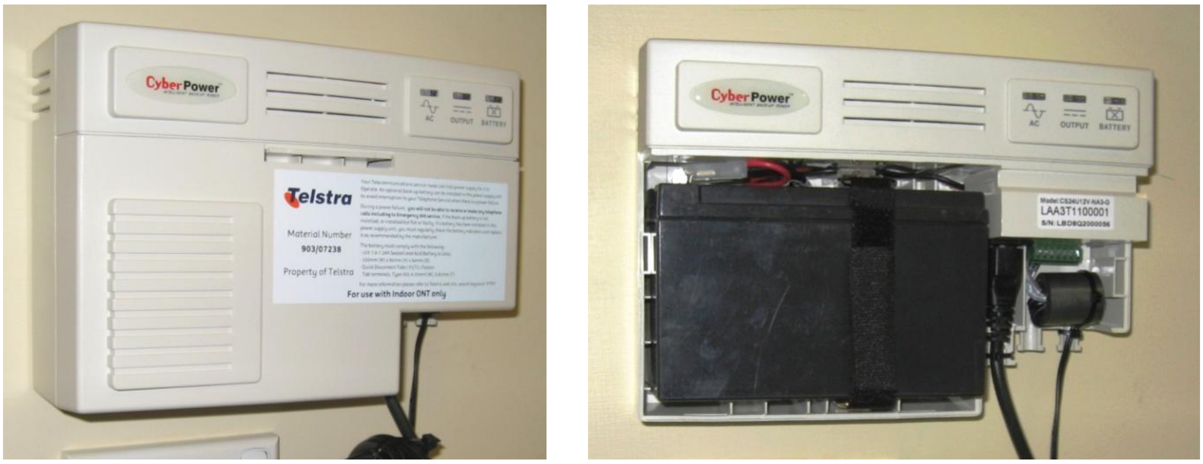
Notes:

1. The builder, electrician, home owner or customer may be required to provide a suitable earth connection for this NTD. Refer to section 11 for more information.
2. Telstra will discontinue use of outdoor FTTP NTDs and use indoor FTTP NTDs for all new installations from late 2013.
3. In some cases, the NTD pictured above may have been installed inside the building (e.g. MDU apartments).
4. Some carriers may require their FTTP NTD to be installed inside an external enclosure provided by the builder or owner. Refer to the relevant carrier's website for more information.

Figure 87 Typical indoor PSU for an outdoor FTTP NTD

(a) PSU with cover fitted

(b) PSU with cover removed to expose the optional backup battery



Notes:

1. This PSU pictured above can provide optional battery backup to maintain operation of a telephone service for a limited time during a power outage (e.g. a blackout).
2. The PSU is designed for indoor installation and it cannot be installed outdoors even if it is housed in an enclosure to protect it from the weather.
3. For information about the backup battery, refer to section 13.

9.6.2 Indoor NTD

The indoor FTTP NTD that Telstra currently uses for MDU apartments is pictured in Figure 88. Telstra will use this NTD for all new Telstra FTTP installations throughout Australia from late 2013.

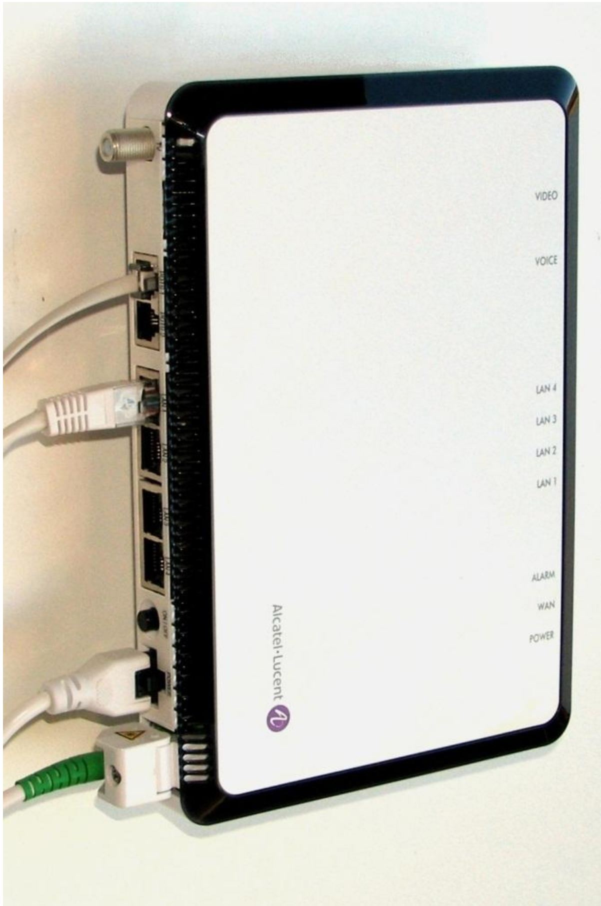
This NTD is usually wall mounted but may be shelf mounted either horizontally or vertically if required. Two types of PSU are available for this NTD and these are illustrated in Figure 89.

At the time of writing, NBN Co used an indoor FTTP NTD of similar shape and size to the Telstra indoor FTTP NTD but used a larger power supply with a backup battery. For current information, refer to the NBN Co website (www.nbnco.com.au).

An indoor NTD is designed for indoor installation and it **must not be installed outdoors** even if it is protected from the weather (such as in an open veranda or housed in an enclosure).

Figure 88 Typical indoor Telstra FTTP NTD

(a) Wall-mounted NTD



(b) Shelf-mounted NTD

Notes:

1. This NTD is used by Telstra for MDU apartments and will be used for all new Telstra FTTP installations from late 2013.
2. The NTD is designed for indoor installation and it cannot be installed outdoors even if it is housed in an enclosure to protect it from the weather.
3. A hard-wired earth is not required for this NTD. An earth is provided from the power outlet earth via the earthing conductor of the PSU power plug and cord.

Figure 89 Typical PSUs for an indoor Telstra FTTP NTD

(a) Standard PSU

(b) PSU with optional battery backup

Notes:

1. The standard PSU and cord are white, while the PSU with the optional battery backup is light grey.
2. Both of the above types of PSU supply a nominal voltage of 12 V DC to the NTD (the actual voltage is 13.6 V). They also extend the earth from the 230 V AC plug to the NTD for protective earthing of the service interfaces.
3. For information about the backup battery, refer to section 13.

9.7 Satellite equipment

The satellite gateway that Telstra currently uses for the supply of broadband services is pictured in

Figure 90. This is connected via two coaxial connecting cords ("fly leads") to two coaxial connectors on a wall plate, which in turn are connected by two coaxial cables to the LNB of the satellite dish. The broadband data service is accessed via an Ethernet port on the rear of the gateway.

NBN Co uses satellite technology in some areas to provide access to high-speed broadband services where FTTP or 3G/4G wireless broadband is not available. Refer to the NBN Co website www.nbnco.com.au for more information.

Figure 90 Typical satellite gateway

Notes:

1. This device has a single 10/100 Mbps Ethernet port.
2. A separate power supply is required to power this gateway and is not shown.

9.8 3G/4G wireless equipment

9.8.1 General

3G/4G wireless broadband is offered by several service providers, from simple USB modems that may be plugged directly into a USB port of a PC, to home network gateways that may be accessed by multiple users. NBN Co will use 3G/4G wireless technology in some areas to provide access to high-speed broadband services where FTTP will not be available.

Telstra uses its Next G™ mobile network to supply both broadband internet services and telephone/fax services where other technologies are not available or suitable. These are described below.

9.8.2 3G/4G broadband internet modem/gateway

A Telstra 3G/4G broadband internet modem or gateway may be used in virtually any location where there is sufficient radio signal to operate a Telstra 3G/4G mobile phone and may be used instead of, or in addition to, any "wireline" telecommunications network technology (ADSL, HFC, FTTP). These modems/gateways are portable, do not necessarily require the installation of any fixed cabling but only provide access to the internet. With these devices, data speed is very much dependent on the strength of the radio signal and the volume of traffic (number of simultaneous users) in the vicinity.

Typical Telstra 3G/4G modems and a Next G™ gateway are shown in Figure 91.

Figure 91 Typical 3G/4G broadband modems and gateway

(a) USB modems for a single PC

3G

4G

(b) Shelf-mounted home network gateway

Notes:

1. The home network gateway shown above has four Ethernet ports plus Wi-Fi capability.
2. A separate power supply is required for the home network gateway and is not shown.

9.8.3 Next G™ Wireless Loop (NGWL) terminal

The Telstra Next G™ network may be used to supply internet, telephone and fax services using a special gateway ("NGWL terminal") where suitable wireline technologies are not available. This method may be used as either a temporary or permanent measure, depending on the circumstances.

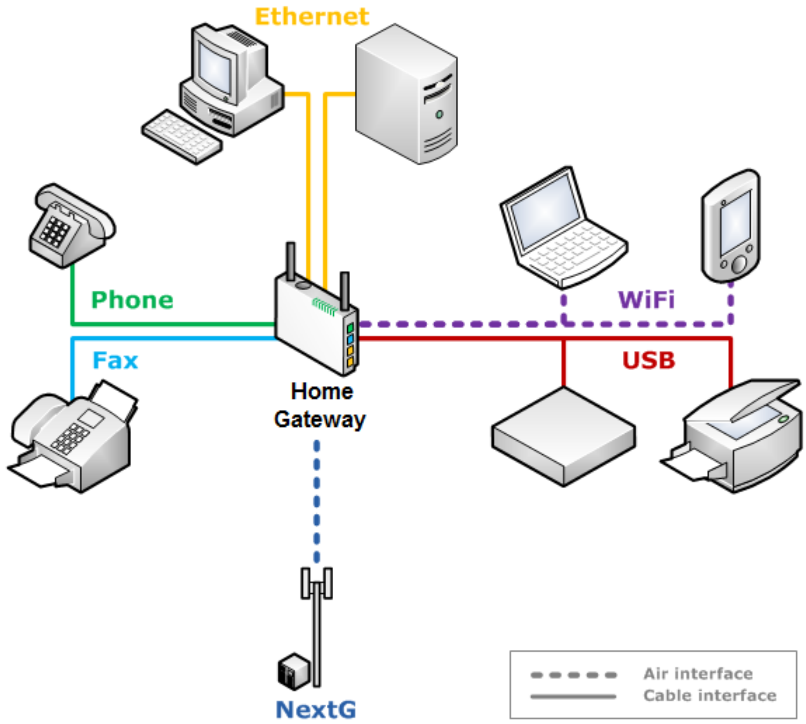
In some cases it will be possible to use the NGWL terminal without the need for an external antenna, in which case the consumer may be able to self-install the terminal by finding a suitable location with good signal strength and connecting it via connecting cords ("fly leads") or patch cords to the generic cabling.

Where an external antenna is required, the antenna and the NGWL terminal must be installed by Telstra.

Refer to Figure 92.

Figure 92 Next G™ Wireless Link (NGWL)

(a) NGWL connections



(b) NGWL terminal (gateway)

Notes:

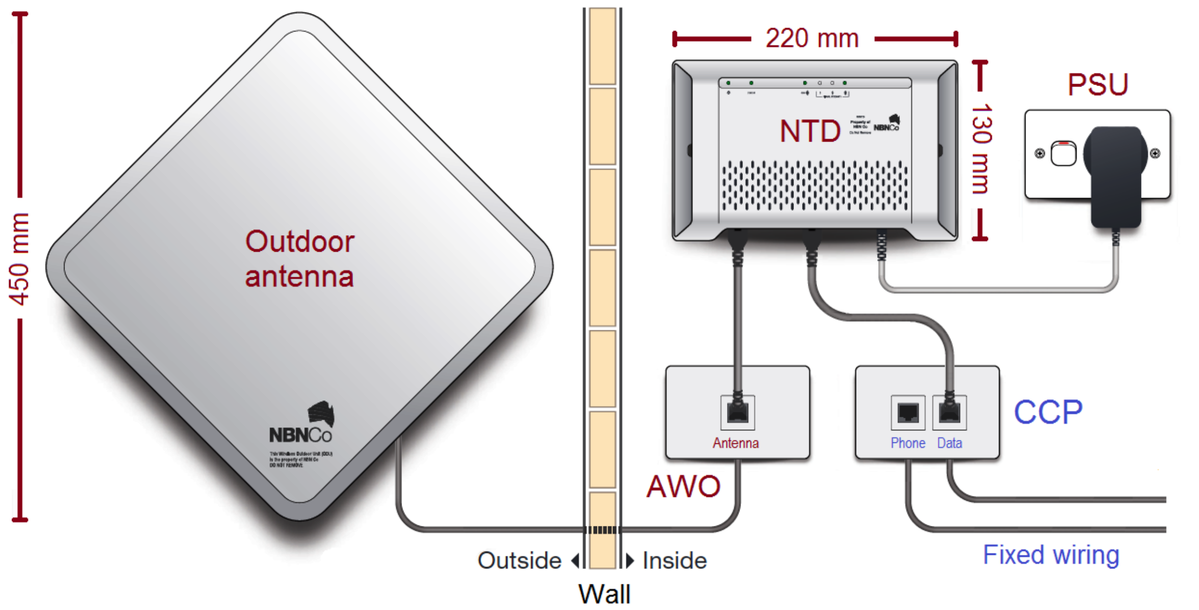
1. The NGWL terminal has two Ethernet ports plus Wi-Fi capability.
2. A separate power supply is required for the NGWL terminal and is not shown.
3. As well as broadband internet, the terminal can supply a telephone and a fax service but these are supplied via separate (RJ11) ports. The telephone port does not support fax transmission.

9.8.4 NBN fixed wireless NTD

NBN fixed wireless uses an enclosed antenna that may be mounted on a mast or on the surface of an external wall. The antenna is connected to the indoor NTD via a Category 5 data cable. The NTD is powered from a separate power supply ("plug pack") that is plugged directly into the power point.

Refer to the NBN Co website www.nbnco.com.au for more information.

Figure 93 NBN fixed wireless equipment



Notes:

1. The broadband service is supplied via an Ethernet port on the indoor NTD which will be connected to a gateway supplied by the service provider. The gateway may be co-located with the NTD or may be located elsewhere and linked to the NTD via the CCP and fixed Category 6 data cabling as shown above. A separate power outlet is required for the gateway.
2. A Category 5 cable is used to connect the outdoor antenna to the indoor NTD.

9.9 Other equipment

9.9.1 Ethernet switch

The number of Ethernet ports available for connection of Ethernet devices may be increased by the addition of an Ethernet switch. The switch may be located at the CCP (recommended) or at any location where a multitude of Ethernet devices need to be aggregated to a single data cable connected to the CCP (such as the home entertainment point if there are insufficient data cables installed to connect the Ethernet devices listed in 10.7.4 on page 192 directly to a switch located at the CCP).

Figure 94 Typical Ethernet switch

Notes:

1. An Ethernet switch is similar in appearance to a router or gateway but does not provide a firewall and merely provides additional ports for connection of Ethernet devices. Popular sizes for homes are 8-port and 16-port.
2. A separate power supply is required to power the switch and is not shown.

9.9.2 Network-Attached Storage (NAS)

A Network-Attached Storage (NAS) device comprises one or more high-capacity hard disk drives with an Ethernet interface to provide access by multiple PCs for central storage of data for the purpose of sharing files or data backup. The NAS operates independently of any PC and may provide for external access via the internet. It is connected to the home network via a router/gateway or Ethernet switch.

The NAS may be located at the CCP or at any TO that is patched to the router, gateway or switch at the CCP. However, the NAS may have a fan and is normally permanently switched on, so it may be considered to be too noisy for some locations.

Figure 95 A typical NAS

Notes:

1. A NAS provides centralised hard disk storage independently of any PC and often provides for external access via the internet. It is connected to the home network via a router/gateway or Ethernet switch.
2. A separate power supply may be required to power the NAS and is not shown.
3. The NAS may be too large to be housed in the CCP enclosure but can usually be located at any place where there is an Ethernet socket and where fan noise will not be a problem.

9.9.3 RF splitter/amplifier

For home cabling, the RF signals from, say, a TV antenna or the RF output of an FTTP NTD may be distributed to two or more TV outlets using an RF splitter or, where necessary, an RF splitter/amplifier. The splitter or splitter/amplifier may be located at the CCP (recommended) or another central location. Any in-building cable distribution system designed to provide access to one or more RF sources from multiple TV outlets is often referred to as an MATV (Master Antenna Television) system.

Figure 96 Typical RF splitter/amplifier

Notes:

1. Even with a strong source signal (e.g. from a TV antenna), if multiple TV points are required it may be necessary to install an RF amplifier to ensure that there is sufficient signal level at each TV point (see 10.8.5.5 on page 200). The splitter/amplifier shown has an antenna port, 8 output ports and supports additional RF input from two separate internal RF sources such as closed circuit TV cameras. Refer to 10.8.7.2.6 (page 213) for other amplifier examples.
2. A separate power supply is required to power the amplifier and is not shown.

10 CUSTOMER CABLING

10.1 Key components

The key components of the customer cabling system are:

- a **Central Connection Point (CCP)** containing a **multi-socket wall plate** or a **patch panel** for connection of services and equipment
- **cabling** between the CCP and outlets in selected rooms
- **Telecommunications Outlets (TOs)**, each comprising one or more sockets on a wall plate.

The cabling installation will also include **tie cabling** between the PCD and the CCP and may optionally include **coaxial cabling** for distribution of RF (Radio Frequency) TV signals.

Coaxial cabling systems (for TV cabling) are separate cabling systems to the data cabling system although they may share the same pathways, spaces and wall plates. For simplicity, coaxial cabling is described separately in 10.3.7 on page 147 (overview) and 10.8 on page 193.

10.2 Central Connection Point (CCP)

10.2.1 Description

The cables from the external PCD are connected to a Central Connection Point (CCP) which facilitates connection of the telecommunications network services to the Telecommunications Outlets (TOs) located in selected rooms. The CCP may consist of:

- a **single, multi-socket wall plate** (for a minimal cabling system); or
- a **patch panel** (for a home networking system).

The CCP:

- provides an indoor cable distribution point and a connection point for the powered equipment; and
- enables service providers or end-users to make service connections according to the technology used.

Whatever form the CCP takes, sufficient space should be provided for the powered equipment (e.g. FTTP NTD, modem/gateway, associated power supplies and connecting cords). For more information, refer to 10.4.3 on page 149.

CCP installation requirements are set out in 10.4 on page 148.

10.2.2 Multi-socket wall plate

A **multi-socket wall plate** provides basic connectivity and minimal functionality. It provides the means to connect the incoming telecommunications network services, e.g. data (internet) and voice (telephone), to the relevant TOs with limited flexibility, which may meet the needs of some home owners or occupants.
A multi-socket wall plate is pictured in Figure 97.
For other examples of wall plate layouts, see Figure 101 to Figure 104 (pages 127 to 130).

For more information, refer to 10.3.4.

Figure 97 A typical multi-socket wall plate

10.2.3 Patch panel

A **patch panel** is a socket array that is used for flexible connection of the incoming telecommunications network services to multiple TOs, enabling the home occupants to tailor the connections to meet their own needs. It also allows the occupants to change the configuration as their needs change without the need to engage a cabling provider to alter the cabling or to rewire the home.

A patch panel will enable the end-user to:

- connect a telephone or VOIP service to any TO
- connect a broadband internet service to any TO
- share a broadband internet service among several personal computers (PCs) using a gateway device
- interconnect digital devices, such as PCs, printers and media players, using a gateway, router or Ethernet switch.

In addition, the end-user will be able to test the telephone lines and the broadband internet service at a readily accessible point, i.e. either at the carrier’s NTD (where end-user access is permitted) or at the patch panel.

The patch panel may be contained in a proprietary home networking box, as shown in Figure 98 (a), or may be constructed by the cabling provider using generic components, as shown in Figure 98 (b).

For typical patch panel configurations, refer to 10.3.

Figure 98 Typical patch panels

(a) A proprietary home networking box

PHOTO COURTESY OF MADISON TECHNOLOGIES

(b) A patch panel made using wall plates and sockets

WALL PLATES & SOCKETS COURTESY OF CLIPSAL BY SCHNEIDER ELECTRIC

10.2.4 CCP installation

For CCP installation guidelines, refer to 10.4 on page 148.

10.3 Cabling options

10.3.1 General

Described below are cabling systems of varying sophistication and cost. In all cases, some form of CCP is required to provide the necessary connectivity for all types of telecommunications network technologies. The CCP:

- provides an indoor cable distribution point and a central point for connection of any powered equipment; and
- contains a multi-socket wall plate or a patch panel to allow service providers or end-users to make service connections according to the technology used.

10.3.2 Cable type

All twisted pair cabling should be 4-pair, **Category 6** (or better) data cable, which may be used for either digital ("data") or analogue ("voice") applications, as explained in 4.14.5 on page 39.

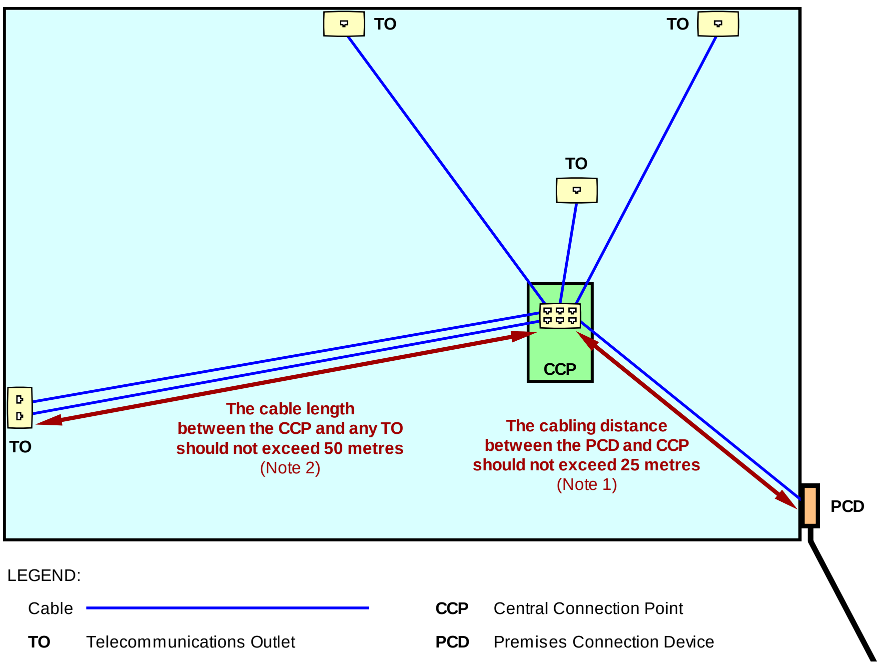
10.3.3 Maximum cabling length

Irrespective of what cabling system is installed:

- the total cabling distance between the PCD and the CCP, including bends and curves in the cabling path, **should not exceed 25 m** unless it is certain that FTTP with an **indoor** NTD will be installed, in which case the distance should not exceed **40 m** for reasons explained in 8.2.2.2 (page 101); and
- the total cabling distance between the CCP and any TO, including bends and curves in the cabling path, **should not exceed 50 m** for reasons explained in 10.5.7 (page 181).

Refer to Figure 99.

Figure 99 Cabling limits for homes



Notes:

1. The **25 m** cabling limit between the PCD and the CCP is to ensure that any coaxial cabling for HFC ("Cable") internet or DC cabling required between an indoor power supply and an outdoor FTTP NTD will be within the specified distance limits. If it is certain that FTTP with an **indoor** NTD will be installed, the cabling limit is **40 m** unless a greater distance is specifically approved by the relevant carrier.
2. The **50 m** limit between the CCP and each TO is to ensure that the TO cabling may support certain types of audio/video networking devices (see 10.8.6.5 on page 206) and future 10G Ethernet using Category 6 cables and connecting hardware (see 4.14.5 on page 39).

10.3.4 Minimal cabling system

A minimal cabling system is shown in Figure 100. This system provides the **bare essentials** required to facilitate connection of services and equipment for **all telecommunications network technologies**. A minimal cabling system may be adequate for some homes, e.g. retirement homes/units, low-cost housing, rental homes/units, boarding rooms.

With this cabling system, the CCP comprises:

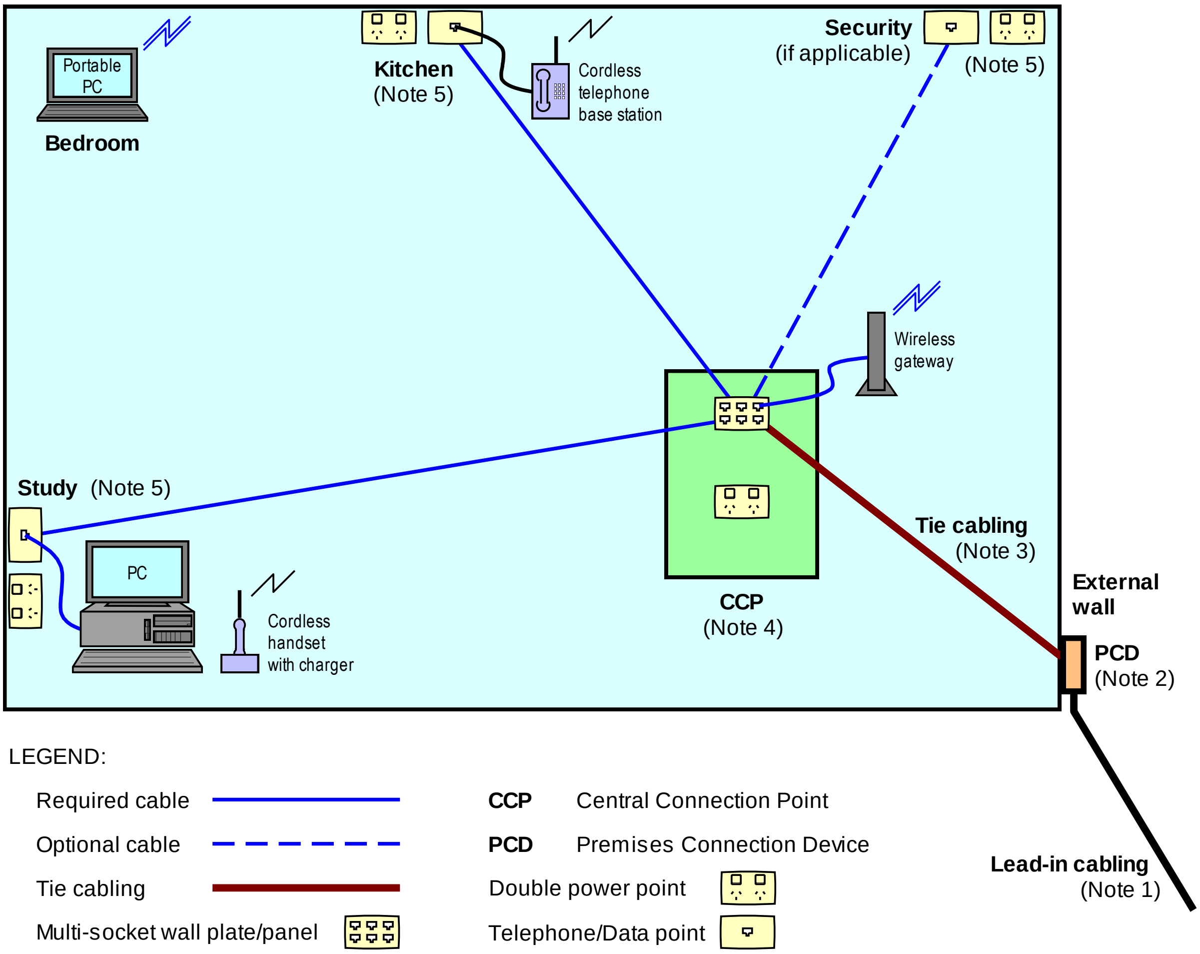
- a single, multi-socket wall plate for connection of services;
- space for a second wall plate for future expansion;
- a Fibre Wall Outlet (FWO) — or space for an FWO — for an indoor FTTP NTD.

At least **two TOs** should be provided — one for **telephone** and one for **data**. An **additional TO** may be required for the connection of **Mode 3 equipment** such as a security alarm panel or a personal response (emergency call) system (for an explanation of "Mode 3" and Mode 3 wiring options, see 10.4.7.4 on page 159).

A **double-socket power point** should be provided **within 1 m of the CCP** for powering of an FTTP NTD and/or a gateway device. A **power point** should also be provided **within 1 m of each TO** for powering of customer equipment (e.g. cordless telephone, gateway device, personal computer).

Typical line and equipment connections are shown in Figure 101 to Figure 104.

Figure 100 Plan of a minimal home cabling system



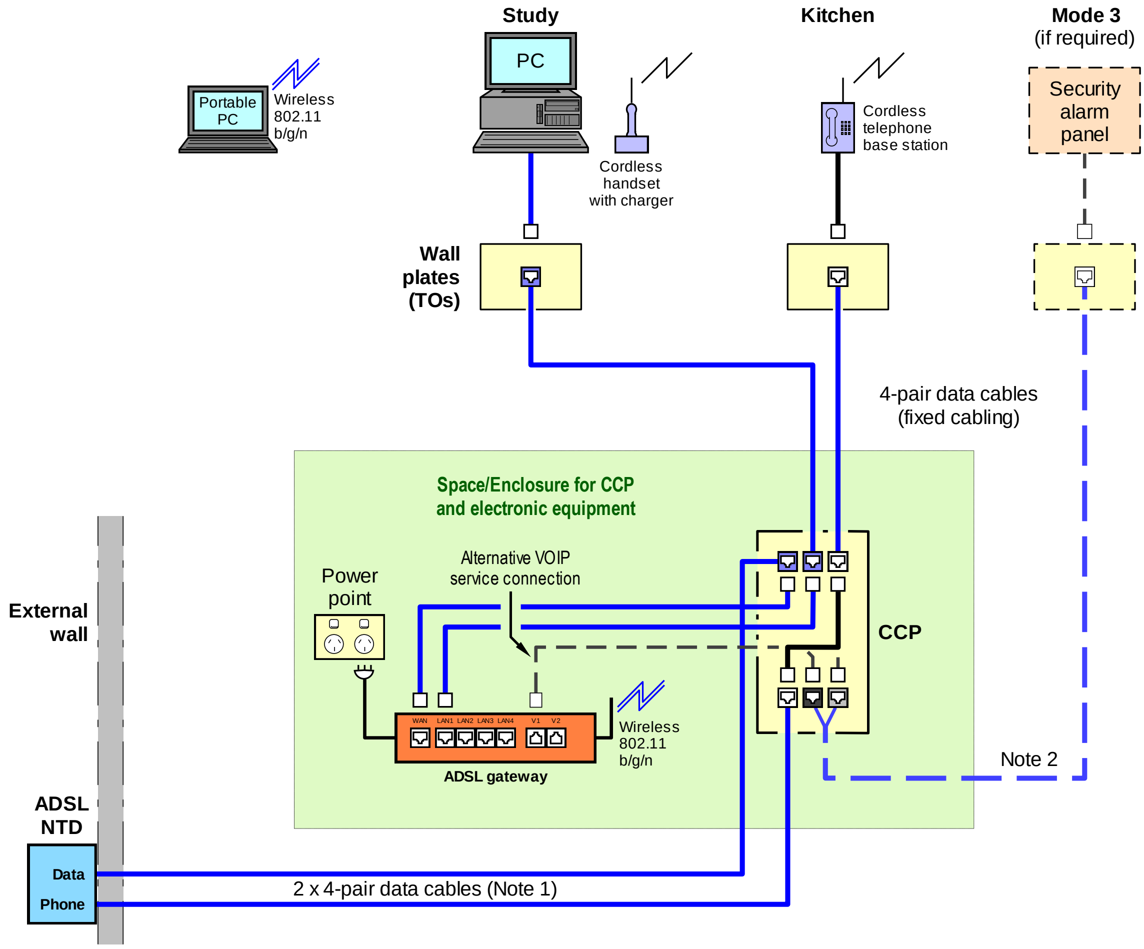
Notes:

1. For lead-in cabling information, refer to section 5.
2. For details about PCDs, refer to section 6. For building entry conduit arrangements, see section 7.
3. For details about tie cabling, refer to section 8.
4. The CCP should be located inside the building in a readily accessible location within a 25 m cabling distance of the PCD if possible (see 10.3.3 on page 124). It should be separated by at least 1 m from possible sources of electromagnetic interference (EMI). Possible locations for the CCP are a garage, utility room, study, walk-in robe or hall closet. The CCP should not be located outdoors or on the inside of an external wall of which the cavity may be damp and dusty. A double-socket power point is required within 1 m of the CCP to power such things as an FTTP NTD and/or a gateway device. Refer to section 9 for more information about powered equipment. Refer to 10.4 for CCP installation requirements.
5. A power point should be located near each TO for powering of customer equipment.
6. This home cabling system provides virtually no capacity for wired networking of the broadband internet service to personal computers (PCs) and entertainment/games equipment. PC networking may be achieved using wireless (Wi-Fi) technology with its inherent limitations (see 4.7 on page 8). Cordless telephone handsets may be used for multiple telephone access. See Figure 101 to Figure 104 for typical line and equipment connections.
7. Where additional telephone connection points are required, these should be star wired from the CCP to support possible future upgrading of the cabling system.

IT'S HOW WE CONNECT

Figure 101 Minimal home cabling system
Typical cabling arrangement and connections for telephone and ADSL services

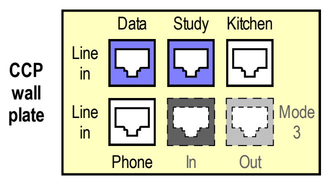
(a) Typical telephone and ADSL service connections



LEGEND:

(socket symbol)	Modular socket	ADSL	Asymmetric Digital Subscriber Line	PC	Personal Computer
(plug symbol)	Modular plug	CCP	Central Connection Point	TOs	Telecommunications Outlets
		NTD	Network Termination Device	VOIP	Voice Over Internet Protocol

(b) Typical CCP layout (using a multi-socket wall plate)

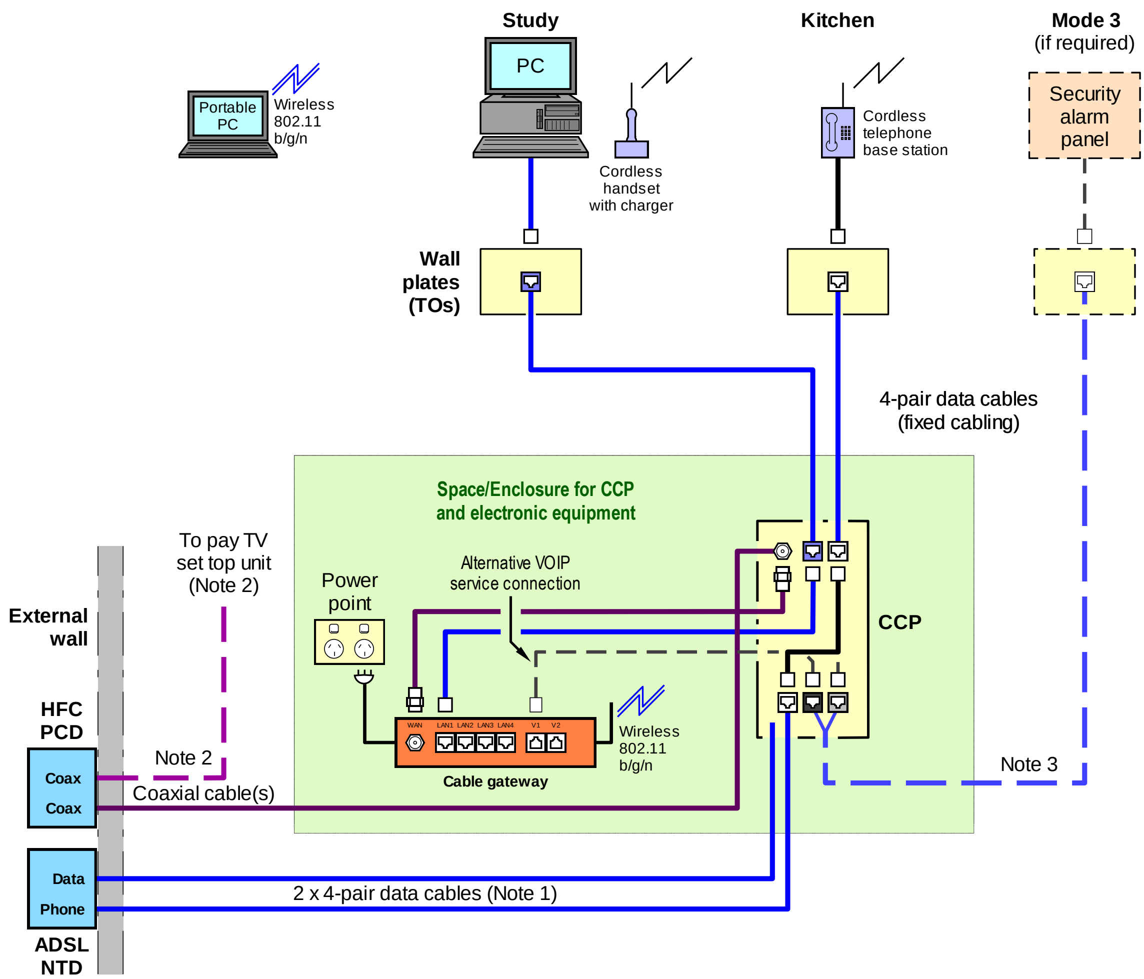


Notes:

1. An ADSL splitter (central filter) may be installed in the NTD or at the CCP. See 10.4.7.2.1 (page 153) for details. Two data cables should be installed between the outdoor NTD and the CCP wall plate for ADSL or future FTTP.
2. For an explanation of "Mode 3" and Mode 3 wiring options, see 10.4.7.4 on page 159.

Figure 102 Minimal home cabling system
Typical cabling arrangement and connections for telephone, HFC and optional ADSL services

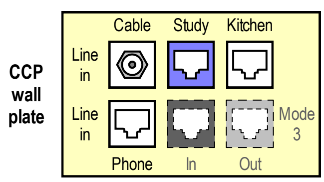
(a) Typical telephone and HFC service connections (plus optional ADSL)



LEGEND:

Modular socket	ADSL	Asymmetric Digital Subscriber Line	PC	Personal Computer
Modular plug	CCP	Central Connection Point	PCD	Premises Connection Device
Coaxial socket	HFC	Hybrid Fibre-Coax (“Cable”)	TOs	Telecommunications Outlets
Coaxial plug	NTD	Network Termination Device	VOIP	Voice Over Internet Protocol

(b) Typical CCP layout (using a multi-socket wall plate)

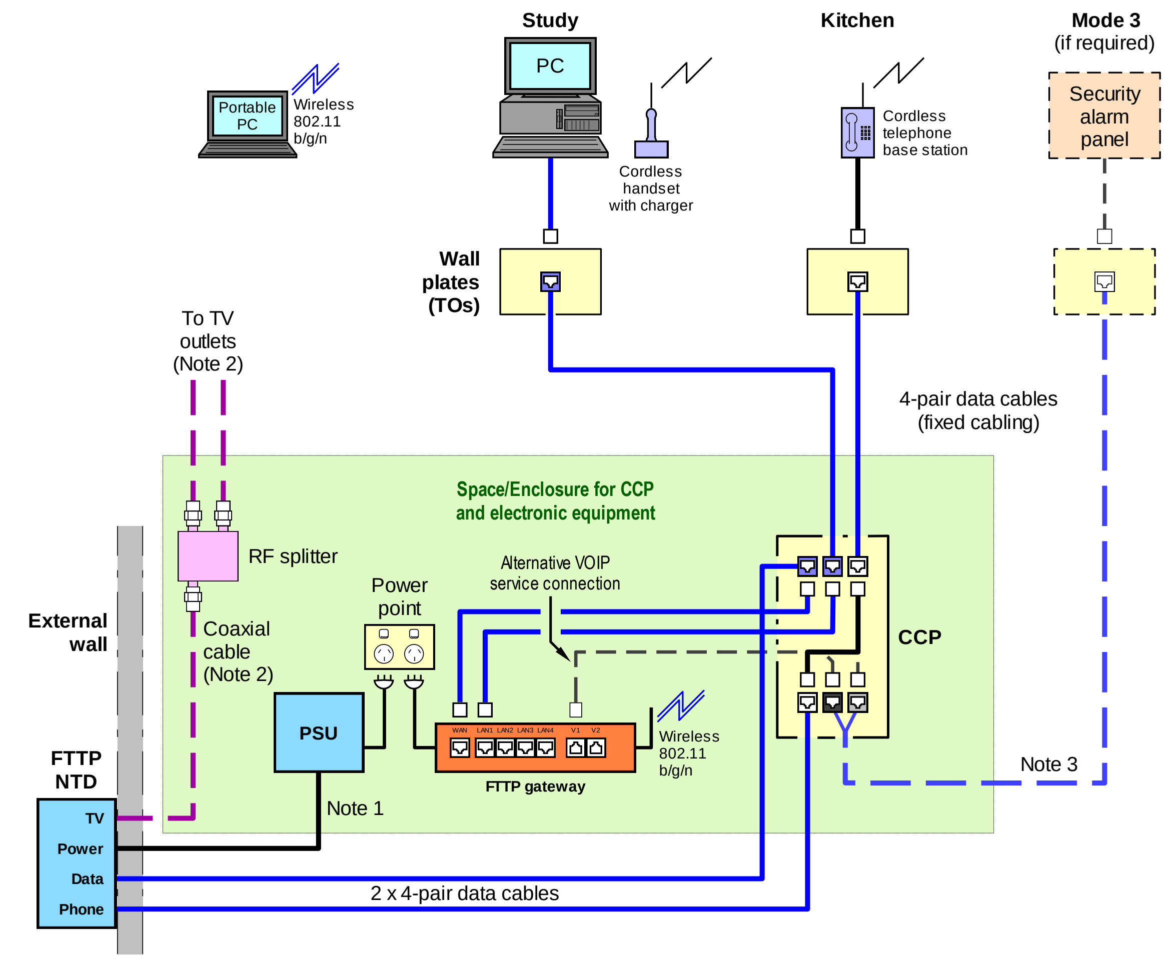


Notes:

1. Two data cables should be installed between the outdoor NTD and the CCP wall plate to support:
   - the supply of telephone and optional ADSL services (unlike HFC, ADSL can usually be supplied by multiple service providers); and
   - a possible, future, outdoor FTTP NTD (e.g. NBN).
2. The coaxial cable for the data service should run to the CCP for connection of the cable gateway. The coaxial cable for the pay TV service should run directly to the wall plate for the STU and **not** to the CCP.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.

Figure 103 Minimal home cabling system
Typical cabling arrangement and connections for FTTP (outdoor NTD)

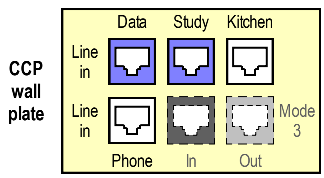
(a) Typical telephone and data service connections (and optional TV and/or pay TV, if applicable)



LEGEND:

(socket symbol) Modular socket		CCP	Central Connection Point	PSU	Power Supply Unit
(plug symbol) Modular plug		FTTP	Fibre To The Premises	RF	Radio Frequency
(coaxial plug symbol) Coaxial plug		NTD	Network Termination Device	TOs	Telecommunications Outlets
		PC	Personal Computer	VOIP	Voice Over Internet Protocol

(b) Typical CCP layout (using a multi-socket wall plate)

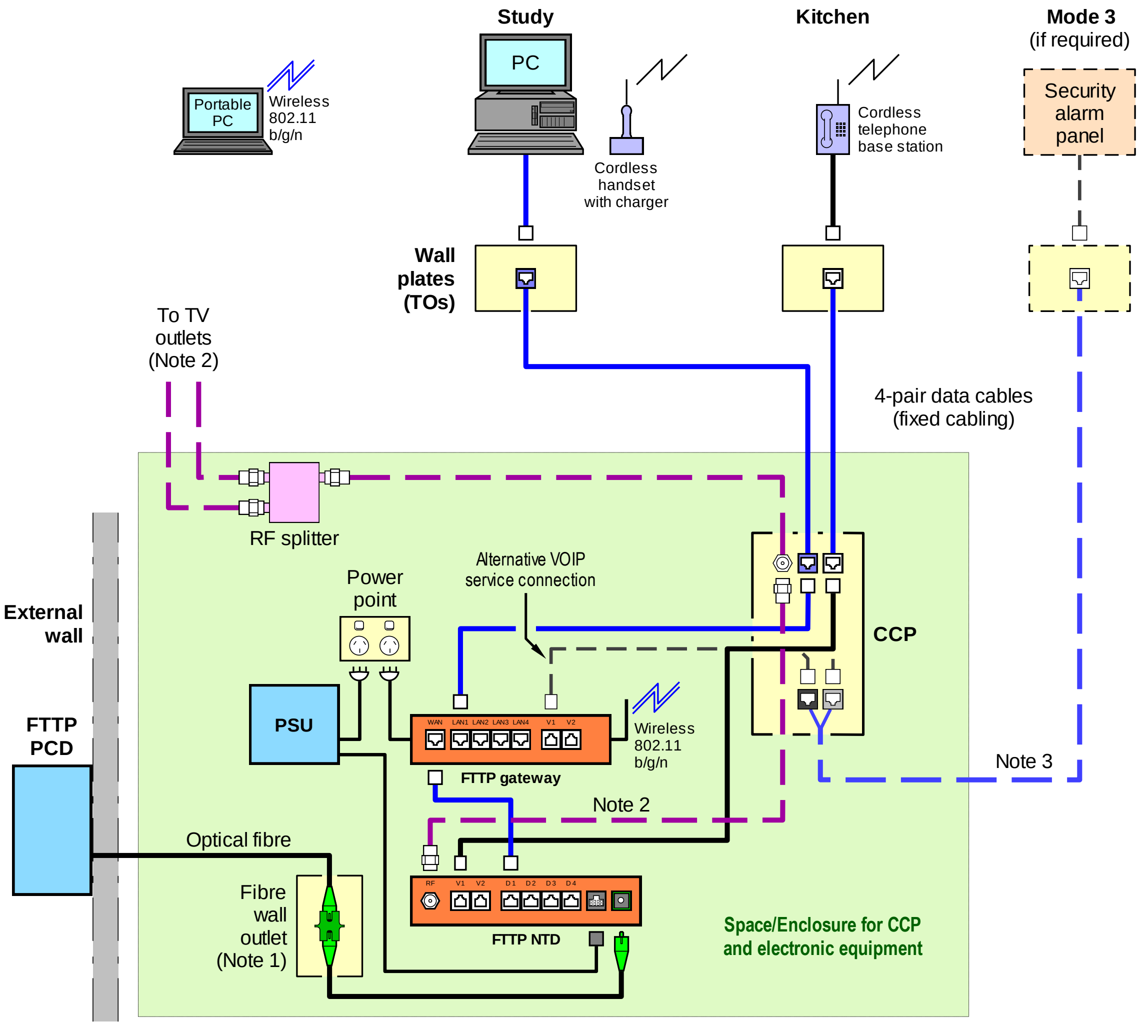


Notes:

1. A special multi-core DC power cable is required between the outdoor FTTP NTD and the indoor PSU. Refer to 10.4.7.2.3 on page 155.
2. Some FTTP NTDs have an RF (Radio Frequency) port for the supply of free-to-air TV, community TV or pay TV services. Where RF TV services are supplied from the NTD, refer to 10.8 (page 193) for coaxial cabling requirements.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.

Figure 104 Minimal home cabling system
Typical cabling arrangement and connections for FTTP (indoor NTD)

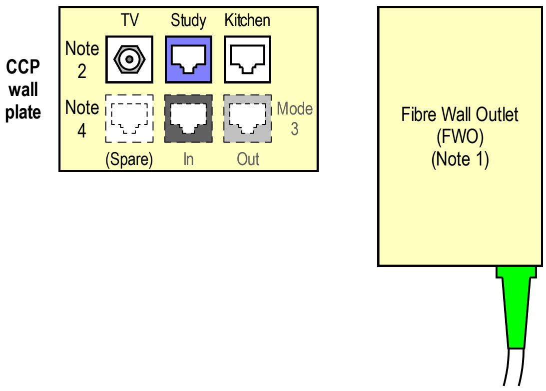
(a) Typical telephone and data service connections (and optional TV and/or pay TV, if applicable)



LEGEND:

Modular socket	CCP	Central Connection Point	PSU	Power Supply Unit
Modular plug	FTTP	Fibre To The Premises	RF	Radio Frequency
Coaxial socket	NTD	Network Termination Device	TOs	Telecommunications Outlets
Coaxial plug	PC	Personal Computer	VOIP	Voice Over Internet Protocol
Optical fibre connector	PCD	Premises Connection Device		

(b) Typical CCP layout (using a multi-socket wall plate)



Notes:

1. The carrier may not use a fibre wall outlet but allowance should be made for one to be installed at the CCP.
2. Some FTTP NTDs have a radio frequency (RF) port for the supply of free-to-air TV and/or pay TV services. Where RF TV services are supplied from the NTD, refer to 10.8 (page 193) for coaxial cabling requirements.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.
4. Where an indoor FTTP NTD is used, the **Line in** sockets are not required because the FTTP services will be connected directly from the rear of the NTD or gateway to the relevant sockets on the CCP.

10.3.5 Basic home networking system

A basic home networking system is shown in Figure 105. This system provides **basic networking facilities** for connection of services and equipment for **all telecommunications network technologies**. Basic networking enables sharing of the services by the occupants (e.g. a family) and enables the occupants to adapt the cabling to their personal needs. This system will also support limited wired networking of personal computers.

With this cabling system, the CCP consists of a **small patch panel** for connection of services and equipment. Provision is made for telecommunications network technology changes and future expansion.

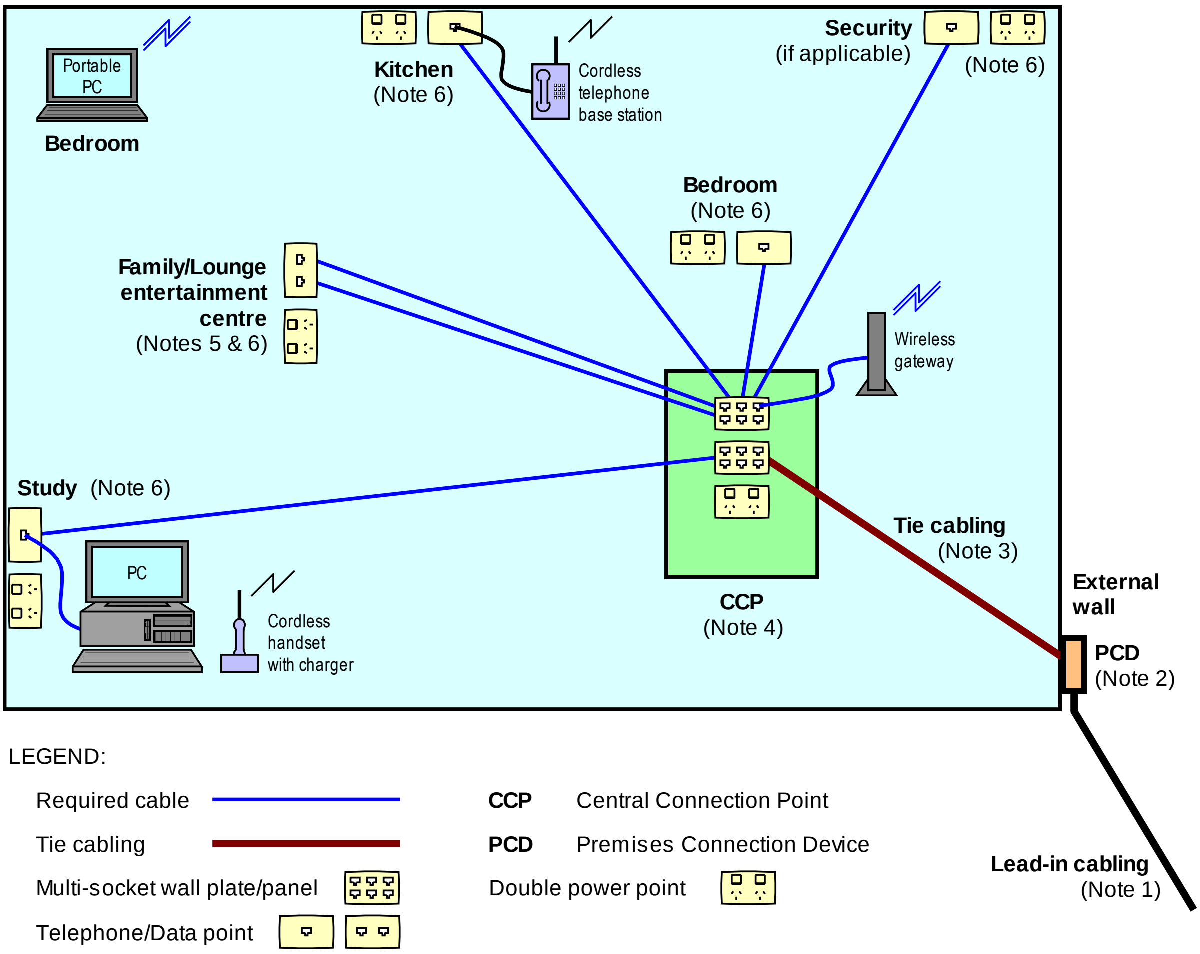
At least **four TOs** should be provided in **four separate rooms**, nominally for wired connection of up to four data or voice (telephone) devices. An **additional TO** may be required for the connection of **Mode 3 equipment** such as a security alarm panel or a personal response (emergency call) system (for an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159).

A **double-socket TO** should be provided at the **main entertainment point** (e.g. next to the TV outlet in the lounge or family room) to provide for Internet Protocol TV (IPTV), interactive pay TV or for connection of Ethernet-based entertainment equipment such as a games console or network media player.

At least one **double-socket power point** should be provided **within 1 m of the CCP** for powering of an FTTP NTD and/or a gateway device. A **power point** should also be provided **within 1 m of each TO** for powering of customer equipment (e.g. cordless telephone, personal computer).

Typical line and equipment connections are shown in Figure 106 to Figure 109, while Figure 110 illustrates a typical CCP patch panel arrangement using socket modules.

Figure 105 Plan of a basic home networking system

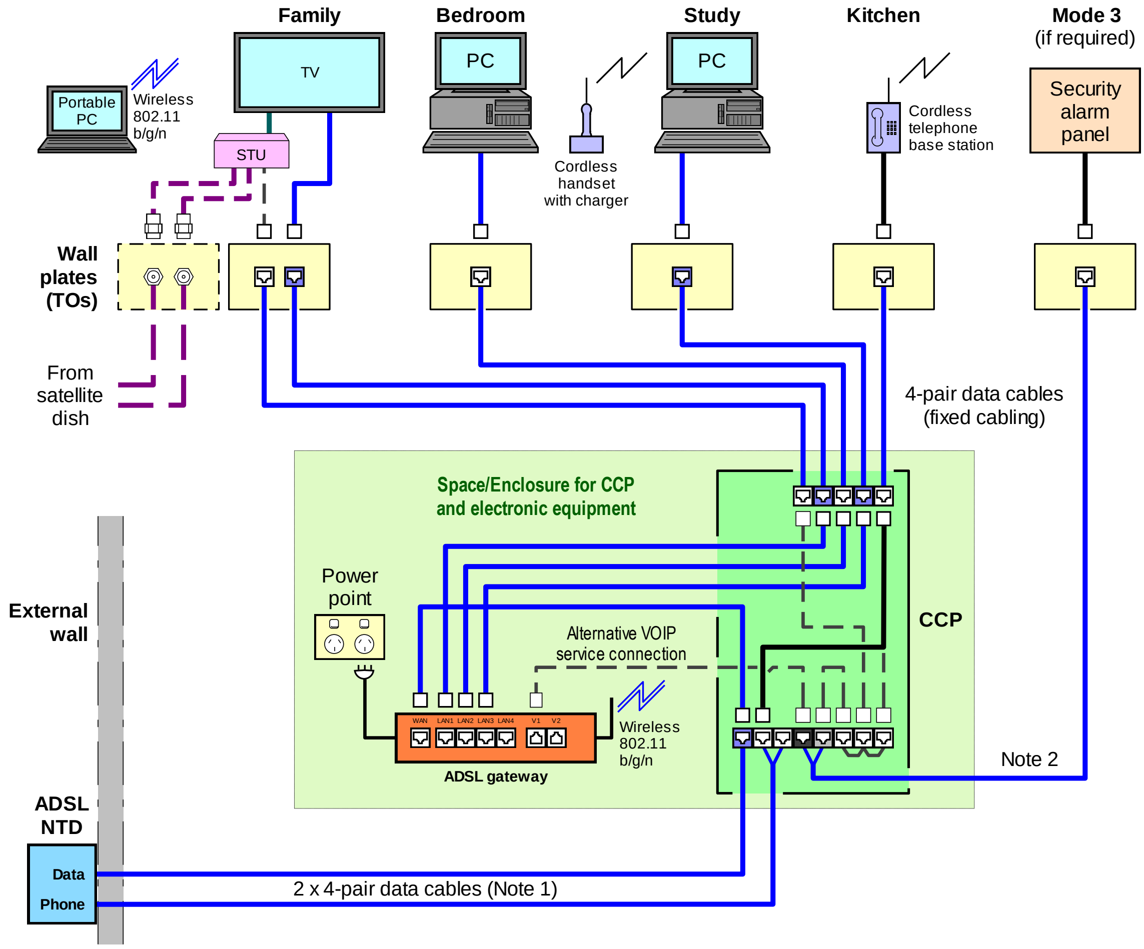


Notes:

1. For lead-in cabling information, refer to section 5.
2. For details about PCDs, refer to section 6. For building entry conduit arrangements, see section 7.
3. For details about tie cabling, refer to section 8.
4. The CCP should be located inside the building in a readily accessible location within a 25 m cabling distance of the PCD if possible (see 10.3.3 on page 124). It should be separated by at least 1 m from possible sources of electromagnetic interference (EMI). Possible locations for the CCP are a garage, utility room, study, walk-in robe or hall closet. The CCP should not be located outdoors or on the inside of an external wall of which the cavity may be damp and dusty. At least one double-socket power point is required within 1 m of the CCP to power such things as an FTTP NTD and/or a gateway device. Refer to section 9 for more information about powered equipment. Refer to 10.4 for CCP installation requirements.
5. At least one double-socket TO should be provided at the home entertainment point for connection of such things as IPTV, a games console, Blu-ray player, network media player or pay TV set top unit.
6. A power point should be located near each TO for powering of customer equipment.
7. This cabling system provides limited capacity for wired networking of the broadband internet service to personal computers (PCs) and entertainment/games equipment and generally relies on the use of cordless telephone handsets for multiple telephone access. PC networking may be supplemented using wireless (Wi-Fi) technology. See Figure 106 to Figure 109 for typical line and equipment connections and Figure 110 for a typical CCP patch panel arrangement using socket modules.

Figure 106 Basic home networking system
Typical cabling arrangement and connections for telephone and ADSL services

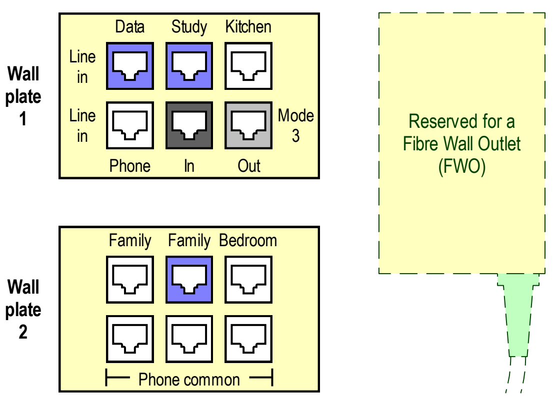
(a) Typical telephone and ADSL service connections



LEGEND:

⊡	Modular socket	ADSL	Asymmetric Digital Subscriber Line	STU	Set Top Unit (pay TV)
□	Modular plug	CCP	Central Connection Point	TOs	Telecommunications Outlets
◎	Coaxial socket	NTD	Network Termination Device	TV	Television
⊟	Coaxial plug	PC	Personal Computer	VOIP	Voice Over Internet Protocol

(b) Typical CCP layout (using multi-socket wall plates)

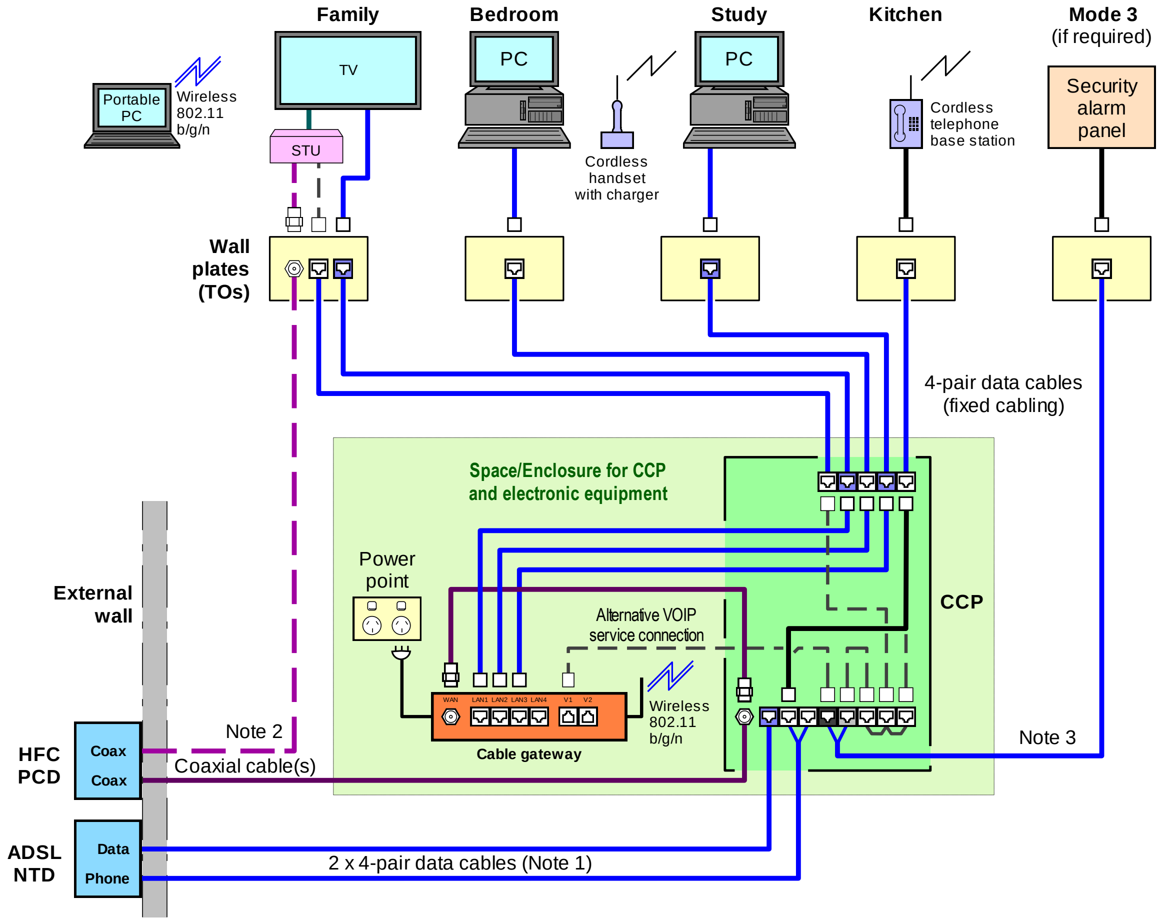


Notes:

1. An ADSL splitter (central filter) should be installed at either the NTD or the CCP (see 10.4.7.2.1 on page 153). However, even if the splitter will be located at the CCP, two data cables should be installed between the outdoor NTD and the CCP for a possible, future outdoor FTTP NTD (e.g. NBN).
2. For an explanation of "Mode 3" and Mode 3 wiring options, see 10.4.7.4 on page 159.

Figure 107 Basic home networking system
Typical cabling arrangement and connections for telephone, HFC and optional ADSL services

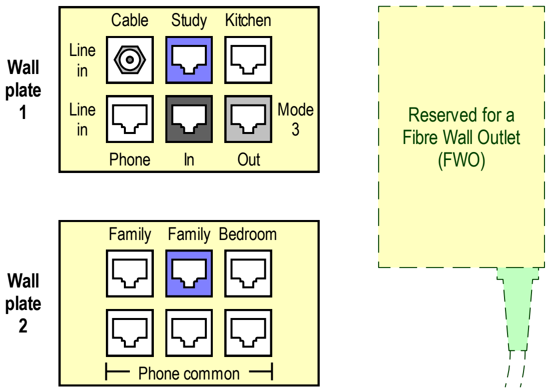
(a) Typical telephone and HFC service connections (plus optional ADSL)



LEGEND:

(socket symbol) Modular socket		ADSL	Asymmetric Digital Subscriber Line	PCD	Premises Connection Device
(plug symbol) Modular plug		CCP	Central Connection Point	STU	Set Top Unit (pay TV)
(coax socket symbol) Coaxial socket		HFC	Hybrid Fibre-Coax (“Cable”)	TOs	Telecommunications Outlets
(coax plug symbol) Coaxial plug		NTD	Network Termination Device	TV	Television
		PC	Personal Computer	VOIP	Voice Over Internet Protocol

(b) Typical CCP layout (using multi-socket wall plates)

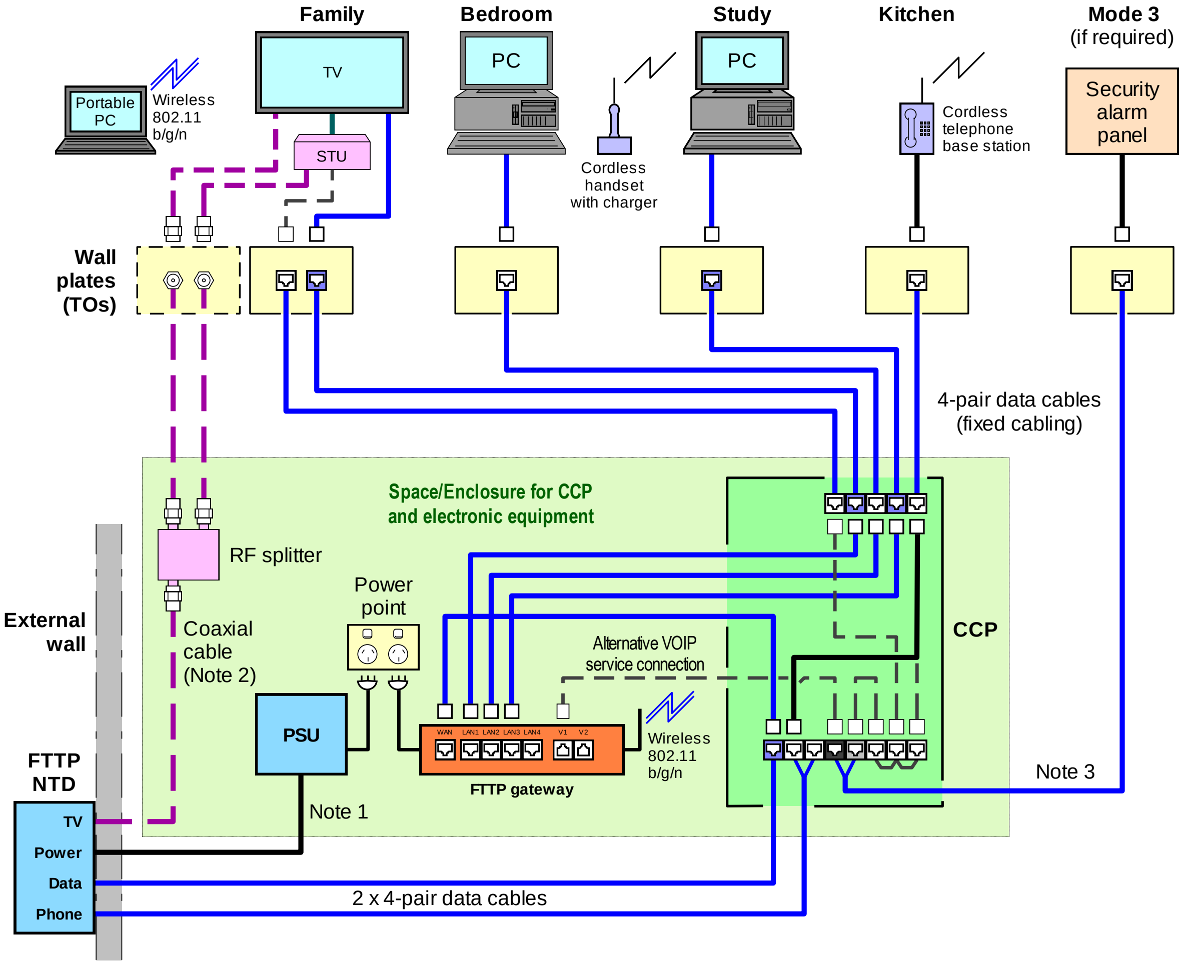


Notes:

1. Two data cables should be installed between the outdoor NTD and the CCP wall plate to support:
   - the supply of telephone and optional ADSL services (unlike HFC, ADSL can usually be supplied by multiple service providers); and
   - a possible, future, outdoor FTTP NTD (e.g. NBN).
2. The coaxial cable for the data service should run to the CCP for connection of the cable gateway. The coaxial cable for the pay TV service should run directly to the wall plate for the STU and **not** to the CCP.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.

Figure 108 Basic home networking system
Typical cabling arrangement and connections for FTTP (outdoor NTD)

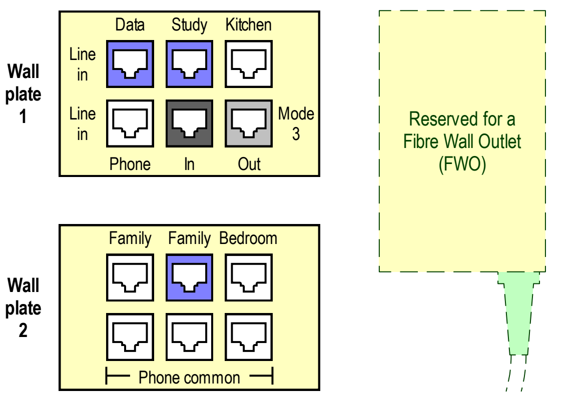
(a) Typical telephone and data service connections (and optional TV and/or pay TV, if applicable)



LEGEND:

Modular socket	CCP	Central Connection Point	RF	Radio Frequency
Modular plug	FTTP	Fibre To The Premises	STU	Set Top Unit (pay TV)
Coaxial socket	NTD	Network Termination Device	TOs	Telecommunications Outlets
Coaxial plug	PC	Personal Computer	TV	Television
	PSU	Power Supply Unit	VOIP	Voice Over Internet Protocol

(b) Typical CCP layout (using multi-socket wall plates)

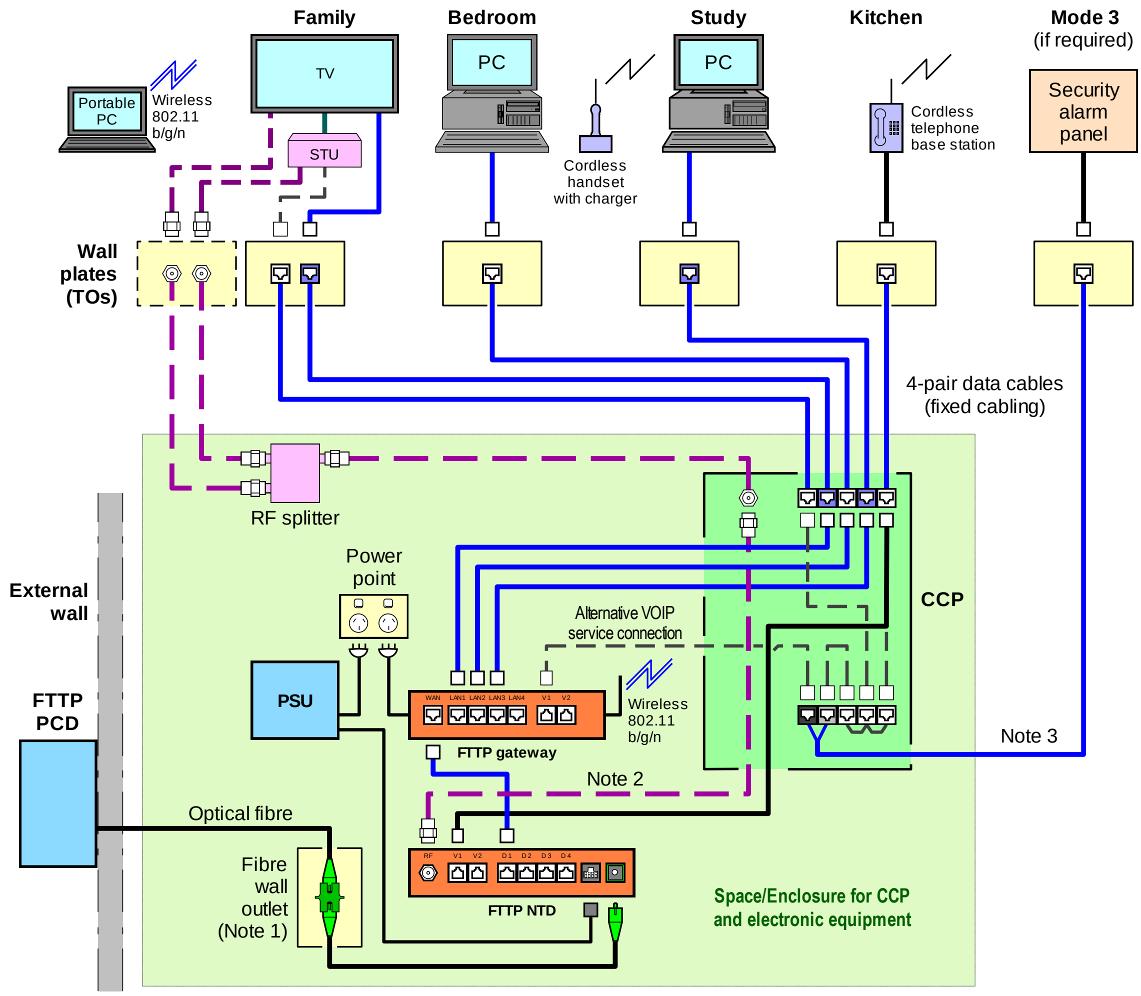


Notes:

1. A special multi-core DC power cable is required between the outdoor FTTP NTD and the indoor PSU.
2. Some FTTP NTDs have an RF (Radio Frequency) port for the supply of free-to-air TV, community TV or pay TV services. Where RF TV services are supplied from the NTD, refer to 10.8 (page 193) for coaxial cabling requirements.
3. For an explanation of "Mode 3" and Mode 3 wiring options, see 10.4.7.4 on page 159.

Figure 109 Basic home networking system
Typical cabling arrangement and connections for FTTP (indoor NTD)

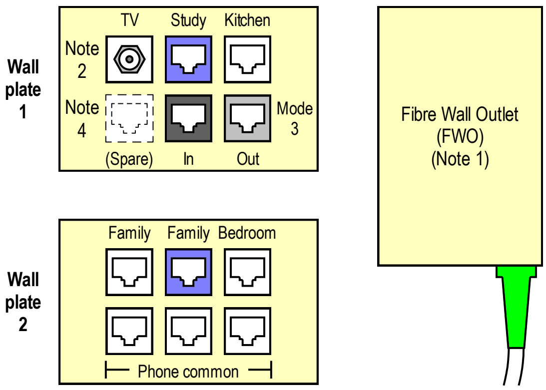
(a) Typical telephone and data service connections (and optional TV and/or pay TV, if applicable)



LEGEND:

Modular socket	CCP	Central Connection Point	PSU	Power Supply Unit
Modular plug	FTTP	Fibre To The Premises	RF	Radio Frequency
Coaxial socket	NTD	Network Termination Device	STU	Set Top Unit (pay TV)
Coaxial plug	PC	Personal Computer	TOs	Telecommunications Outlets
Optical fibre connector	PCD	Premises Connection Device	VOIP	Voice Over Internet Protocol

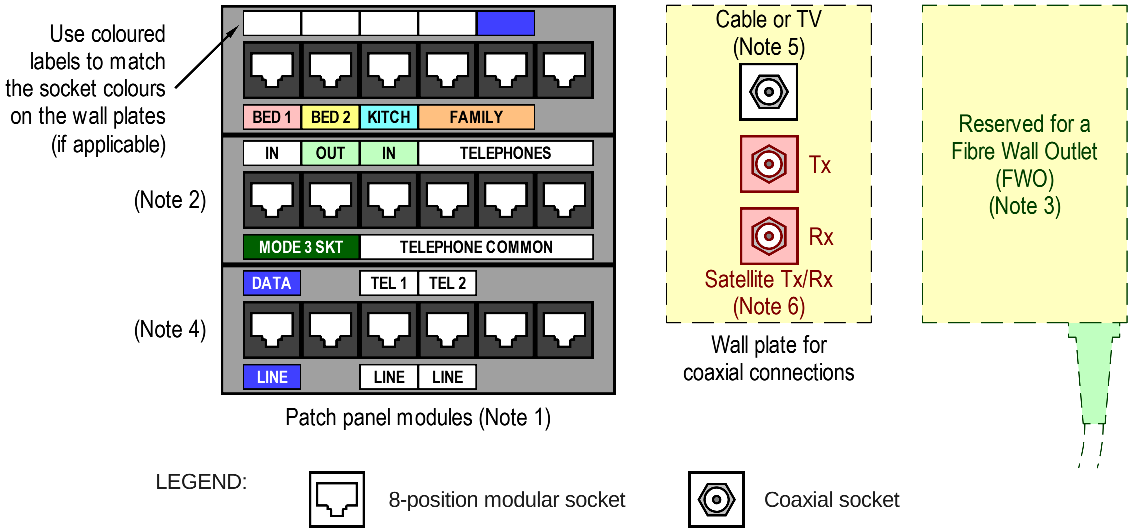
(b) Typical CCP layout (using multi-socket wall plates)



Notes:

1. The carrier may not use a fibre wall outlet but allowance should be made for one to be installed at the CCP.
2. Some FTTP NTDs have a radio frequency (RF) port for the supply of free-to-air TV and/or pay TV services. Where RF TV services are supplied from the NTD, refer to 10.8 (page 193) for coaxial cabling requirements.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.
4. Where an indoor FTTP NTD is used, the **Line in** sockets are not required because the FTTP services will be connected directly from the rear of the NTD or gateway to the relevant sockets on the CCP.

Figure 110 Typical CCP layout for a basic home networking system using socket modules



Notes:

1. Some home networking boxes use modules that contain a bank of six sockets (as shown above) while others may use modules containing eight or more sockets. See Figure 98 (a) on page 123 for a typical proprietary home networking box. Some home networking boxes also provide a coaxial connector for connection of a cable (HFC) modem/gateway.
2. If Mode 3 equipment (such as a security alarm panel or a personal response system) is to be installed, additional sockets may need to be allocated on the patch panel. Refer to 10.4.7.4 on page 159 for details.
3. The Fibre Wall Outlet (FWO) is used for connection of the fixed optical fibre cable (from the outdoor PCD) to the indoor FTTP NTD fly lead. The carrier may not install an FWO but allowance should be made for one. The space required for the FWO and the NTD fly lead is slightly larger than the size of a standard wall plate.
4. Where an indoor FTTP NTD is used, the **LINE** sockets are not required because the FTTP services will be connected directly from the rear of the NTD or gateway to the relevant sockets on the patch panel.
5. A separate coaxial connector may be required for connection of a cable modem/gateway (where HFC is available) or to connect the RF (coaxial) port of an indoor FTTP NTD to the fixed coaxial cabling (some FTTP NTDs have an RF port for the supply of free-to-air TV, community TV or pay TV services). NBN Co NTDs do not supply RF services.
6. Most homes will not require access to satellite broadband. However, if satellite broadband will be used, the coaxial cables from the satellite dish may terminate on a separate wall plate adjacent to the patch panel for connection of the satellite gateway. Alternatively, this wall plate may be used for the NBN fixed wireless antenna connection, noting that this connection is a Category 5 modular connection, not coaxial (refer to 9.8.4 on page 120).

10.3.6 Standard home networking system

10.3.6.1 Core system

A "standard" home networking system is shown in Figure 111. This system differs from the basic home networking system described in 10.3.5 by the addition of a second TO socket in each room to support additional telephone service connections plus full wired home networking — including IPTV, on-line games and high definition media (audio/video) streaming.

This cabling system is referred to as a "standard" system because it is considered to be the minimum ICT (Information and Communications Technologies) requirement for compliance with Australian Standard AS/NZS ISO/IEC 15018, *Information technology — Generic cabling for homes*.

With this cabling system, the CCP consists of a patch panel for connection of services and equipment. Provision should be made for telecommunications network technology changes and future expansion.

At least **four double-socket TOs** should be provided in **four separate rooms** for wired connection of data and voice (telephone) services. An **additional TO** may be required for the connection of **Mode 3 equipment** such as a security alarm panel or a personal response (emergency call) system (for an explanation of "Mode 3" and Mode 3 wiring options, see 10.4.7.4 on page 159). **Extra TOs** should also be provided in the **main bedroom** and any room designated as a **study** or **home office** (see 10.3.6.2).

It is also recommended that a **TO with at least four sockets** be provided at the **main entertainment point** (e.g. next to the TV outlet in the lounge or family room) to provide for:

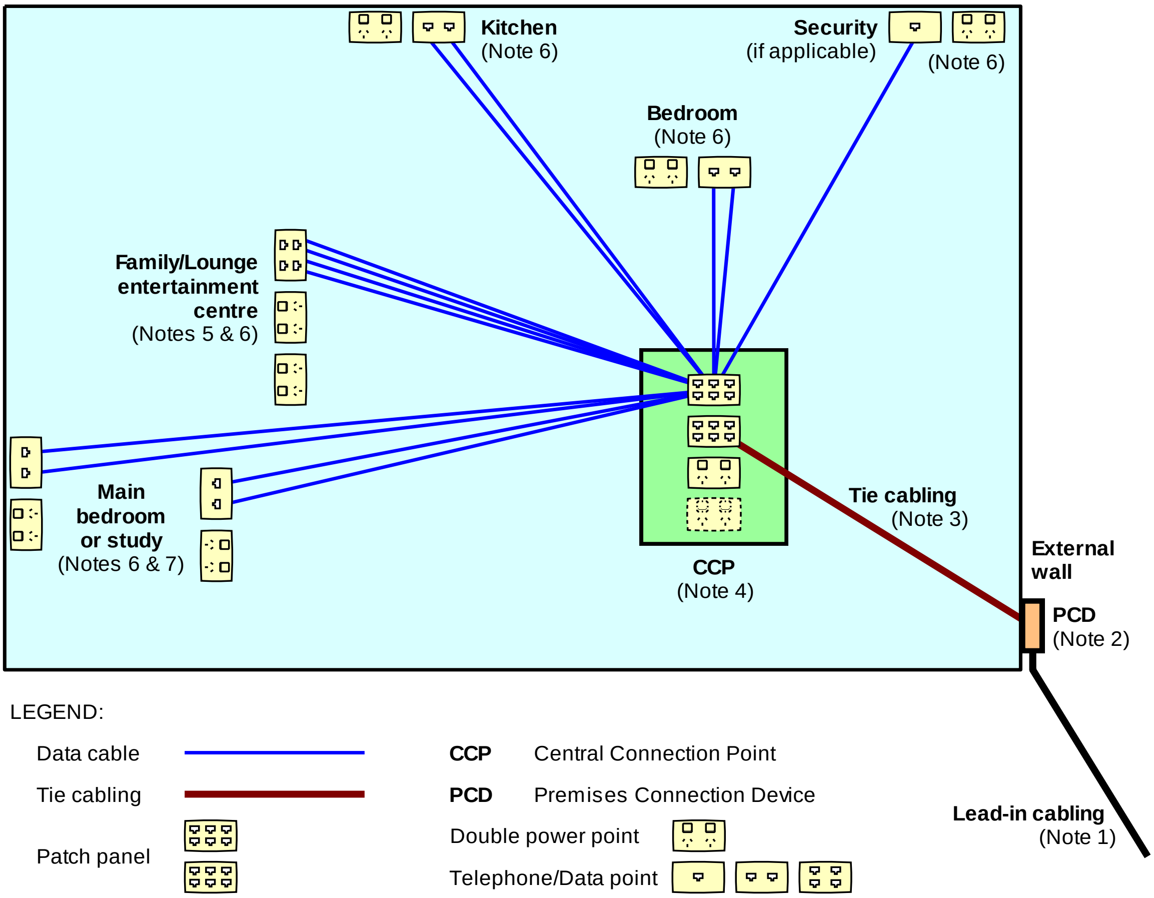
- a telephone or Ethernet connection for a pay TV set top unit
- a separate Ethernet connection for one or more of the following:
  - television set
  - Blu-ray player
  - network media player
  - games console
- high-definition audio/video streaming over the data cabling (see 10.8.6.5 on page 206).

Note: The pay TV set top unit requires connection to either the telephone service or an Ethernet connection to support interactive TV (see 9.5.2 on page 113). Most modern digital TV sets and Blu-ray players have an Ethernet port for access to IPTV and online firmware updates. Network media players require an Ethernet connection for IPTV, media distribution across the home network and online firmware updates. Most games consoles have an Ethernet port for access to online games and IPTV.

At least one **double-socket power point** should be provided **within 1 m of the CCP** for powering of an FTTP NTD and/or a gateway device. A **power point** should also be provided **within 1 m of each TO** for powering of customer equipment (e.g. cordless telephone, personal computer).

Typical line and equipment connections are shown in Figure 112 to Figure 115, while Figure 116 and Figure 117 illustrate the corresponding patch panel configurations at the CCP.

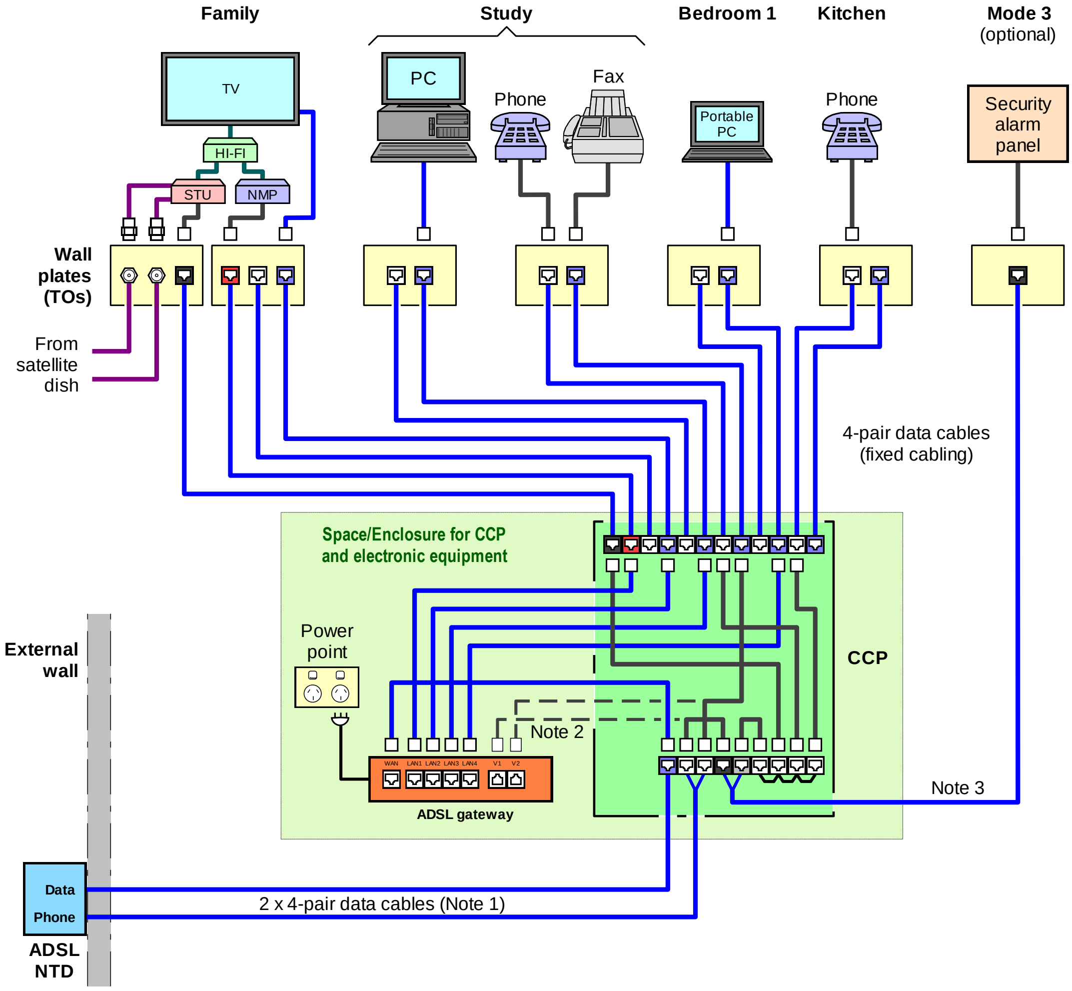
Figure 111 Plan of a standard home networking system



Notes:

1. For lead-in cabling information, refer to section 5.
2. For details about PCDs, refer to section 6. For building entry conduit arrangements, see section 7.
3. For details about tie cabling, refer to section 8.
4. The CCP should be located inside the building in a readily accessible location within a 25 m cabling distance of the PCD if possible (see 10.3.3 on page 124). It should be separated by at least 1 m from possible sources of electromagnetic interference (EMI). Possible locations for the CCP are a garage, utility room, study, walk-in robe or hall closet. The CCP should not be located outdoors or on the inside of an external wall of which the cavity may be damp and dusty. At least one double-socket power point is required within 1 m of the CCP to power such things as an FTTP NTD and/or a gateway device. Refer to section 9 for more information about powered equipment. Refer to 10.4 for CCP installation requirements.
5. At least one double-socket TO should be provided at the home entertainment point for connection of IPTV and a games console. However, four sockets are recommended at this location for this cabling system to provide additional data connections for such things as a Blu-ray player, network media player, pay TV set top unit or high-definition audio/video streaming over UTP (see 10.8.6.5 on page 206).
6. A power outlet should be located near each TO for powering of customer equipment.
7. The installation of a second TO is recommended for at least the main bedroom and any room to be used as a home office or study. Refer to 10.3.6.2 (page 146).
8. This cabling system supports distribution of two or more telephone services (including VOIP services) and wired networking of personal computers (PCs) and entertainment/games equipment, including IPTV, on-line games and high definition media (audio/video) streaming. Telephone service access and PC networking may be supplemented using cordless or wireless (Wi-Fi) technologies. See Figure 112 to Figure 115 for typical line and equipment connections, and Figure 116 and Figure 117 for corresponding CCP patch panel arrangements.

Figure 112 Standard home networking system
Typical cabling arrangement and connections for telephone and ADSL services



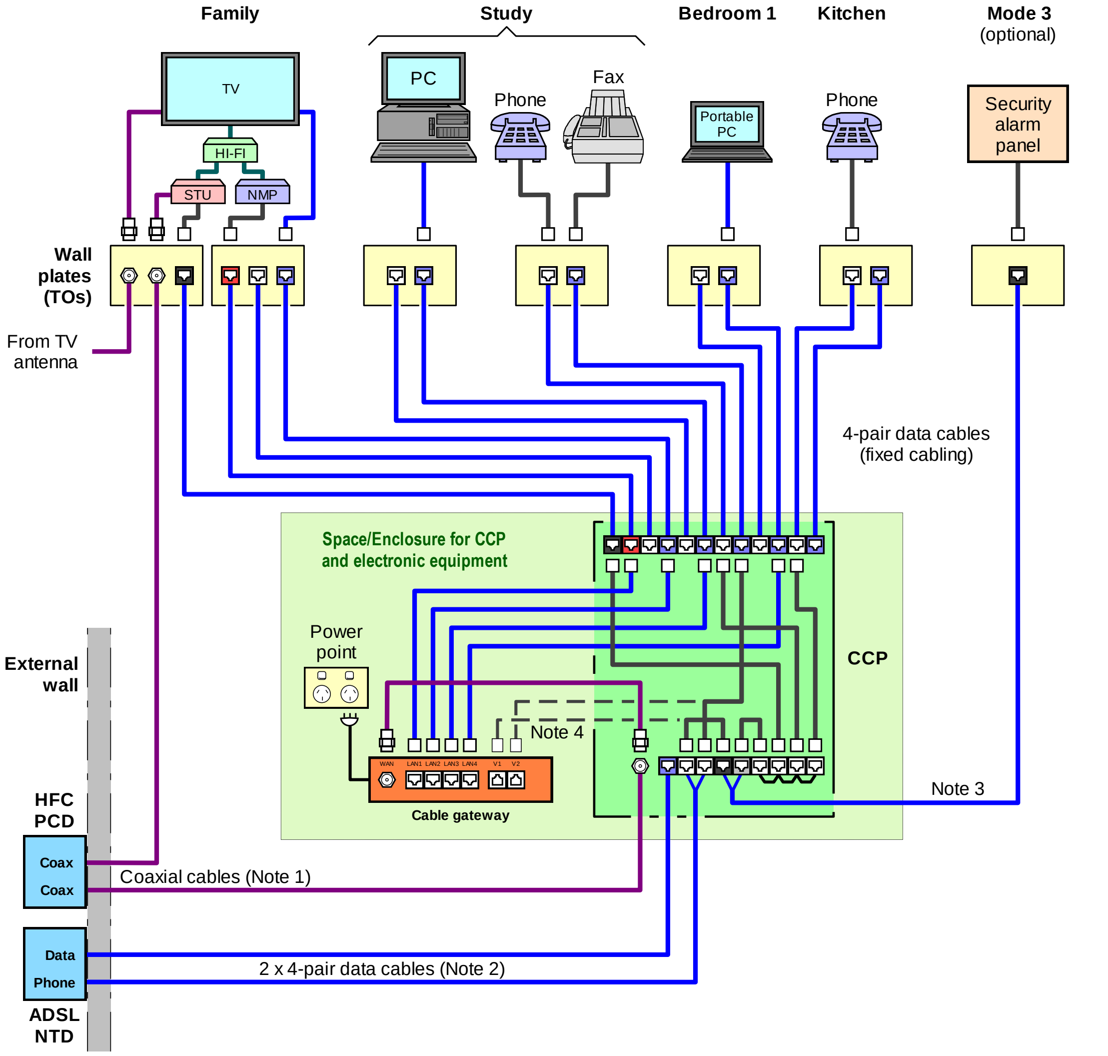
LEGEND:

	Modular socket	ADSL	Asymmetric Digital Subscriber Line	PC	Personal Computer
	Modular plug	CCP	Central Connection Point	STU	Set Top Unit (pay TV)
	Coaxial socket	HI-FI	High-Fidelity amplifier/receiver	TOs	Telecommunications Outlets
	Coaxial plug	NMP	Network Media Player	TV	Television
		NTD	Network Termination Device		

Notes:

1. An ADSL splitter (central filter) should be installed at either the NTD or the CCP (see 10.4.7.2.1 on page 153). However, even if the splitter will be located at the CCP, two data cables should be installed between the outdoor NTD and the CCP for a possible, future outdoor FTTP NTD (e.g. NBN).
2. Alternative telephone services may be provided from VOIP ports on the gateway.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.
4. For typical CCP patch panel layouts, refer to Figure 116 and Figure 117.

Figure 113 Standard home networking system
Typical cabling arrangement and connections for telephone, HFC and optional ADSL services



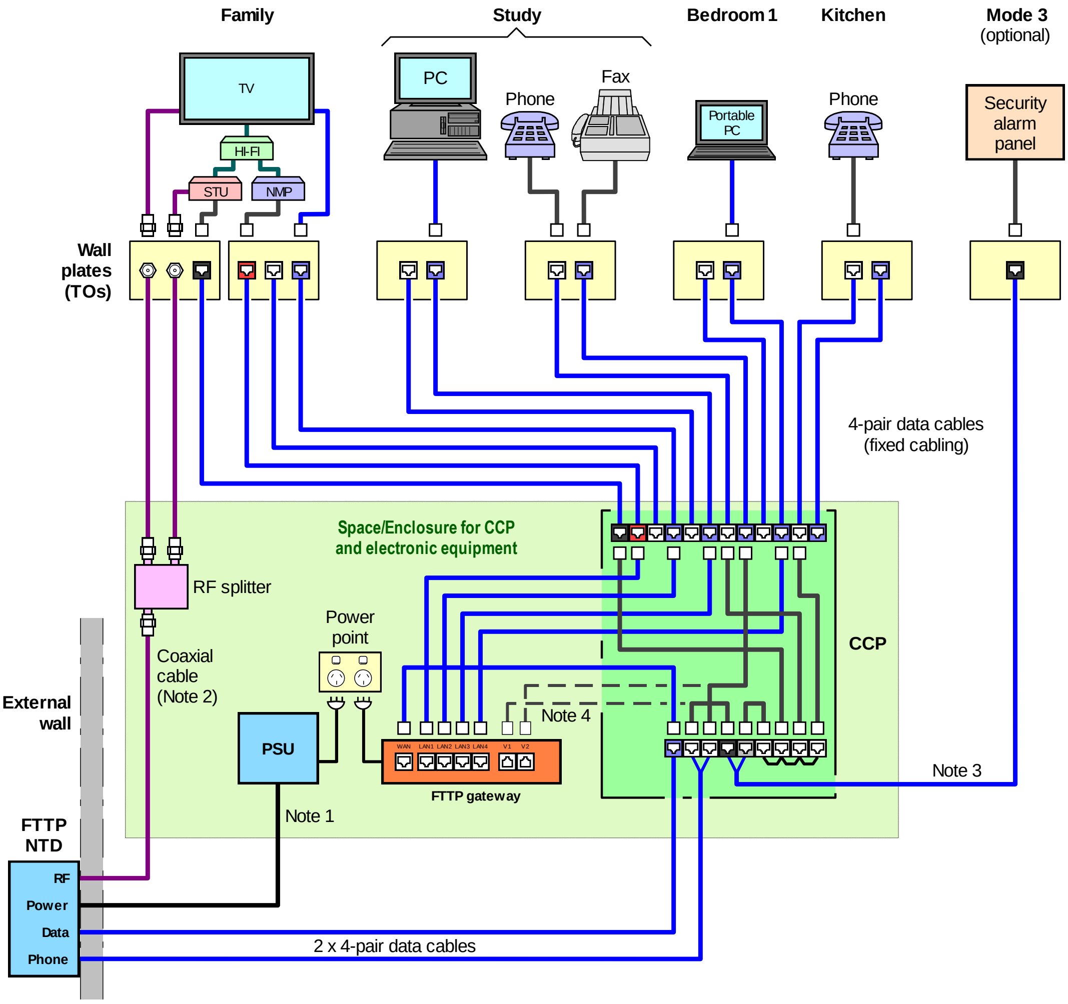
LEGEND:

(symbol)	Modular socket	ADSL	Asymmetric Digital Subscriber Line	PC	Personal Computer
(symbol)	Modular plug	CCP	Central Connection Point	PCD	Premises Connection Device
(symbol)	Coaxial socket	HFC	Hybrid Fibre-Coax ("Cable")	STU	Set Top Unit (pay TV)
(symbol)	Coaxial plug	HI-FI	High-Fidelity amplifier/receiver	TOs	Telecommunications Outlets
		NMP	Network Media Player	TV	Television
		NTD	Network Termination Device		

Notes:

1. The coaxial cable for the internet service should run to the CCP for connection of the cable gateway. The coaxial cable for the pay TV service should run directly to the wall plate to be used for connection of the STU and **not** to the CCP.
2. Two data cables should be installed between the outdoor NTD and the CCP wall plate to support:
   - the supply of telephone and optional ADSL services (unlike HFC, ADSL can usually be supplied by multiple service providers); and
   - a possible, future, outdoor FTTP NTD (e.g. NBN).
3. For an explanation of "Mode 3" and Mode 3 wiring options, see 10.4.7.4 on page 159.
4. Alternative telephone services may be provided from VOIP ports on the gateway.
5. For typical CCP patch panel layouts, refer to Figure 116 and Figure 117.

Figure 114 Standard home networking system
Typical cabling arrangement and connections for FTTP (outdoor NTD)



LEGEND:

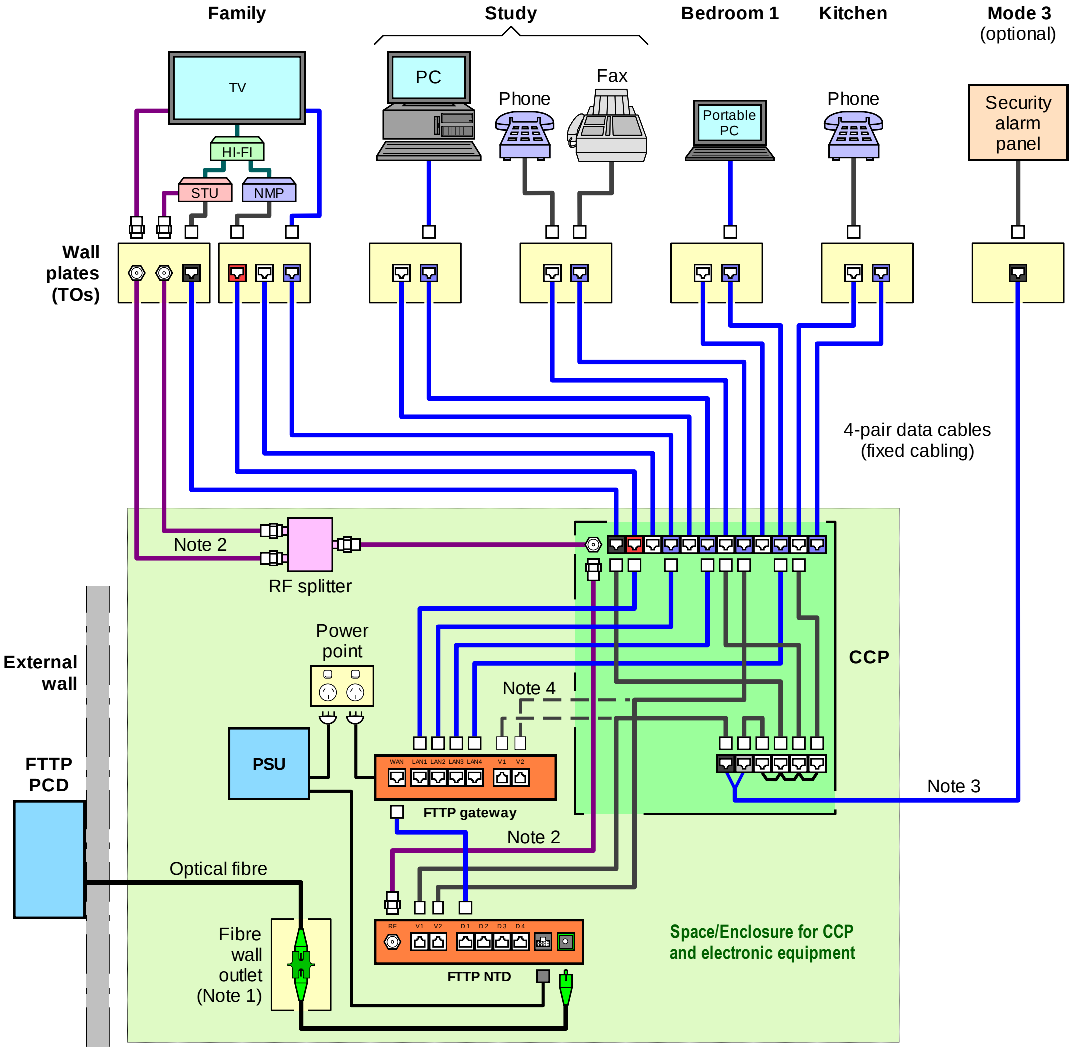
(symbol)	Modular socket	CCP	Central Connection Point	PC	Personal Computer
(symbol)	Modular plug	FTTP	Fibre To The Premises	PSU	Power Supply Unit
(symbol)	Coaxial socket	HI-FI	High-Fidelity amplifier/receiver	RF	Radio Frequency
(symbol)	Coaxial plug	NMP	Network Media Player	STU	Set Top Unit (pay TV)
		NTD	Network Termination Device	TOs	Telecommunications Outlets

Notes:

1. A special multi-core DC power cable is required between the outdoor FTTP NTD and the indoor PSU.
2. Some FTTP NTDs have an RF (Radio Frequency) port for the supply of free-to-air TV, community TV or pay TV services. Where RF TV services are supplied from the NTD, refer to 10.8 (page 193) for coaxial cabling requirements.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.
4. Alternative telephone services may be provided from VOIP ports on the gateway.
5. For typical CCP patch panel layouts, refer to Figure 116 and Figure 117.

IT'S HOW WE CONNECT

Figure 115 Standard home networking system
Typical cabling arrangement and connections for FTTP (indoor NTD)



LEGEND:

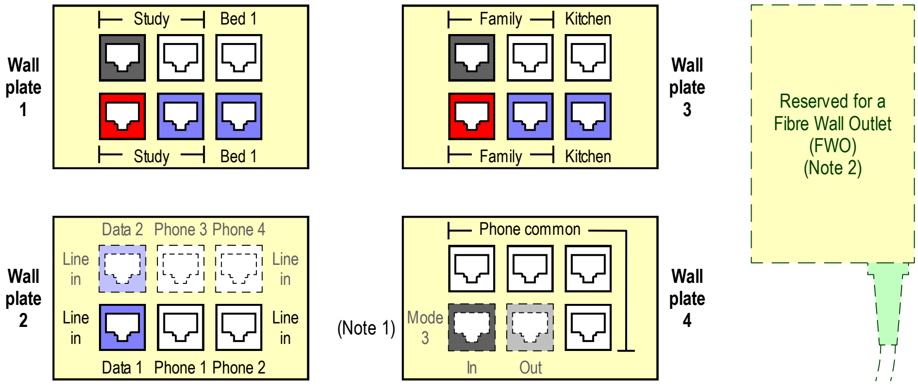
	Modular socket	CCP	Central Connection Point	PCD	Premises Connection Device
	Modular plug	FTTP	Fibre To The Premises	PSU	Power Supply Unit
	Coaxial socket	HI-FI	High-Fidelity amplifier/receiver	RF	Radio Frequency
	Coaxial plug	NMP	Network Media Player	STU	Set Top Unit (pay TV)
	Optical fibre connector	NTD	Network Termination Device	TOs	Telecommunications Outlets
	Optical fibre adaptor	PC	Personal Computer	TV	Television

Notes:

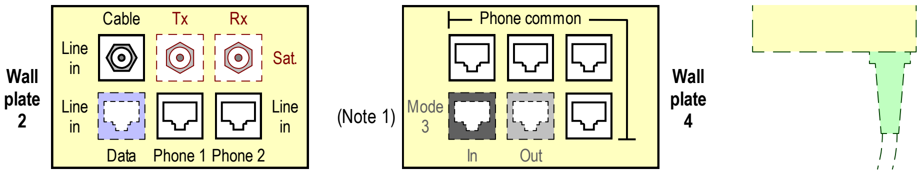
1. The carrier may not use a fibre wall outlet but allowance should be made for one to be installed at the CCP.
2. Some FTTP NTDs have a radio frequency (RF) port for the supply of free-to-air TV and/or pay TV services. Where RF TV services are supplied from the NTD, refer to 10.8 (page 193) for coaxial cabling requirements.
3. For an explanation of “Mode 3” and Mode 3 wiring options, see 10.4.7.4 on page 159.
4. Alternative telephone services may be provided from VOIP ports on the gateway.
5. For typical CCP patch panel layouts, refer to Figure 116 and Figure 117.

Figure 116 Typical CCP layouts for a standard home networking system using wall plates

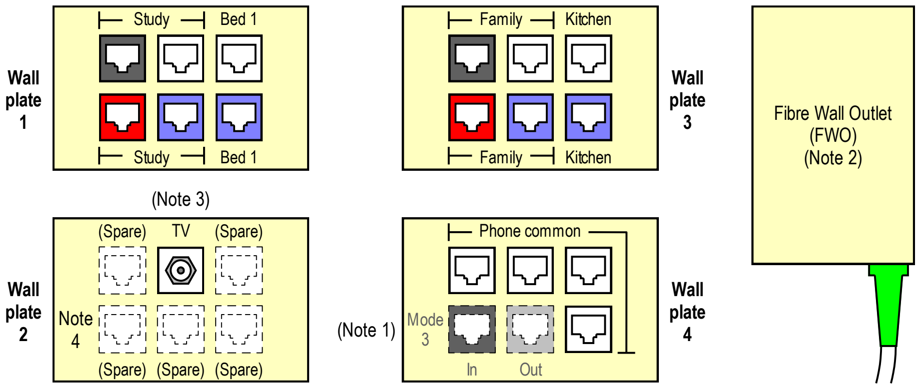
(a) Where services are supplied from an outdoor ADSL NTD or FTTP NTD

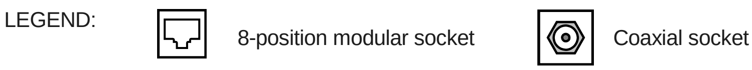


(b) Variation to (a) above for HFC ("Cable") or satellite broadband



(c) Where services are supplied from an indoor FTTP NTD



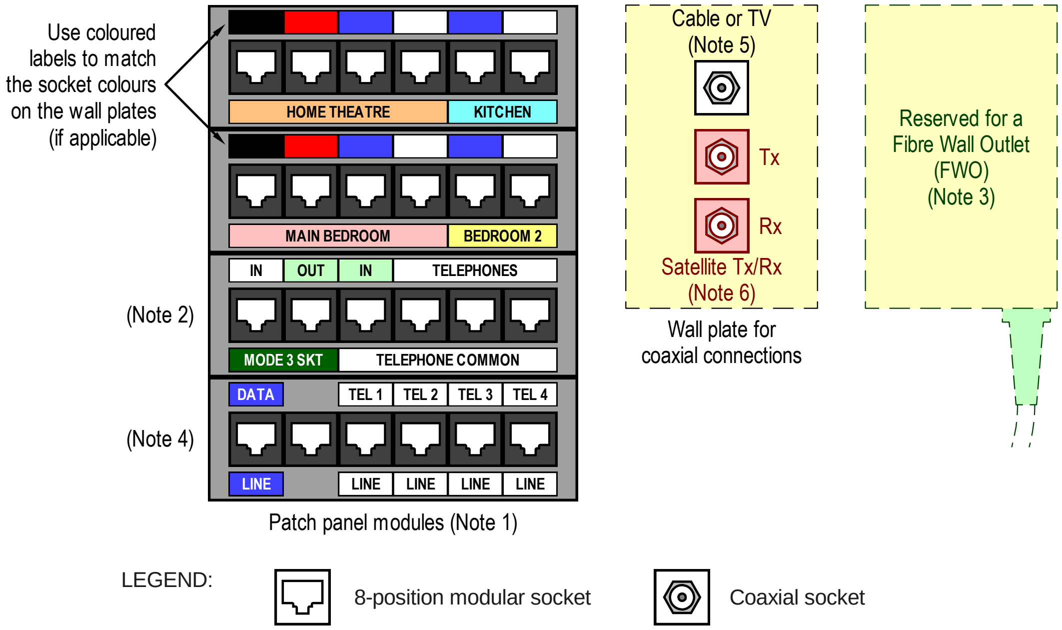


Notes:

1. If a Mode 3 device (such as a security alarm panel or a personal response system) is to be installed, extra sockets may be required on the wall plate. Refer to 10.4.7.4 on page 159 for details.
2. The Fibre Wall Outlet (FWO) is used for connection of the fixed optical fibre cable (from the outdoor PCD) to the indoor FTTP NTD fly lead. The carrier may not install an FWO but allowance should be made for one. The space required for the FWO and the NTD fly lead is slightly larger than the size of a standard wall plate.
3. Some FTTP NTDs have an RF port for the supply of free-to-air TV, community TV or pay TV. NBN Co NTDs do not supply RF services. If a coaxial socket and a modular socket are to be fitted one above the other on the same wall plate, position the coaxial socket **above** the modular socket so that the end-user will have suitable finger access to the retaining clip at the bottom of any modular plug connected to the modular socket.
4. Where an indoor FTTP NTD is used, the **Line in** sockets are not required because the FTTP services will be connected directly from the rear of the NTD or gateway to the relevant sockets on the patch panel.

IT'S HOW WE CONNECT

Figure 117 Typical CCP layouts for a standard home networking system using socket modules



Notes:

1. Some home networking boxes use modules that contain a bank of six sockets (as shown above) while others may use modules containing eight or more sockets. See Figure 98 (a) on page 123 for a typical proprietary home networking box. Some home networking boxes also provide a coaxial connector for connection of a cable modem/gateway.
2. If Mode 3 equipment (such as a security alarm panel or a personal response system) is to be installed, additional sockets may need to be allocated on the patch panel. Refer to 10.4.7.4 on page 159 for details.
3. The Fibre Wall Outlet (FWO) is used for connection of the fixed optical fibre cable (from the outdoor PCD) to the indoor FTTP NTD fly lead. The carrier may not install an FWO but allowance should be made for one. The space required for the FWO and the NTD fly lead is slightly larger than the size of a standard wall plate.
4. Where an indoor FTTP NTD is used, the **LINE** sockets are not required because the FTTP services will be connected directly from the rear of the NTD or gateway to the relevant sockets on the patch panel.
5. A separate coaxial connector may be required for connection of a cable modem/gateway (where HFC is available) or to connect the RF (coaxial) port of an indoor FTTP NTD to the fixed coaxial cabling (some FTTP NTDs have an RF port for the supply of free-to-air TV, community TV or pay TV). NBN Co NTDs do not supply RF services.
6. Most homes will not require access to satellite broadband. However, if satellite broadband will be used, the coaxial cables from the satellite dish may terminate on a separate wall plate adjacent to the patch panel for connection of the satellite gateway. Alternatively, this wall plate may be used for the NBN fixed wireless antenna connection, noting that this connection is a Category 5 modular connection, not coaxial (refer to 9.8.4 on page 120).

10.3.6.2 Additional TOs

If only one TO is to be provided in a bedroom, locate it next to the TV outlet.

Additional TOs are recommended for some rooms to provide additional connectivity, for example:

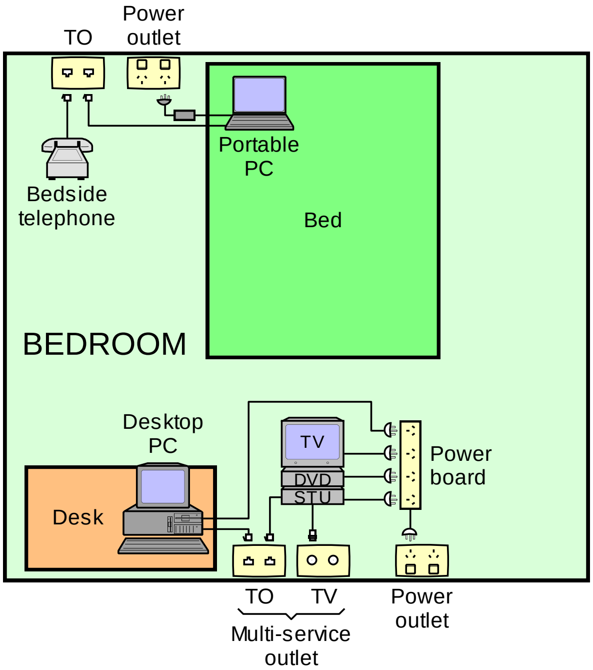
- Install one or two additional TOs in any room that may be used as a study or home office, for connection of additional lines or equipment such as a second telephone service, a fax machine or a network printer.
- Install an additional TO beside the bed in the master bedroom for connection of a telephone, internet radio or a portable (laptop/notebook) computer (see Figure 118).

Additional TOs may also be considered for the following locations:

- at the electrical switchboard for energy management (ensure that appropriate separation is maintained between the telecommunications and power cabling in accordance with the wiring rules)
- beside or behind the kitchen refrigerator for connection of an “Internet Fridge”
- in the laundry for connection of a “web-enabled” washing machine.

Figure 118 Two TOs installed on separate walls
(recommended for at least the main bedroom and any study or home office)

(a) Typical arrangement



(b) Typical multi-service outlet

Tip: If an F-connector and a modular socket are to be fitted one above the other on the same wall plate, position the F-connector **above** the modular socket so that the end-user will have suitable finger access to the retaining clip at the bottom of any modular plug connected to the modular socket.

Notes:

1. If the cabling budget is limited and this precludes the installation of two TOs in the room, **the TO should be installed next to the TV outlet** to support:
   - wired Ethernet connection of a desktop PC
   - wired Ethernet connection of a TV (IPTV), network media device or games console
   - connection of a pay TV set top unit (STU) to the internet or the telephone service for interactive pay TV.

   For homes with timber-framed cavity walls, cordless or wireless technology may provide suitable bedside access to the telephone or internet service.
2. Each TO should have at least two sockets. Consideration should be given to providing at least three data sockets near the TV to support high-definition audio/video streaming over the data cabling — refer to 10.8.6.5 (page 206).
3. For coaxial cabling guidelines, refer to 10.8 on page 193.

10.3.7 TV system cabling

Coaxial cabling systems (for TV cabling) are separate cabling systems to the data cabling system although they may share the same pathways, spaces and wall plates. For simplicity, coaxial cabling is described separately in this document.

Any HFC cabling (for “cable” internet and pay TV) must be totally separate to any TV antenna or satellite TV cabling. HFC cabling is star wired from a splitter or amplifier the external PCD.

TV antenna cabling may be star wired from:

- a splitter/amplifier located in the CCP enclosure;
- a separate enclosure to the CCP enclosure;
- the roof space; or
- a masthead amplifier.

Satellite TV cabling may be combined with TV antenna (“terrestrial TV”) cabling using a “multiswitch” from which the coaxial cabling may be star wired to the TV outlets (wall plates).

Refer to 10.8 on page 193 for coaxial cabling requirements.

10.3.8 Smart Wiring™

Consumers may wish to consider installing Smart Wiring™ by an accredited Smart Wired® installer to ensure that they have convenient access to all services. A typical Smart Wired® system will include data, telephone and TV cabling as described in this document but may also include integrated cabling for the following services:

- home theatre
- energy management
- security
- digital home health
- age and assisted living
- intelligent lighting and power.

Refer to the Smart Wired® web site www.smartwiredhouse.com.au for more information.

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® Registered trade mark of the International Copper Association Australia (ICAA)

10.4 CCP installation

10.4.1 CCP design

For a minimal cabling system described in 10.3.4 (page 125), the CCP may be as simple as a single wall plate with multiple sockets located next to the powered equipment, as shown in Figure 119. For a home networking system, the CCP may be a proprietary home networking box, such as the example shown in Figure 98 (a) on page 123, or it may be assembled using generic components such as standard electrical wall plates and modular sockets as shown in Figure 98 (b).

Figure 119 A typical NBN NTD installation with a CCP wall plate

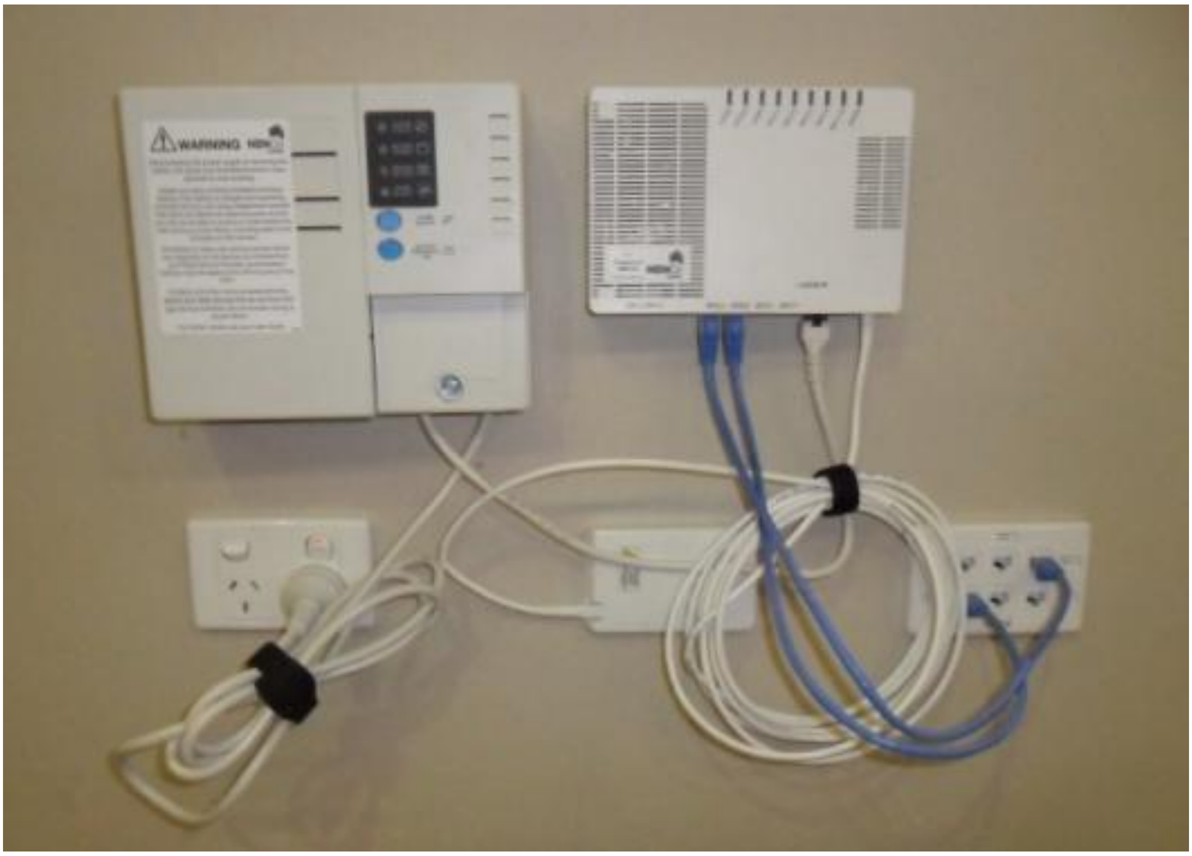


PHOTO COURTESY OF CLIPSAL BY SCHNEIDER ELECTRIC

Note: A gateway is required for a data service and has not been shown in the above photograph. The gateway may be located with the NTD or may be placed in another room (e.g. next to the PC). If the gateway is located with the NTD, the second socket of the power point shown above may be used to power the gateway.

10.4.2 CCP location

The CCP should be installed **inside the building** in a readily accessible location, preferably **within a 25 m cabling distance of the PCD**, i.e. the total length of any cable between the PCD and the CCP, including bends and curves, must not exceed 25 m if possible (refer to 10.3.3 on page 124).

Note: The **25 m** limit is to ensure that any coaxial cabling for HFC ("Cable") internet or DC power supply cabling for an outdoor FTTP NTD will be within specified limits. If it is certain that FTTP with an **indoor** NTD will be installed, the cabling distance should not exceed **40 m**.

The CCP must be readily accessible by the end-user, service provider and, if applicable, the carrier. Therefore it should be installed within the range of **350 mm** to **1800 mm** from the floor, i.e. no part of the CCP or any equipment located at the CCP should be outside that range (see Figure 80 and Figure 81).

The CCP does not need to be located in the centre of the home unless the home is so large that any cable between the CCP and any TO is likely to exceed a length of **50 m** or it is to house a central wireless (Wi-Fi) access point.

Note: A maximum length of 50 m is recommended to support future 10GBase-T Ethernet using Category 6 components and to ensure compatibility with some equipment that may use the data cabling for distribution of audio/video (A/V) signals from a TV appliance (see 10.8.6.5 on page 206).

The CCP should **not** be located within the **roof space** or any **underfloor space**.

The CCP should not be located within **1 m** of **likely sources of electromagnetic interference**, such as:

- an electrical switchboard or electricity supply meters
- any fluorescent light
- an electrical transformer of any description
- an electric motor or generator (e.g. ducted vacuum system motor, fixed electric drill, grinder or saw)
- any area where an arc welder may be used
- an air-conditioning unit
- a refrigerator or freezer
- a microwave oven
- an induction cooktop
- a television set
- loudspeakers.

Recommended locations for the CCP are a garage, utility room, study, walk-in robe or hall closet.

The CCP enclosure **should not be recessed into the cavity of an external wall**, as the cavity may be damp, which means the inside of the enclosure may be damp, and this may lead to corrosion of the CCP components. The enclosure may also be exposed to the entry of dust and debris from the roof space.

Note: Dust and debris may enter the CCP enclosure via cable entry holes and any other holes or gaps in the recessed portion of the enclosure. While it may be possible to seal these against the entry of dust and debris, this is virtually impossible to do for moist air. The enclosure may be installed on the surface of the internal wall but the cable entry holes to the wall cavity should be stopped to minimise the entry of humid air and debris from the cavity to the enclosure.

10.4.3 Space requirements

Sufficient space is required at the CCP location to provide:

- air circulation for the powered equipment;
- the required clearances to access the equipment and connections;
- the required separation distances between telecommunications and power cabling and sockets; and
- room to manipulate and accommodate the connecting cords (including spare cords).

10.4.4 CCP enclosure

The CCP should be installed in an enclosure that incorporates the following features:

- sufficient space to accommodate an indoor FTTP NTD and PSU, a fibre wall outlet, a gateway device and power supply, at least one double power point, a CCP and all connecting cords
- a cover to protect against the ingress of dust and accidental disturbance of cord connections (a lockable cover is recommended so that the CCP may be secured against unauthorised alterations)
- non-metallic construction (e.g. made of plastic or timber) if it is intended to house a wireless device
- provision for cords to enter the enclosure with the cover closed to provide for connection of any equipment located outside the enclosure, e.g. a Network-Attached Storage (NAS) device.

The enclosure may be an “off-the-shelf” product or constructed from timber fibreboard (e.g. as part of the home cabinetwork). A metallic enclosure is not recommended if it is intended to house a wireless gateway unless a separate wireless access point will be provided in accordance with 10.6 (page 189).

An enclosure with the following minimum **internal** dimensions is recommended to allow the enclosure (whether made from plastic, metal or fibreboard) to fit between timber studs spaced at 450 mm centres:

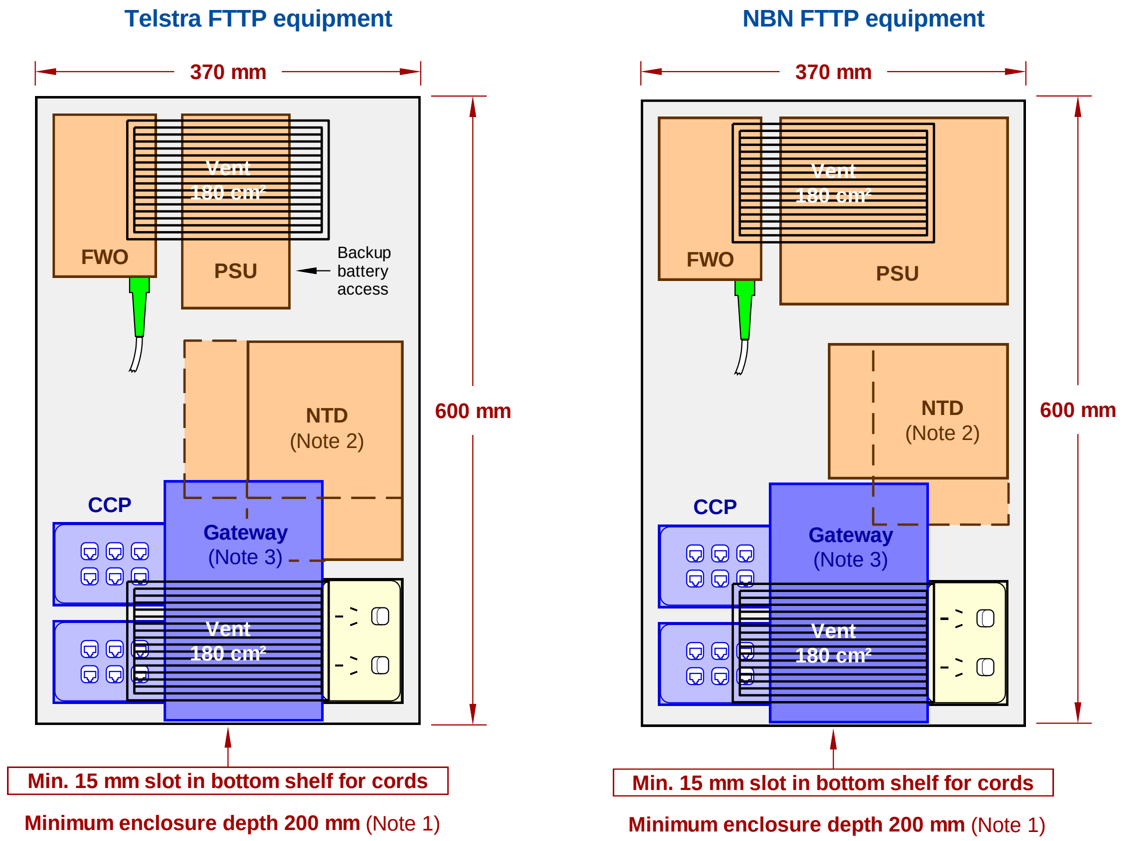
- 370 mm wide
- 600 mm high
- 200 mm deep.

Any enclosure intended to house any **powered equipment** must be **vented**.

Refer to Figure 120.

Examples of CCP enclosures are pictured in Figure 121, Figure 122 and Figure 123.

Figure 120 Minimum CCP enclosure dimensions and typical equipment arrangements (worst-case scenario — FTTP)



FWO = Fibre Wall Outlet NTD = Network Termination Device PSU = Power Supply Unit

Notes:

1. The internal depth of the enclosure should be at least 200 mm.
2. The Telstra NTD may be mounted in either horizontal or vertical orientation. The NBN Co NTD is normally mounted horizontally.
3. Vents providing at least 180 cm² of ventilation (e.g. 180 mm x 100 mm) are required at the top and bottom of the enclosure door. A cord access slot should be provided in the bottom of the enclosure for connection of external devices (e.g. a NAS) or for power cord entry where the power point is outside the enclosure.
4. The service provider’s gateway may stand vertically on the bottom shelf in front of the other equipment.

Figure 121 A typical NBN NTD installation with a small prefabricated CCP enclosure

PHOTO COURTESY OF CLIPSAL BY SCHNEIDER ELECTRIC

Note: In the above example, the CCP and the gateway are installed in an enclosure whereas the NBN equipment is mounted on the wall beside it.

Figure 122 A prefabricated plastic CCP enclosure designed to house NBN equipment

PHOTO COURTESY OF CLIPSAL BY SCHNEIDER ELECTRIC

Note: The dimensions of the above enclosure are 740 mm high x 400 mm wide x 145 mm deep.

Figure 123 An example of a custom-made CCP enclosure (using laminated fibreboard)

Note: This type of enclosure may be incorporated in the cabinetwork inclusions for a new home.

10.4.5 Access and labelling

As the intention is for the end-users (home occupants) to interconnect the services and equipment at the CCP, it is important that:

- the CCP can be easily and safely accessed;
- the CCP sockets are arranged logically; and
- the CCP sockets are clearly labelled so that an end-user can readily identify the incoming services and associate the CCP sockets with the corresponding TO sockets.

Typical CCP socket arrangements are shown in 10.3.4 to 10.3.6 (pages 125 to 145).

A plan of the building, showing the location of all outlets, the cabling pathways and any access holes, should be left in the CCP enclosure.

10.4.6 Safety requirements

It is a requirement of Australian Standard AS/CA S008, *Requirements for customer cabling products*, and Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)* that customers must not be able to touch any cable terminations or earthing terminals without the need to use a tool to access them. Accordingly, all cable connections must be made behind the face of any wall plate or patch panel or must be shrouded by a cover that is only removable by the use of a tool.

10.4.7 Wiring of CCP sockets

10.4.7.1 General

The CCP is usually configured by the installer on site and may be wired in many different ways. A voice service or port may be physically connected to two or more telephones (or equivalent). However, a data service or port must be physically connected to **only one** device. Where a data service is to be shared, this must be achieved electronically via a gateway, router or Ethernet switch.

10.4.7.2 Incoming services from the NTD

10.4.7.2.1 ADSL

At least two data cables are required between the NTD and the CCP — one for the ADSL service and one for the telephone service(s). The ADSL service should be wired via a central filter to a single socket at the CCP to which the ADSL modem/gateway may be connected. The central filter may be located in either the outdoor NTD or at the CCP (refer to Figure 11 and Figure 12 on page 22). However, a central filter located at the CCP (or between the NTD and the CCP) will need to be removed and the CCP rewired if the ADSL NTD is subsequently replaced by an outdoor FTTP NTD. For this reason, it is recommended that the filter be installed in the ADSL NTD.

If the central filter is not located at the NTD, it should be installed in a readily accessible location for repair or replacement and should **not** be installed in the roof space or in a wall cavity.

For a list of certified central filters (“remote splitters”) for installation on the customer side of the NTD, go to http://www.telstra.com.au/adsl/equipmnt.htm.

The Ethernet port(s) on the modem/gateway may be connected to the CCP socket(s) for the relevant TO(s) or to another Ethernet device at the CCP, such as a router or switch, to provide multiple user access to the internet.

Refer to Figure 124.

10.4.7.2.2 HFC

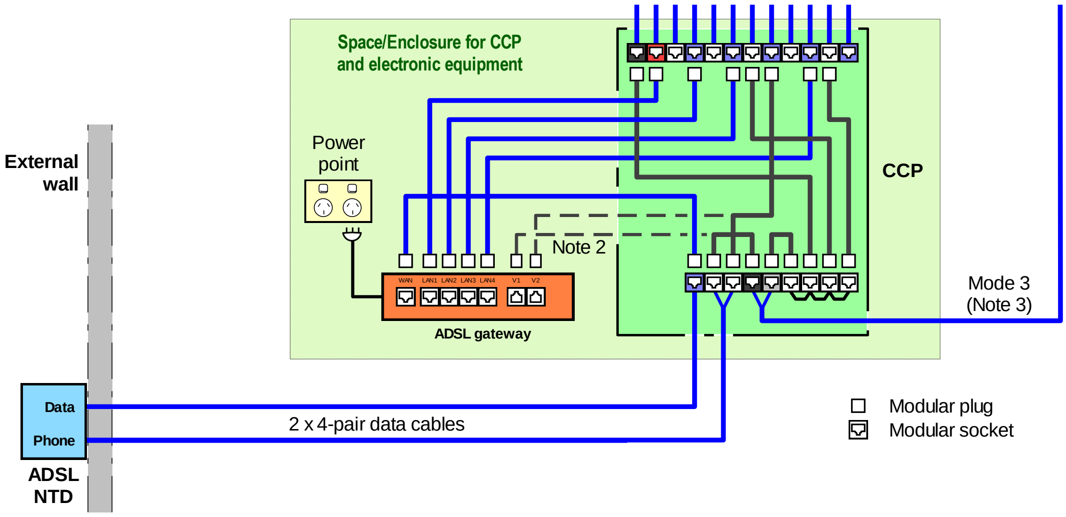
An HFC (“Cable”) service should be cabled from the outdoor PCD (isolation box) to a single F-connector at the CCP to which the cable modem/gateway may be connected. The Ethernet port(s) on the modem or gateway may then be patched directly to the CCP socket(s) for the relevant TO(s) or to another Ethernet device at the CCP, such as a router or switch, to provide multiple user access to the internet.

If a **pay TV service** (e.g. FOXTEL) is required, this must be cabled directly from the splitter in the outdoor PCD (isolation box) to the wall plate where the set top unit will be located (e.g. the entertainment centre) and **must not be cabled to the CCP**.

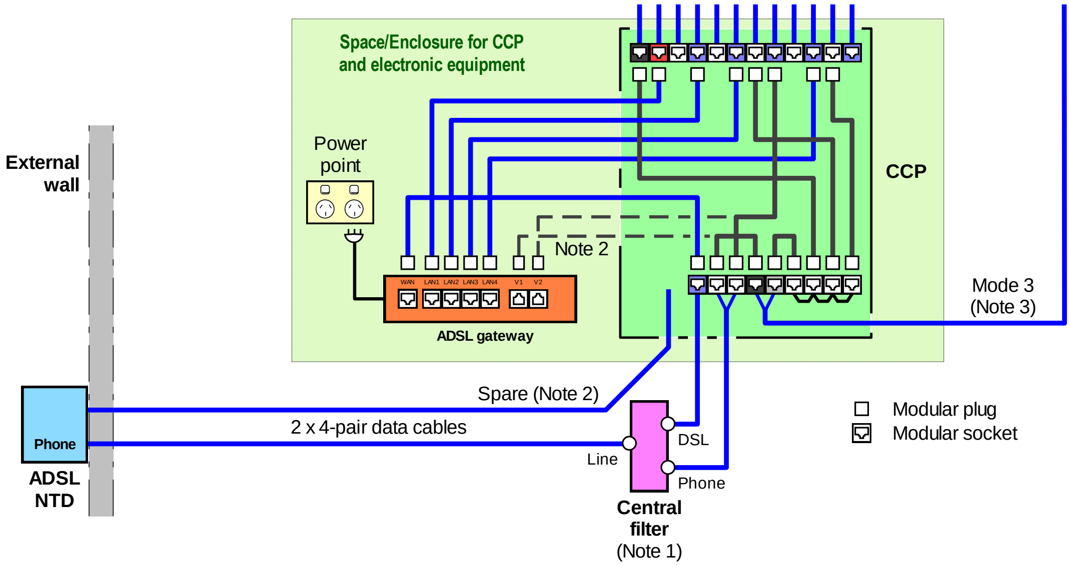
Refer to Figure 125.

Figure 124 Connection of an ADSL service at the CCP

(a) Central filter located at the outdoor NTD



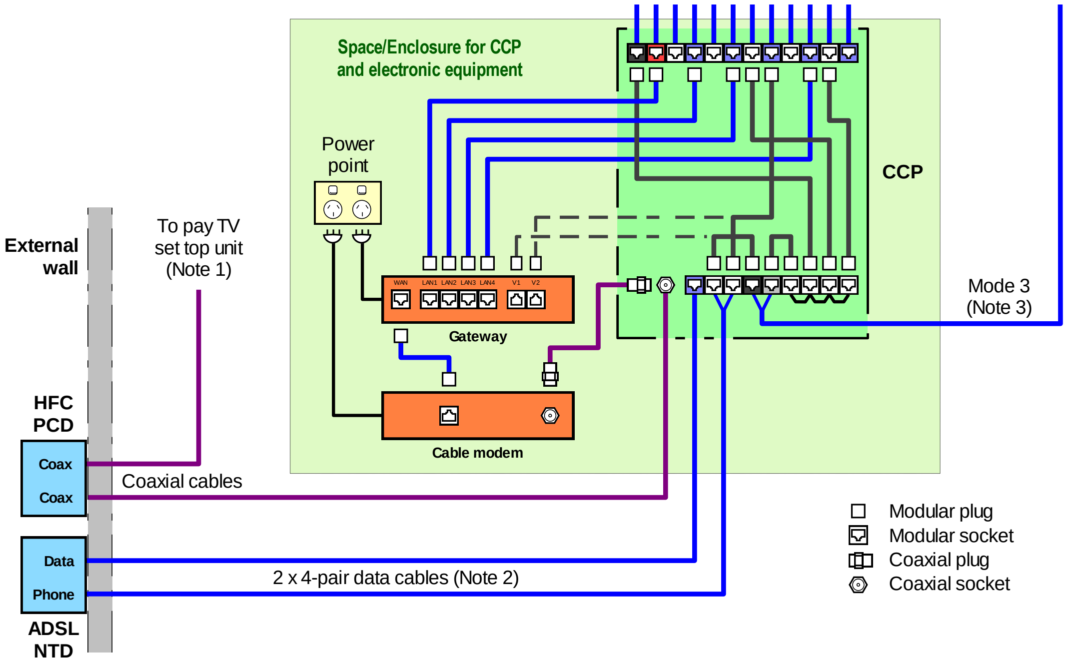
(b) Central filter located at the CCP



Notes:

1. The DSL central filter may be located in the NTD as shown in (a) or at the CCP as shown in (b) (see Figure 11 and Figure 12 on page 22). For a list of certified filters/splitters for installation on the customer side of the NTD, refer to the Telstra website at http://www.telstra.com.au/adsl/equipmnt.htm. A central filter located at the CCP (or between the NTD and the CCP) will need to be removed and the CCP rewired if the ADSL NTD is subsequently replaced by an outdoor FTTP NTD. For this reason, it is recommended that the filter be installed in the ADSL NTD.
2. At least two data cables should be provided between the NTD and the CCP — one for the ADSL service and one for the telephone service(s) — whether or not the ADSL central filter is located at the NTD or the CCP. This is essential for full compatibility with FTTP, i.e. in case an outdoor FTTP NTD is subsequently installed to replace the ADSL NTD (refer to Figure 126).
3. If a Mode 3 connection is required, refer to 10.4.7.4 on page 159.

Figure 125 Connection of an HFC ("cable") broadband service and, optionally, telephone and ADSL at the CCP



Notes:

1. A single coaxial cable is required between the PCD (isolation box) and an F-connector at the CCP for connection of the HFC ("Cable") gateway. If a pay TV service (e.g. FOXTEL) is required, this must be cabled directly from the splitter in the PCD to the wall plate that is to be used for connection of the set top unit and must **not** be cabled to the CCP.
2. Two data cables should be installed between the outdoor NTD and the CCP to support:
   - the supply of telephone and optional ADSL services (unlike HFC, ADSL can usually be supplied by multiple service providers); and
   - a possible, future, outdoor FTTP NTD (e.g. NBN).
3. If a Mode 3 connection is required, refer to 10.4.7.4 on page 159.

10.4.7.2.3 FTTP

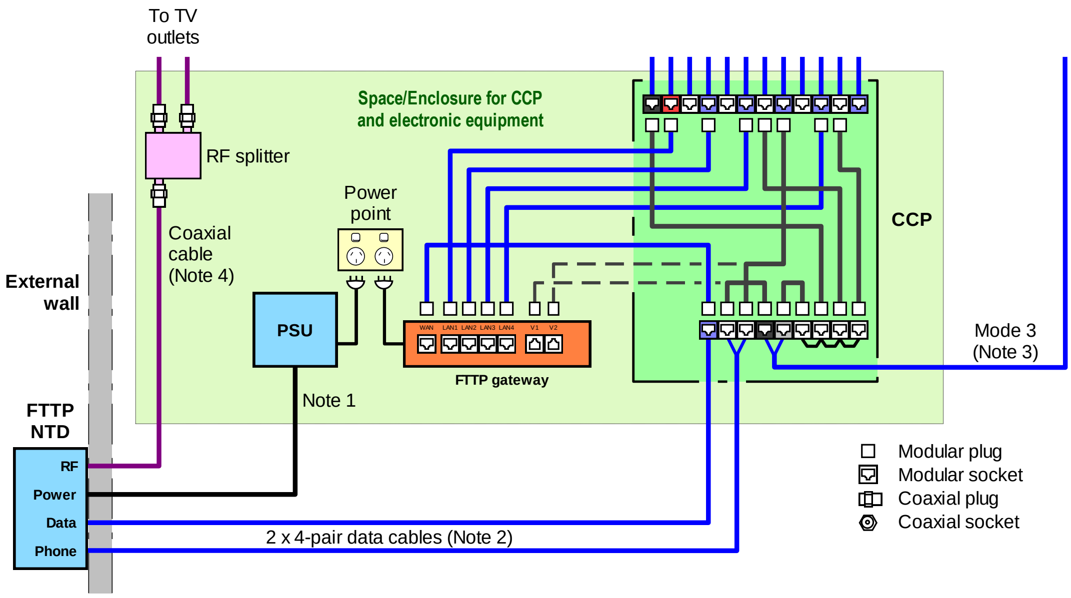
The data service from an FTTP NTD is Ethernet, not ADSL.

The data service from an **outdoor** FTTP NTD should be cabled directly to a single socket at the CCP for connection to the gateway. At least two data cables are required between the NTD and the CCP — one for the Ethernet service and one for telephone services. Refer to Figure 126.

No fixed cabling is required between an **indoor** FTTP NTD and the CCP unless the NTD will be located in a different room to the CCP (not recommended). With an indoor FTTP NTD, the services are presented on modular (RJ) sockets on the rear of the NTD and these will be connected directly to the gateway or to sockets on the CCP for the relevant TO(s) using connecting cords ("fly leads") or "patch cords" as shown in Figure 127. If the FTTP NTD is not located at the CCP, the service ports may be extended to the CCP via fly leads or patch cords to fixed cabling in accordance with the same principle as shown in Figure 82 (page 110). At least three data cables should be provided for this purpose — one for a data service (Ethernet), one for a telephone service and one for either a second data service (Ethernet) or a second telephone service.

To ensure that consumers can legally make or alter connections to the NTD ports, fixed cabling must **not** be connected directly to the sockets of an indoor FTTP NTD — the services should only be connected via A-ticked fly leads or patch cords to fixed sockets on which the fixed cabling is connected (refer to 10.4.8.5 on page 173 for an explanation of the legal issues).

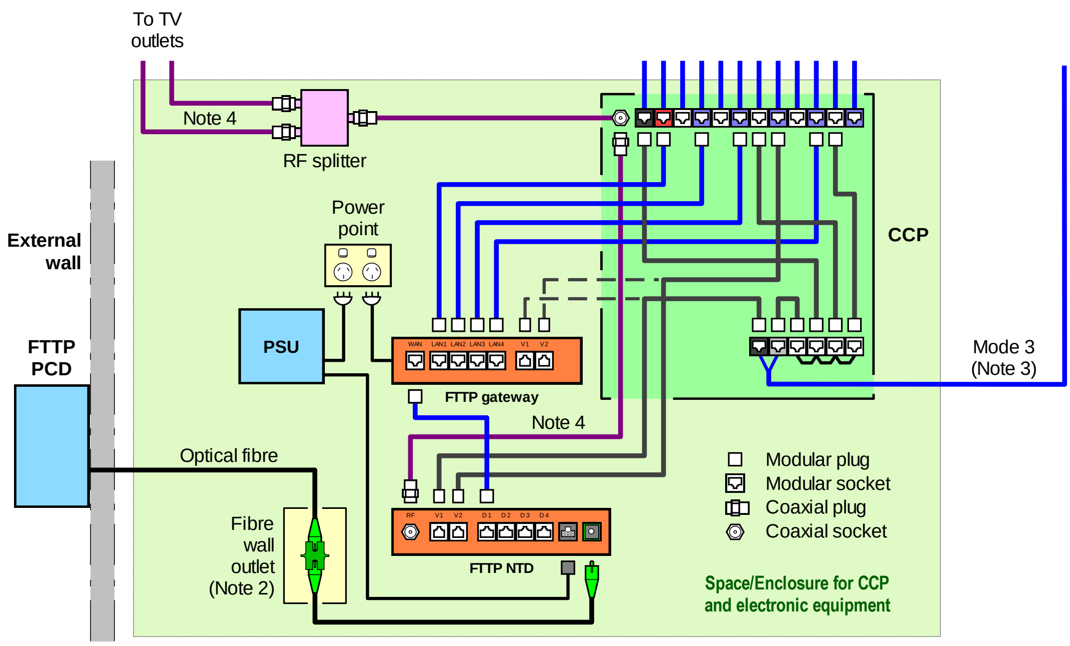
Figure 126 Connection of FTTP services at the CCP (outdoor NTD)



Notes:

1. A special multi-core DC power cable is required between the outdoor NTD and the indoor PSU.
2. At least two data cables should be provided between the NTD and the CCP — one for telephone services and one for data (the data service from the FTTP NTD is Ethernet, not ADSL).
3. If a Mode 3 connection is required, refer to 10.4.7.4 on page 159.
4. Coaxial cabling will also be required if the NTD supports RF TV distribution.

Figure 127 Connection of FTTP services at the CCP (indoor NTD)



Notes:

1. Other than the optical fibre cable between the PCD and the FTTP NTD (which is installed by the carrier), no fixed cabling is required to connect the services at the CCP. The services are connected from the NTD via connecting cords (“fly leads”) or patch cords to the gateway or directly to the CCP sockets for the relevant TOs.
2. The carrier may not use a fibre wall outlet. However, allowance should be made for one to be installed.
3. If a Mode 3 connection is required, refer to 10.4.7.4 on page 159.
4. Coaxial cabling will also be required if the NTD supports RF TV distribution.

10.4.7.2.4 Satellite

The coaxial cables from the satellite dish must be cabled directly to F-connectors on a wall plate for connection of the satellite gateway/NTD. If the gateway/NTD can be located at the CCP, the Ethernet port of the gateway/NTD may be connected directly to the appropriate TO or to another Ethernet device (such as a wireless router) using a connecting cord ("fly lead") or patch cord, in the same way as shown in Figure 127 for FTTP services; otherwise the Ethernet port may be extended to the CCP via a via a fly lead or patch cord to fixed cabling in accordance with the same principle shown in Figure 82 (page 110).

Remember not to confuse satellite broadband with satellite TV — these use different satellites, operate at difference frequency bands and require different satellite dishes. Satellite TV can be combined with other TV services (using a "multiswitch") but satellite broadband cannot.

10.4.7.2.5 3G/4G wireless

If the 3G/4G gateway/NTD can be located at the CCP, the services appear on modular (RJ) sockets on the rear of the gateway/NTD and these will be connected directly to CCP sockets for the relevant TO(s) or to other powered equipment using connecting cords ("fly leads") or patch cords, in the same way as shown in Figure 127 for FTTP services. If the 3G/4G gateway/NTD is not located at the CCP, the service ports may be extended to the CCP via fly leads or patch cords to fixed cabling in accordance with the same principle shown in Figure 82 (page 110).

10.4.7.3 Telephone service connections

To maximise CCP flexibility and to reduce the risk of damage to any VOIP equipment or electric shock to end-users from telecommunications network voltages when using VOIP equipment, it is important that:

- any **telephone line** from the NTD is only terminated on **one socket** at the CCP; and
- multiple telephone/VOIP service connections are facilitated via a separate "PHONE COMMON" patch field.

Refer to Figure 128 (a).

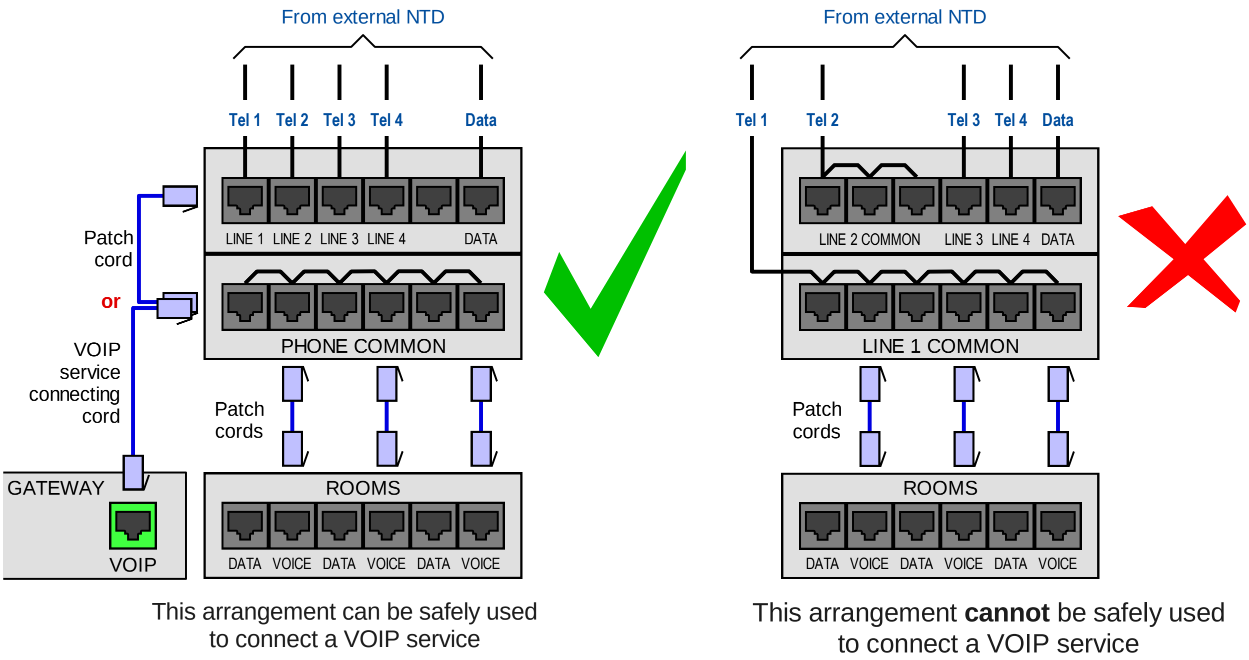
In addition, to avoid potential problems with any telephone equipment that has extra cord conductors connected to circuitry inside the equipment (such as answering machines or fax machines designed for optional "Mode 3" connection — see 10.4.8.6 on page 174), it is important that:

- only **one pair** of the connecting cable from the NTD is terminated on the **telephone socket** as shown in Figure 128 (b); and
- sockets used to facilitate **multiple telephone/VOIP service connections** are interconnected via a **single pair** of conductors as shown in Figure 128 (c).

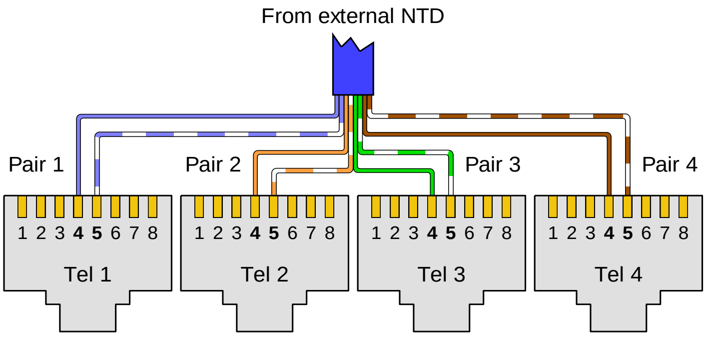
Some VOIP gateways allow for a conventional ("landile") telephone service to be connected as a "fallback" service on power failure or to catch any incoming calls from the Public Switched Telephone Network (PSTN). In such cases, the incoming telephone line will be patched to a port on the VOIP gateway and the VOIP service will be patched to the PHONE COMMON patch field for patching to the relevant TOs. Refer to Figure 129.

Figure 128 How to wire the CCP for connection of telephone services

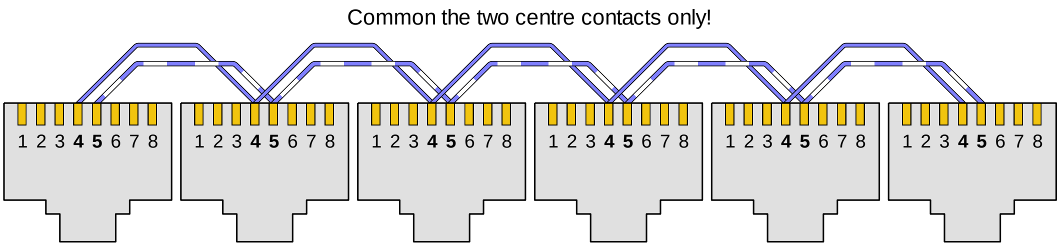
(a) Facilitating multiple voice (telephone/VOIP) service connections (Note 1)



(b) Wiring of the telephone sockets (Note 2)



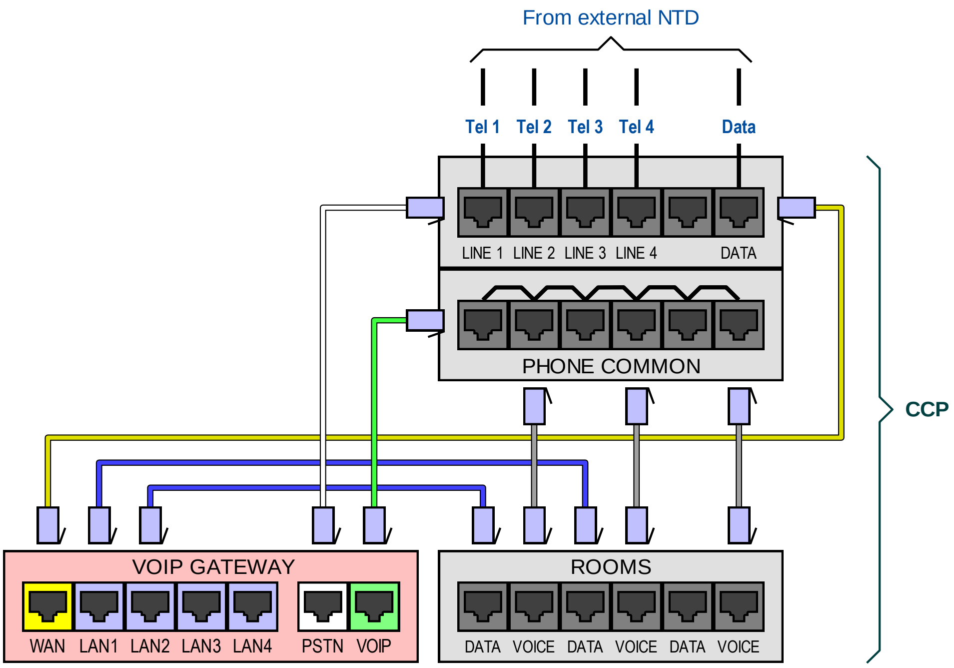
(c) Wiring of the PHONE COMMON patch field sockets (Notes 2 and 3)



Notes:

1. For safety and technical reasons, it is essential that any telephone wiring from the carrier's telecommunications network can be easily isolated from any VOIP equipment (e.g. by removing a patch cord).
2. To avoid problems with certain types of telephone equipment that may have more than two cord conductors, it is important to only connect the two centre contacts of any telephone/VOIP sockets — see 10.4.8.6 on page 174.
3. Most insulation displacement connectors (IDCs) will only reliably terminate one conductor in each slot. Loop the conductors through the IDCs of the intermediate sockets — do **not** terminate two conductors in the same slot. Do not use "off-the-shelf" socket modules that common more than the two centre contacts of the socket together.

Figure 129 Connecting a PSTN line and a VOIP service via a VOIP gateway with PSTN fallback



Note: If a Mode 3 connection is required, refer to 10.4.7.4. In such cases, the line from the outdoor NTD will be connected to the Mode 3 TO first, then to the PSTN port of the VOIP gateway, and then the VOIP port of the VOIP gateway will be connected to the PHONE COMMON.

10.4.7.4 "Mode 3" and "Mode 5" connections

10.4.7.4.1 Description

Many homes will have a requirement to connect customer equipment that, when triggered, isolates all other customer equipment from the telephone line and then automatically dials a programmed telephone number (e.g. to raise an alarm). Common examples of such equipment are monitored security alarm systems and personal response (emergency call) systems. Examples of other customer equipment that may use this connection arrangement to prevent accidental disruption of a call in progress from other equipment connected to the same line are dial-up computer modems, fax machines and telephone answering machines.

This connection arrangement is called "Mode 3" or "Mode 5". Mode 3 and Mode 5 connection arrangements are illustrated in Figure 130. Mode 5 is rarely used and is easily adaptable from Mode 3 (as described in Figure 130), so only Mode 3 is mentioned in this document henceforth.

In order for Mode 3 equipment to have connection priority over the other connected equipment, it must be the first equipment connected to the telephone line.

10.4.7.4.2 Minimal cabling system

For a **minimal cabling system**, all TOs should be star wired from the CCP to support possible future wiring alterations or upgrading of the cabling system. The Mode 3 TO should be wired in accordance with 10.4.7.4.3 (b) or (c). However, each of these arrangements will require the use of at least one extra patch cord, which may confuse some end-users. To avoid such confusion, one of the following arrangements may be preferable for aged or infirm customers (e.g. in aged-care living units):

- If the services are supplied from an **outdoor** NTD, the Mode 3 TO may be wired per Figure 131.
- If the services are supplied from an **indoor** NTD, the Mode 3 TO may be wired per Figure 132.

10.4.7.4.3 Home networking systems

For a **home networking system**, there are three ways to cable a Mode 3 connection:

(a) Where the telephone service is supplied via an outdoor NTD, the Mode 3 TO may be hard-wired in accordance with Figure 133. This is the most secure method (i.e. the Mode 3 equipment is not susceptible to accidental or deliberate disconnection at the CCP) but it is not suitable for services supplied from an indoor device such as an FTTP NTD or a VOIP gateway. Therefore, it is **not recommended** for new home cabling installations. Use either (b) or (c) described below.

(b) Where the telephone service is supplied from an indoor device such as an FTTP NTD or a VOIP gateway and there will be a dedicated Mode 3 TO (e.g. for a fixed security alarm panel), the Mode 3 TO may be wired in accordance with Figure 134. This method may also be used for a telephone service supplied from an outdoor NTD, so it is useable for all telecommunications network technologies.

(c) Where the telephone service is supplied from an indoor device such as an FTTP NTD or a VOIP gateway and a Mode 3 connection may be required at any TO (e.g. for future connection of a security alarm panel or a personal response system), “Mode 3 adaptor” sockets may be provided at the CCP in accordance with Figure 135 to enable any TO to be used for a Mode 3 connection. This method may also be used for a telephone service supplied from an outdoor NTD, so it is useable for all telecommunications network technologies.

Method (b) or method (c) is recommended for home networking systems. However, clear labelling of the CCP sockets and the connecting cords is important to reduce the risk of accidental disconnection of the Mode 3 equipment.

10.4.7.4.4 Connecting more than one Mode 3 device

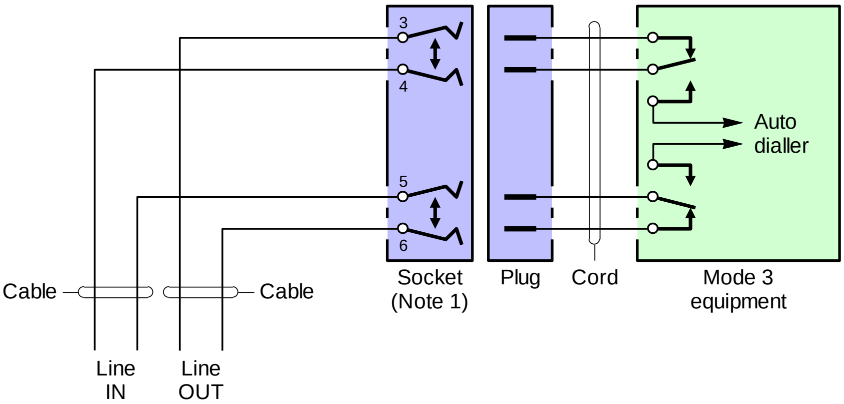
Two or more Mode 3 sockets may be connected in tandem using any of the cabling methods described in 10.4.7.4.2 and 10.4.7.4.3, e.g. for connection of both a security alarm panel and a personal response system. Figure 136 on page 167 shows two Mode 3 sockets cabled in accordance with method (b) and method (c) described in 10.4.7.4.3.

WARNING: Mode 3 or Mode 5 connections on VOIP ports.

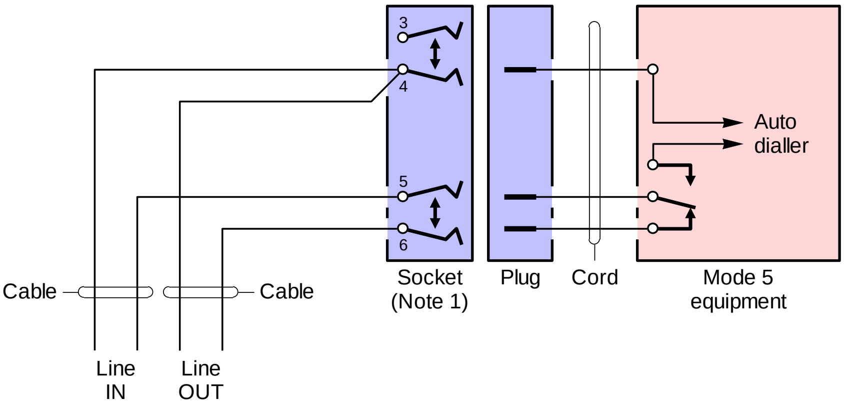
Critical Mode 3 or Mode 5 equipment (such as security alarms and personal response systems) normally have battery backup so that they will operate during power failure (e.g. a blackout). However, VOIP gateways do not usually have battery backup and they will not work on power failure unless they are powered from a separate UPS (Uninterruptible Power Supply). While the PSU from an FTTP NTD may have a backup battery, this will only maintain operation of the FTTP NTD during power failure (and usually only the first telephone service on that NTD), not any gateway connected to it.

Figure 130 Mode 3 and Mode 5 connection arrangements using 8P modular sockets

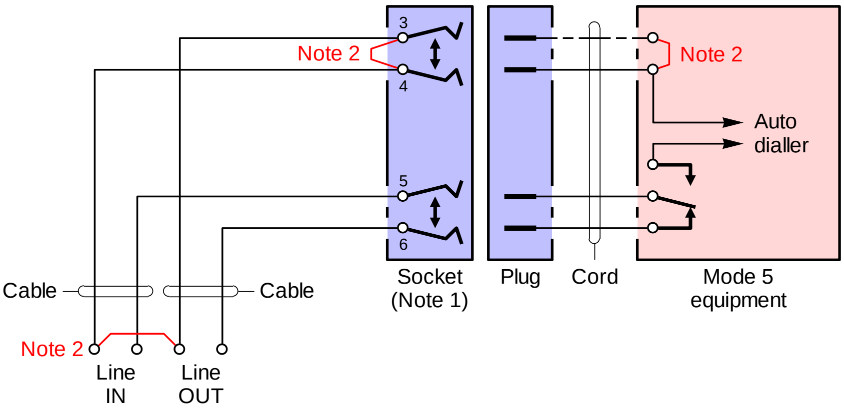
(a) Mode 3 connection arrangement



(b) Mode 5 connection arrangement (Mode 5 is less common than Mode 3)



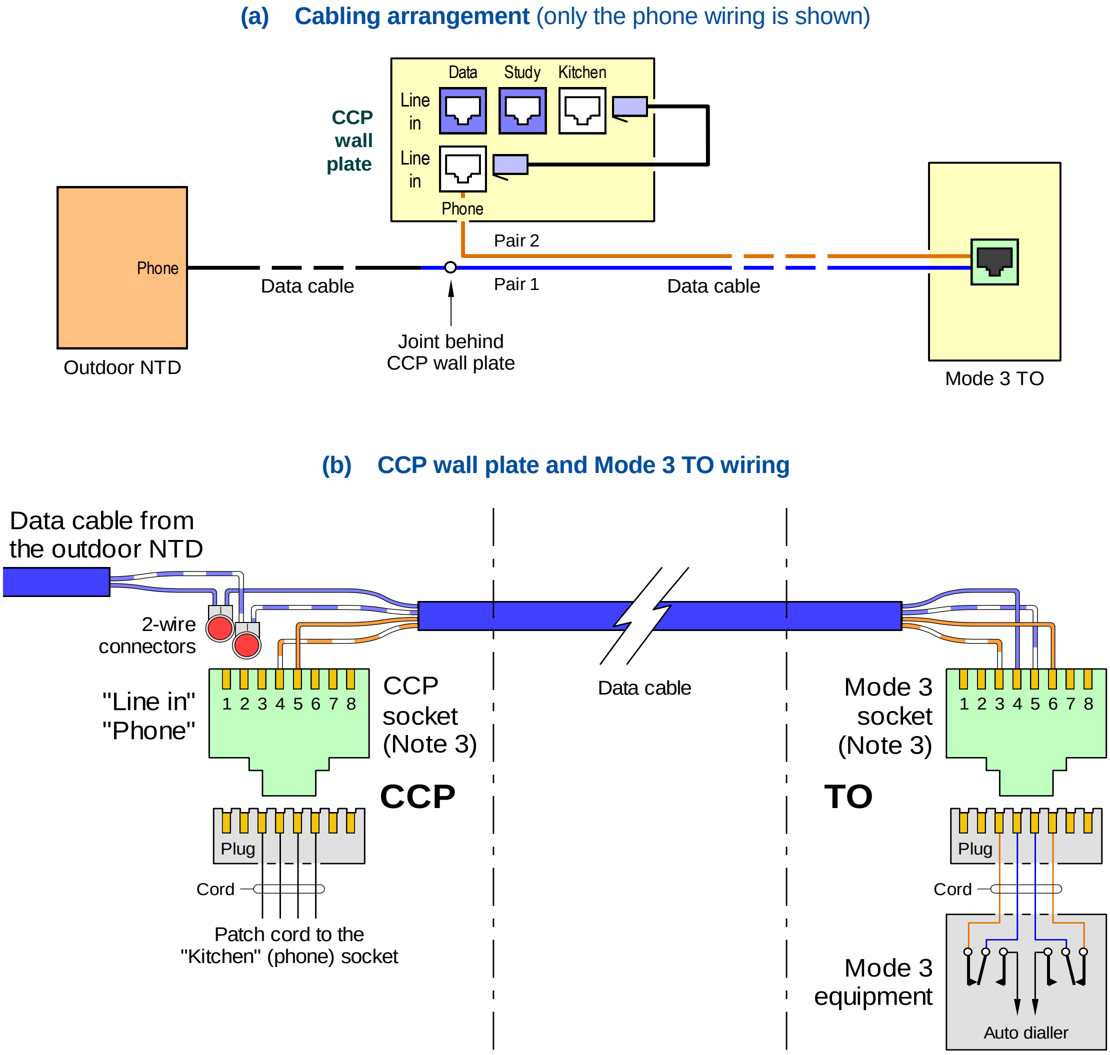
(c) Adapting Mode 5 equipment to a Mode 3 connection (Note 1)



Notes:

1. With a Mode 3 or Mode 5 connection, the auto-dialling equipment takes priority over the line and disconnects all other telephone equipment when the unit is activated. If a special “switching” type socket is used as shown in the above diagrams, the line will be automatically connected through if the Mode 3/Mode 5 equipment is unplugged.
2. Generic cabling should only provide for Mode 3 connections, Mode 3 being more commonly used. Where Mode 5 equipment is to be connected to a socket wired as Mode 3, a strap or link should be provided in the customer equipment to bridge the connection between contacts 3 and 4 of the socket or, if the equipment only has three cord conductors, a strap or link should be provided at the CCP (first preference) or the TO (second preference).

Figure 131 Minimal cabling system — Mode 3 wiring from the CCP wall plate for an outdoor ADSL/FTTP NTD only (not recommended)

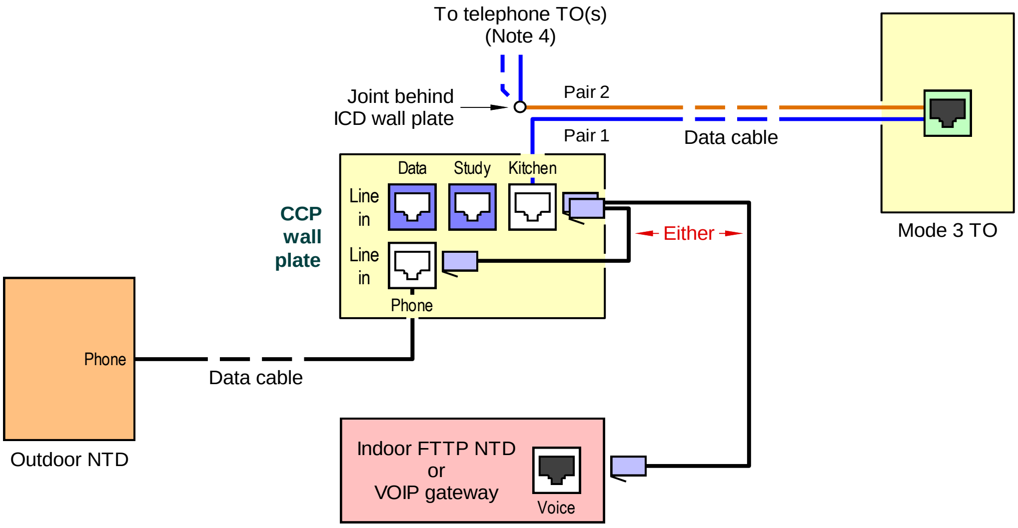


Notes:

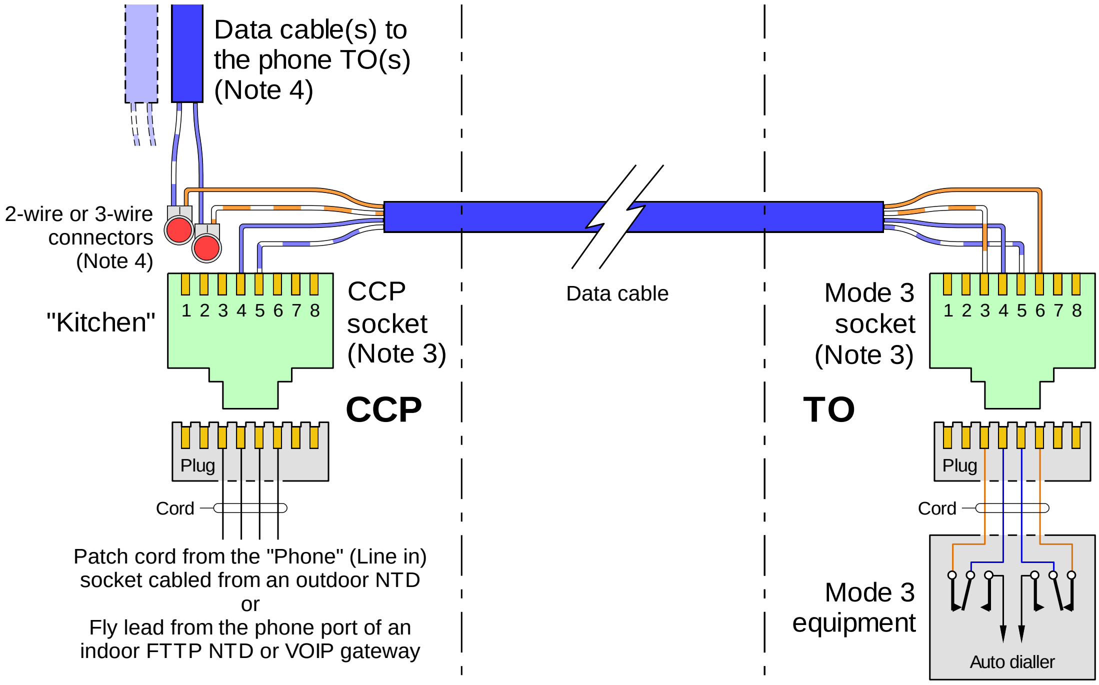
1. The above wiring arrangement is not compatible with all telecommunications network technologies and it lacks flexibility if no Mode 3 equipment is to be connected or is subsequently disconnected. Either of the arrangements described in 10.4.7.4.3 (b) or (c) is recommended but these require the use of at least one additional patch cord, which may confuse some end-users. To avoid such confusion, the arrangement shown above (for an **outdoor** NTD **only**) or in Figure 132 (for either an **indoor** or **outdoor** NTD) may be preferable for aged or infirm customers.
2. The Mode 3 socket will need to be rewired at the CCP in accordance with Figure 132, Figure 134 or Figure 135 if an indoor FTTP NTD is subsequently installed (e.g. future service migration to the NBN). The CCP sockets will also need to be rewired if Mode 3 equipment ends up not being connected or is subsequently disconnected.
3. The **Mode 3 TO socket** terminations should comply with the colour code described in Figure 150 and Table 6 on page 185. However, the **CCP socket** should be terminated as shown above (colour and mate reversed) to maintain the same line polarities at each socket.
4. The CCP wall plate designations correspond to the minimal cabling system described in 10.3.4 (page 125).

Figure 132 Minimal cabling system — Mode 3 wiring from the CCP wall plate for an indoor FTTP NTD or VOIP gateway or an outdoor ADSL/FTTP NTD

(a) Cabling arrangement (only the phone wiring is shown)



(b) CCP wall plate and Mode 3 TO wiring

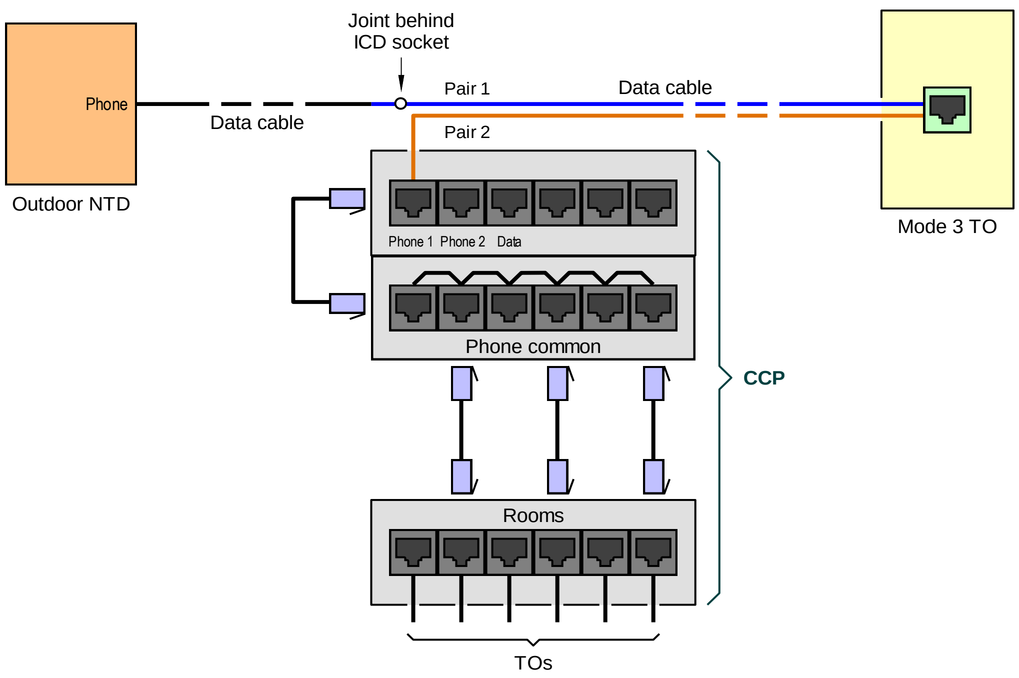


Notes:

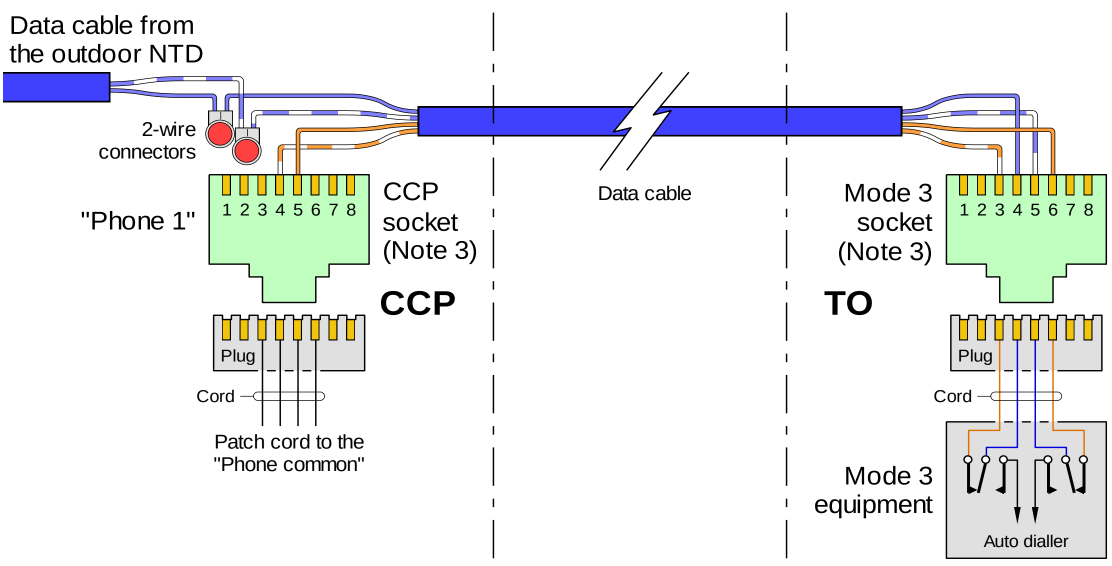
1. While the above wiring arrangement is compatible with all telecommunications network technologies, it lacks flexibility if no Mode 3 equipment is to be connected (see Note 2). Either of the arrangements described in 10.4.7.4.3 (b) or (c) is recommended but these require the use of at least one additional patch cord, which may confuse some end-users. To avoid such confusion, the arrangement shown above (for an **indoor** FTTP NTD) or in Figure 131 (for an **outdoor** ADSL or FTTP NTD) may be preferable for aged or infirm customers.
2. The CCP sockets may need to be rewired if Mode 3 equipment ends up not being connected or is subsequently disconnected.
3. The **Mode 3 TO socket** terminations should comply with the colour code described in Figure 150 and Table 6 on page 185. However, the **CCP socket** should be terminated as shown above (colour and mate reversed) to maintain the same line polarities at each socket.
4. An additional phone TO may be connected at the CCP socket using 3-wire connectors.
5. The CCP wall plate designations correspond to the minimal cabling system described in 10.3.4 (page 125).

Figure 133 Home networking system — Mode 3 wiring from the CCP for an outdoor ADSL/FTTP NTD only (not recommended)

(a) Cabling arrangement (only the phone wiring is shown)



(b) CCP and TO wiring

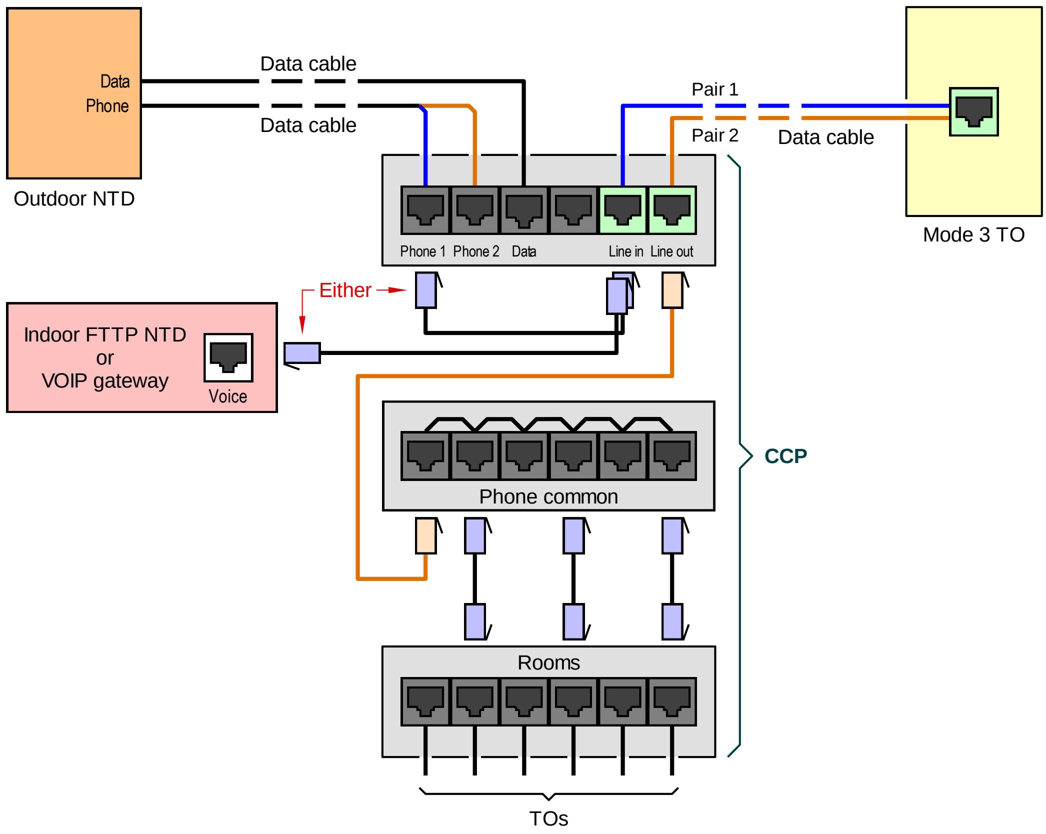


Notes:

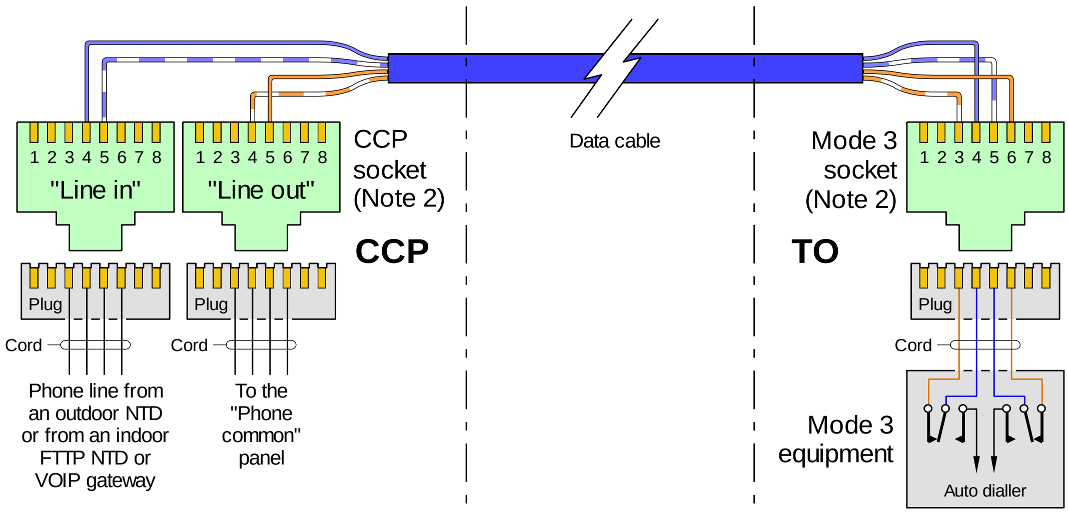
1. This wiring method is useable for a 2-wire telephone line from an **outdoor** ADSL/FTTP NTD **only**. It is not compatible with services supplied from an indoor device such as an indoor FTTP NTD or a VOIP gateway. For this reason, it is **not recommended** for new home cabling installations.
2. The Mode 3 socket will need to be rewired at the CCP in accordance with Figure 134 or Figure 135 if an indoor FTTP NTD is subsequently installed (e.g. future service migration to the NBN).
3. The **Mode 3 TO socket** terminations should comply with the colour code described in Figure 150 and Table 6 on page 185. However, the **CCP socket** should be terminated as shown above (colour and mate reversed) to maintain the same line polarities at each socket.

Figure 134 Home networking system — dedicated but patchable Mode 3 wiring from the CCP for an outdoor or indoor NTD (or an indoor VOIP gateway)

(a) Connection method for a dedicated Mode 3 TO



(b) CCP wiring for connection of a dedicated Mode 3 TO

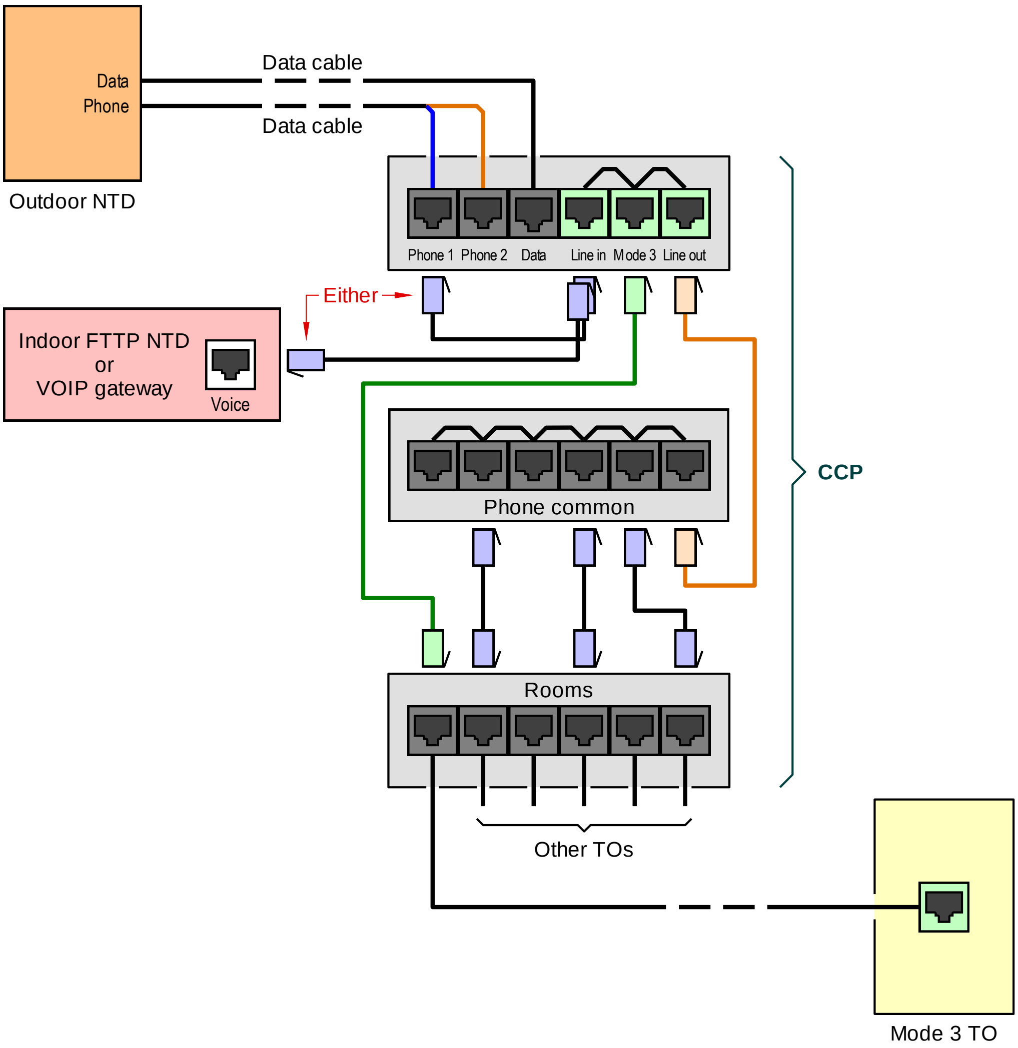


Notes:

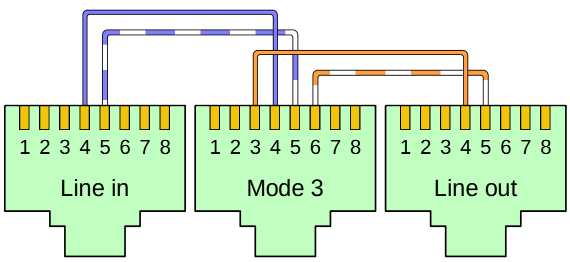
1. This wiring method may be used for a TO specifically assigned to connection of Mode 3 equipment (such as a security alarm panel or a personal response system) and is useable for a 2-wire telephone line from an **outdoor** ADSL/FTTP NTD or an **indoor** FTTP NTD or VOIP gateway (i.e. it is “NBN compatible”).
2. The **Mode 3 socket** terminations should comply with the colour code described in Figure 150 and Table 6 on page 185. However, the **CCP sockets** should be terminated as shown above (orange conductor and mate reversed) to maintain the same line polarities at each socket.

Figure 135 Home networking system — wiring of Mode 3 adaptor sockets at the CCP for an outdoor or indoor NTD (or an indoor VOIP gateway) to connect Mode 3 equipment at any TO

(a) Connection method for Mode 3 equipment using Mode 3 adaptor sockets



(b) Mode 3 adaptor sockets wiring at the CCP (Note 2)

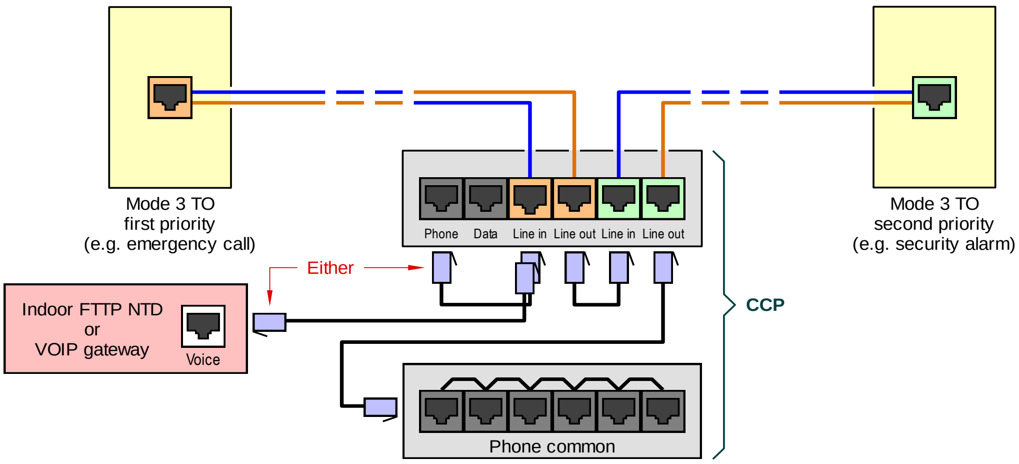


Notes:

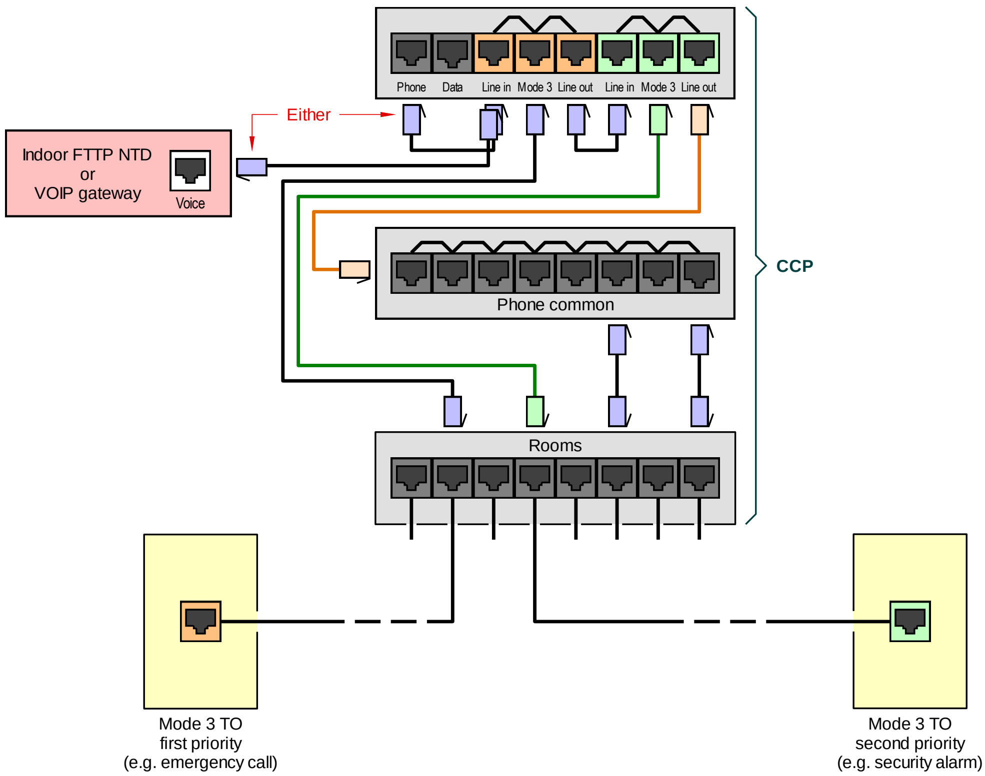
1. This method of connecting Mode 3 equipment (such as a security alarm panel or a personal response system) may be used to connect Mode 3 equipment to **any TO** and is useable for a 2-wire telephone line from an **outdoor** ADSL/FTTP NTD or an **indoor** FTTP NTD or VOIP gateway (i.e. it is “NBN compatible”).
2. The adaptor sockets should be wired **exactly** as shown above to maintain the same line polarities at all sockets.
3. Labelling of the Mode 3 adaptor sockets and clear user instructions on how to connect them are very important.

Figure 136 Home networking system — patching of two Mode 3 connections at the CCP

(a) Using two fixed Mode 3 TOs wired in accordance with Figure 134



(b) Using two Mode 3 adaptor sockets in accordance with Figure 135



Notes:

1. A personal response (emergency call) system should take priority over any other Mode 3 equipment (i.e. it should be first in the connection chain).
2. Labelling of the Mode 3 sockets and clear user instructions on how to connect them are very important.

10.4.7.5 Data cable connections

Except in the case of a dedicated Mode 3/Mode 5 TO described in 10.4.7.4, each TO cable may be used for connection of either voice (telephone) or data (Ethernet) equipment. For technical reasons it is important that any **Ethernet port** from any Ethernet device **is only connected to one socket at a time**. Therefore, it is imperative that any cable between the CCP and a TO is only connected to **one socket at each end** so that the end-user can't accidentally connect two or more Ethernet devices to the same Ethernet port.

Don't daisy-chain any TO sockets at either end of the TO cable. To do otherwise will negate the generic nature and, therefore, the flexibility of the cabling system. If multiple connections are required for sharing of a telephone service, this may be achieved by use of a separate bank of interconnected sockets referred to in this document as a "PHONE COMMON" as described in 10.4.7.3.

Except for any "PHONE COMMON" patch field described above, all **four cable pairs** should be terminated on **each socket** to support Gigabit Ethernet (and future 10G Ethernet). This includes any cable connecting an ADSL service from the outdoor NTD even though only one pair is used for ADSL (this ensures the connection is "fibre ready" in case the outdoor ADSL NTD is replaced with an outdoor FTTP NTD at a later time).

Where a data service is to be shared or data equipment is to be interconnected, this must be achieved electronically either using a wireless (Wi-Fi) gateway/router or by individual ("point-to-point") connections between an Ethernet gateway/router or switch and each item of equipment to be connected. This principle is demonstrated in Figure 106 to Figure 109 (pages 133 to 136) and Figure 112 to Figure 115 (pages 140 to 143).

10.4.7.6 Building a generic patch panel

A generic (non-proprietary) patch panel may be constructed from standard multi-gang wall plates and flush-mounting modular sockets. With this type of patch panel, if a modular socket goes faulty or sockets need to be added later, virtually any brand of socket that is physically compatible with the wall plate can be used.

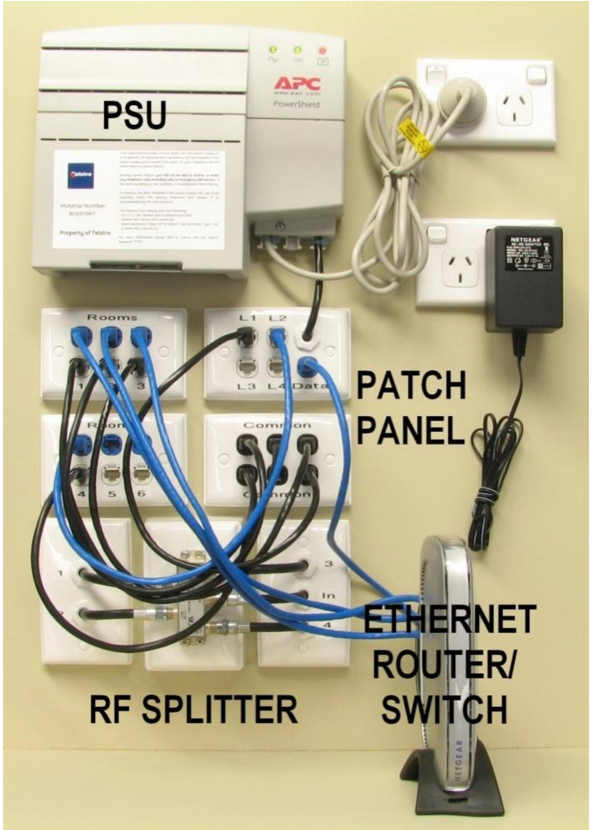
Figure 137 shows a typical generic patch panel made using conventional wall plates fixed to a cavity wall (e.g. inside a cupboard or a cabinet described in 10.4.4 on page 149).

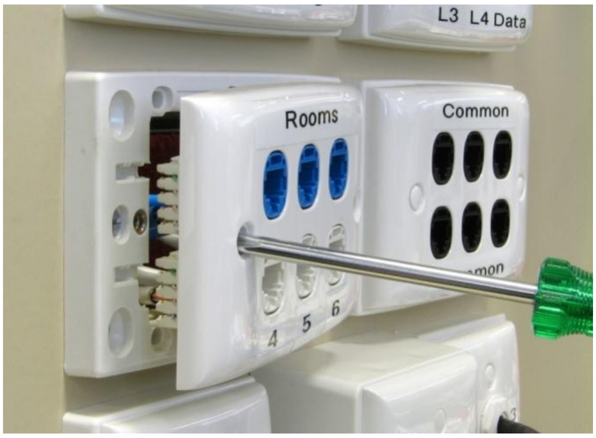
This style of patch panel has low socket density, so it may only be suitable for relatively small installations (e.g. having no more than a total of 24 TO cables).

Figure 137 A generic CCP patch panel made from standard wall plates and modular sockets

(a) Typical CCP patch panel made from standard wall plates and sockets

(b) Use shallow mounting blocks to facilitate easy removal of plates for upgrade/repair

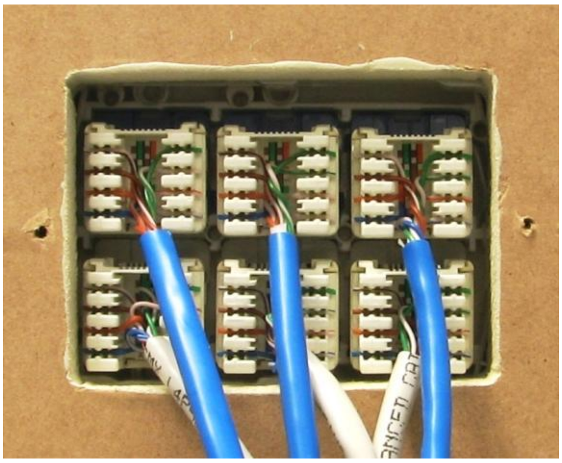




Notes:

1. If the mounting surface is painted, the use of shallow mounting blocks is recommended, as shown in (b) above, to facilitate easy removal of the wall plates for future testing, repairs or alterations. Otherwise the plates will tend to stick to the paint making them difficult and potentially dangerous to remove (a sharp blade will usually need to be used to break the bond between the plate and the paint).
2. The 4-pair data cable from each TO socket is terminated directly to the corresponding patch panel socket as shown in Figure 138. Intermediate termination modules may degrade link performance (see 4.14.4.2) and should not be used.
3. Colour coding of the sockets at the TOs and the corresponding sockets in the CCP patch panel avoids the need to mark them "Voice" and "Data" (or similar), which is misleading because any socket can be used for any purpose.

Figure 138 Termination of cables on the rear of the patch panel shown in Figure 137



Note: The cables from the outlets should terminate directly onto the patch panel sockets as shown at left.

10.4.8 Patch cords and equipment fly leads

10.4.8.1 General

A **cord used to connect equipment** to a socket on a wall plate or a patch panel is often described as a "**fly lead**" whereas a **cord used to interconnect two sockets** on a wall plate or a patch panel is generally referred to as a "**patch cord**". Patch cords used for Ethernet connections have 8 conductors and are marked with their performance rating, e.g. Category 5 (or "5e"), Category 6, Category 6_A.

A patch cord can be used as a fly lead for connection of an Ethernet device to a patch panel, TO (wall plate) or directly to another Ethernet device. However, a fly lead designed for connection of "voice" (telephone) equipment should not be used as a patch cord (i.e. for interconnection of patch panel sockets) due to the different wiring and type of plug used (see the next paragraph).

Modular plugs and sockets are used for connection of most telecommunications equipment in customer premises. Traditionally, 6-position (6P) modular plugs and sockets were used for connection of telephone equipment while 8-postion (8P) modular plugs and sockets were used for connection of data equipment. The original reason for using 6P modular plugs and sockets for telephone connections and 8P modular plugs and sockets for data connections was ostensibly to prevent an end-user from inadvertently connecting data equipment to a telephone line (which operates at a higher voltage) to avoid damage to the data equipment and possible electric shock to the end-user. Conversely, while a 6P plug will fit into an 8P socket, plugging telephone equipment into a data socket is not likely to cause equipment damage or create any risk of electric shock to the end-user because the telephone equipment is designed and insulated to withstand higher voltages.

While equipment manufacturers have maintained the convention of using 6P modular plugs and sockets for connection of the equipment to telephone lines, this convention is no longer followed in the cabling industry. With the advent of generic cabling (i.e. using 8P modular sockets for all applications) the original risks of damage or electric shock described above presumably no longer exist or have been long forgotten.

10.4.8.2 Ethernet patch cords and fly leads

Patch cords and fly leads for Ethernet connections and for patching of telephone services on a patch panel should have 8-position 8-contact (8P8C) modular plugs (otherwise known as "RJ45") and should be rated to match or exceed the category of the cable used (e.g. if Category 6 cabling is installed, the cords/leads should be Category 6 or Category 6_A).

Patch cords should be "straight through" (not "crossover") type (see Figure 140). To minimise clutter, patch cords should only be as long as necessary to connect between the furthest patch panel sockets.

Note: If a "crossover" connecting cord is supplied with an Ethernet gateway/router, it can generally be used for connection of any Ethernet device because most modern Ethernet devices have auto-sensing ports. However, such cords are **not suitable** for patching of **telephone** services.

A mixture of patch cord colours may assist the end-user, e.g. black for "voice" (telephone) connections, blue for "data" (Ethernet) connections and white, yellow or green for other connections.

One patch cord should be provided for each TO socket plus at least two spare cords. Where sockets are colour-coded, the patch cords may be provided in colours that match the socket colours.

Figure 139 Ethernet patch cord or fly lead

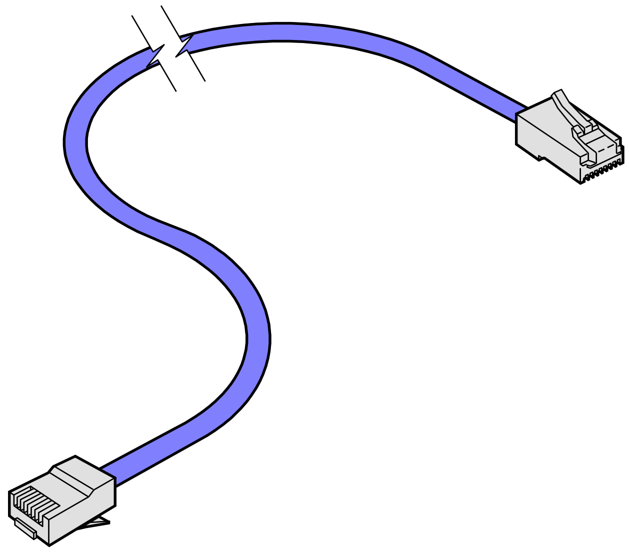
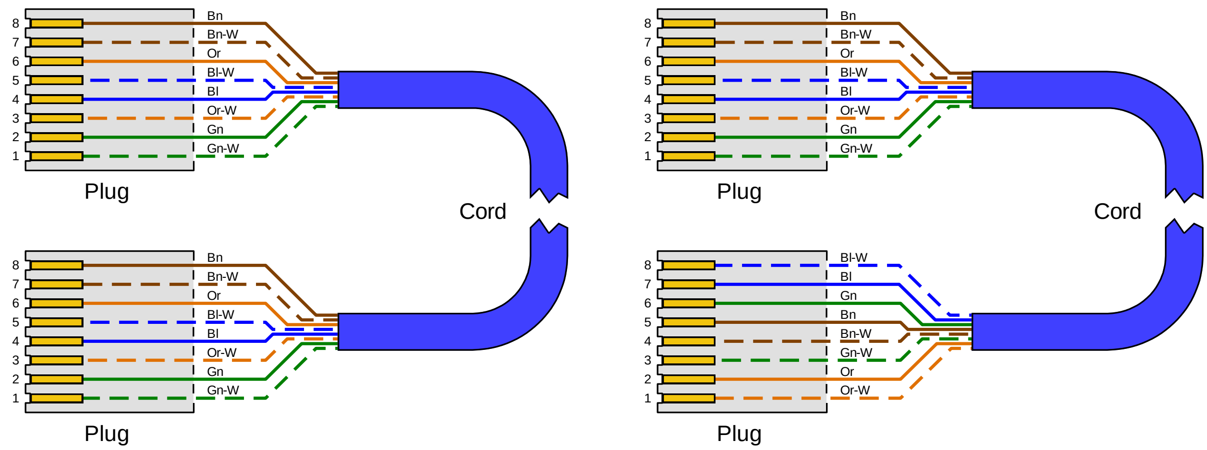


Figure 140 Straight-through and crossover patch cord wiring (T568A Gigabit Ethernet)

(a) Straight-through patch cord connections **(b) Crossover patch cord connections**



Notes:

1. Crossover cords may be required in some cases to reverse the Ethernet “send” and “receive” pairs.
2. It doesn’t matter if a patch cord is wired to T568A or T568B (see 10.5.11 on page 184), as long as the wiring is exactly the same at both ends of a straight-through cord or the corresponding pairs are crossed over correctly for a crossover cord.

10.4.8.3 Telephone port fly leads

Telephone ports on equipment are invariably 6-position 2-contact (6P2C) or 6-position 4-contact (6P4C) modular sockets, otherwise known as “RJ11” (or “RJ12” in some circles). While an RJ11 plug will fit into an RJ45 socket, an RJ45 plug will not fit into an RJ11 socket. Therefore the fly lead must either have an RJ11 plug both ends or an RJ11 plug one end and an RJ45 plug the other end. In the former case, the RJ11 plug connected to the RJ45 patch panel socket (or TO socket) should be designed to plug into an RJ45 socket (see 10.4.8.4) and should be fitted with a spacer to prevent sideways movement of the plug in the socket, which may damage the socket contacts or result in a faulty connection (see Figure 143).

The use of 2-conductor fly leads is recommended to avoid the problem described in 10.4.8.6.

Figure 141 Voice (telephone) equipment fly lead

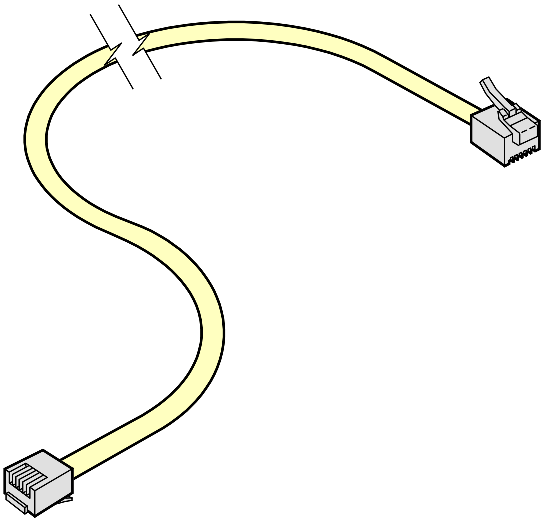
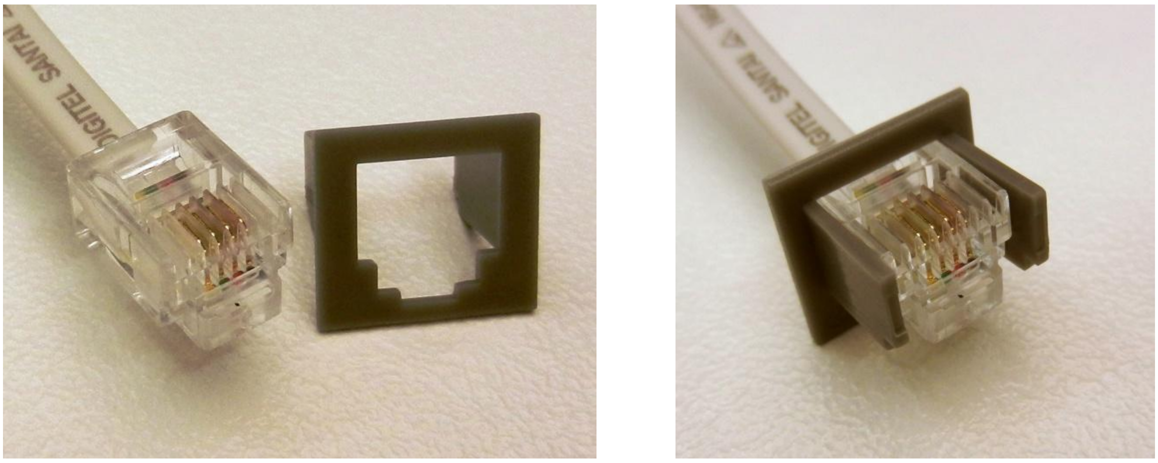


Figure 142 6P modular plug with spacer



Notes:

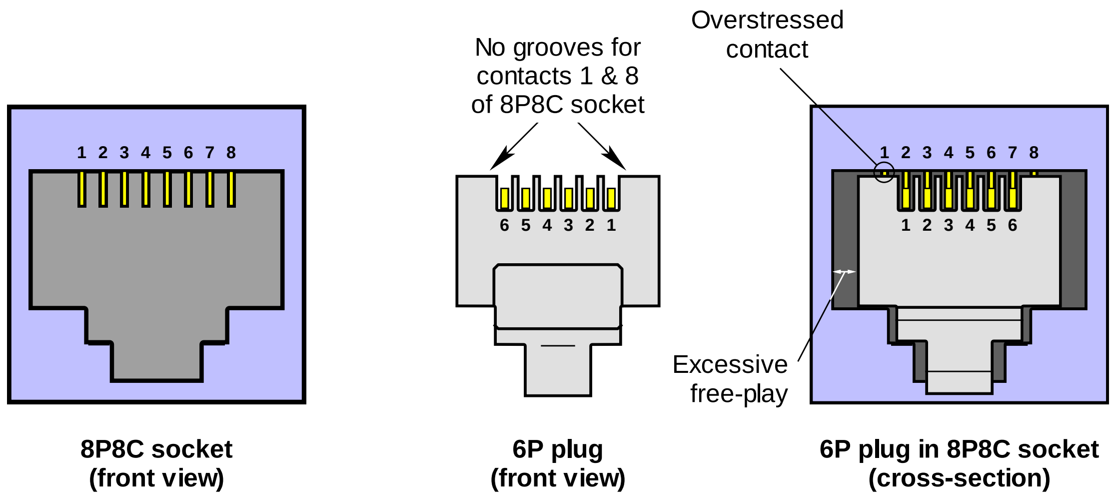
1. Any 6P ("RJ11") modular sockets used in a generic cabling system should have eight slots in the plastic moulding, as in the one shown above, to avoid possible damage to the 8P8P ("RJ45") sockets as described in 10.4.8.4.
2. A spacer is required for connection of the RJ11 plug to an RJ45 socket of generic cabling to prevent damage to the socket contacts or a faulty connection due to sideways movement of the plug in the socket (see Figure 143).

10.4.8.4 Possible damage to 8P8C ("RJ45") sockets by 6P ("RJ11") plugs

6P modular plugs will plug into an 8P socket. However, some 6P plugs will damage the outer contact springs of an 8P8C socket (see Figure 143) and may also have excessive free-play that allows horizontal leverage to be exerted on all contact springs, so it is preferable to use an 8P plug to connect to an 8P socket.

Some 6P plugs have extra grooves in the plug moulding for contacts 1 and 8 of 8P8C sockets as shown in Figure 142, and will not crush the outer contact springs of 8P8C sockets. However, all 6P plugs will have excessive free-play and sideways leverage to the contact springs is not prevented unless a 6P-to-8P spacer/reducer is used as shown in Figure 142.

Figure 143 Possible problems with 6P plugs connected to 8P8C sockets



Notes:

1. Some 6P plugs may damage the outer contact springs of 8P8C sockets. Telstra uses 8P4C sockets (i.e. equipped with only the inner four contact springs) for connection of its services at wall plates to avoid this problem.
2. Some 6P plugs have extra grooves in the plug moulding for contacts 1 and 8 of 8P8C sockets, and will not crush the outer contact springs of 8P8C sockets. However, all 6P plugs will have excessive free-play and sideways leverage to the contact springs is not prevented unless a 6P-to-8P spacer/reducer is used. Refer to Figure 142 for an example of a 6P plug designed to plug into either a 6P or an 8P socket.

10.4.8.5 Making your own patch cords or fly leads

While it is technically feasible for registered cablers to make their own patch cords or fly leads using suitable components, this is not recommended for technical and legal reasons explained in the Notes below. Strictly speaking, consumers can only legally use A-ticked, factory-made patch cords or fly leads, so while it may be legal for a registered cabler to manufacture patch cords or fly leads, they cannot be legally used by the end-user. In any case, cords and leads assembled by cablers tend to be inferior to, and more expensive than, factory-assembled cords and leads.

Notes:

1. Patch cords and fly leads must be manufactured using “cordage” that has stranded or tinsel conductors and using plugs designed specifically for crimping on the type of cordage used. Cable with solid conductors must not be used for this purpose and, in any case, would require the use of special plugs designed for crimping on solid-conductor cable.
2. Plugging a cable or cord into a socket is “cabling work” as defined in section 418 of the *Telecommunications Act 1997*, for which cabling provider registration would normally be required. However, end-users (customers) are exempted from the need to be registered cablers to plug properly manufactured and compliance-labelled cords into wall sockets or patch panels by virtue of the *Telecommunications (Types of Cabling Work) Declaration 1997*, which declares that the connection by an end-user of a compliance-labelled (e.g. A-ticked), pre-terminated patch cord, pre-terminated patch lead, adaptor or pre-terminated telephone extension cord, is a type of cabling work that is exempt from the cabling provider registration requirements.

10.4.8.6 Telephone or "voice" ports on indoor FTTP NTDs

With some indoor FTTP NTDs, the two telephone ("voice") ports are commoned in an "RJ14" wiring arrangement as shown in Figure 144. This is presumably done to enable a single fly lead to be used to connect both telephone services to the fixed cabling (instead of using two separate fly leads for each service). This arrangement is incompatible with generic cabling and can cause problems when plugging telephone equipment directly into the NTD port if that equipment is connected via an equipment cord that has more than two conductors and:

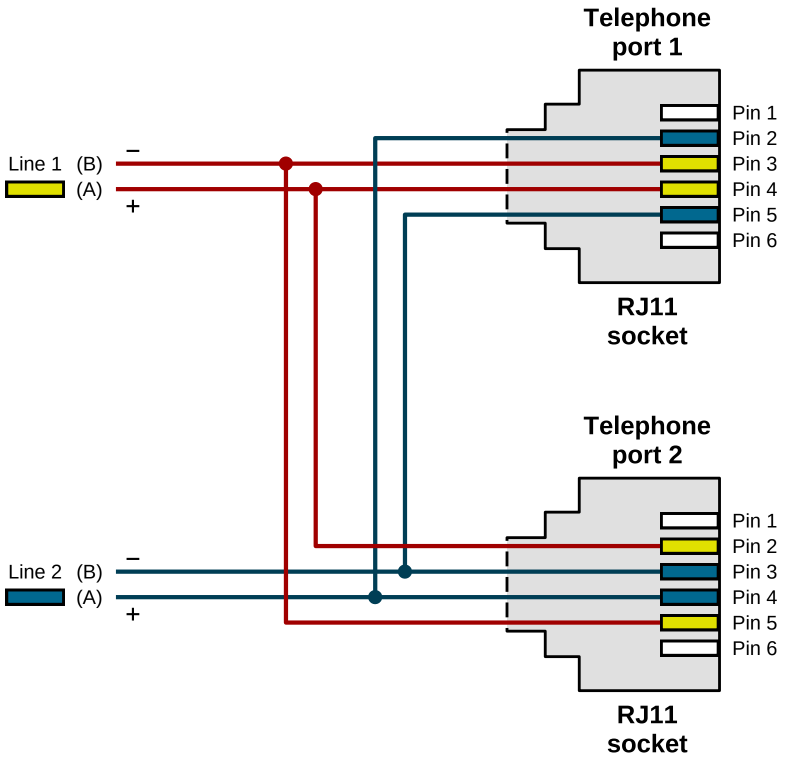
- the equipment is internally designed to support a Mode 3 or Mode 5 connection or some other 3-conductor or 4-conductor connection arrangement (e.g. a two-line connection); or
- the spare cord conductors or contacts 2 and 5 of the RJ11 equipment socket are connected to other circuit elements within the customer equipment.

Examples of customer equipment that are commonly configured to support Mode 3 connections are emergency call diallers, dial-up computer modems, fax machines and telephone answering machines. Other types of customer equipment may have connecting cords with more than two conductors, with the possibility of the third and fourth cord conductor being connected to circuit elements inside the equipment. These potential problems are explained further in Figure 145.

Problems will not be experienced if the telephone equipment is only connected to the NTD or a TO using a two-conductor connecting cord or fly lead. The risk of problems is also reduced if patch panel sockets for telephone services are only connected via two conductors as described in 10.4.7.3 on page 157 and shown in Figure 128 on page 158.

Note: Naturally, any Mode 3/Mode 5 or two-line equipment required to function as such will need to be connected via a 4-conductor cord (or 3-conductor cord in the case of Mode 5).

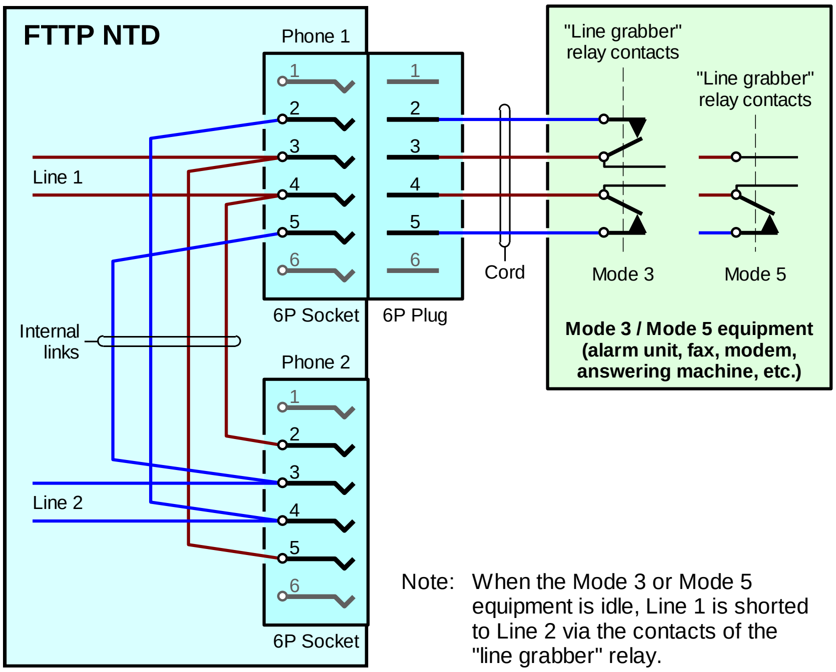
Figure 144 Example of commoned telephone/voice ports on an indoor FTTP NTD



Note: Indoor NTD ports are sometimes wired this way to enable a single fly lead to be used to connect both telephone services to the fixed cabling (instead of using a separate fly lead for each service). This connection arrangement may be referred to as "RJ14".

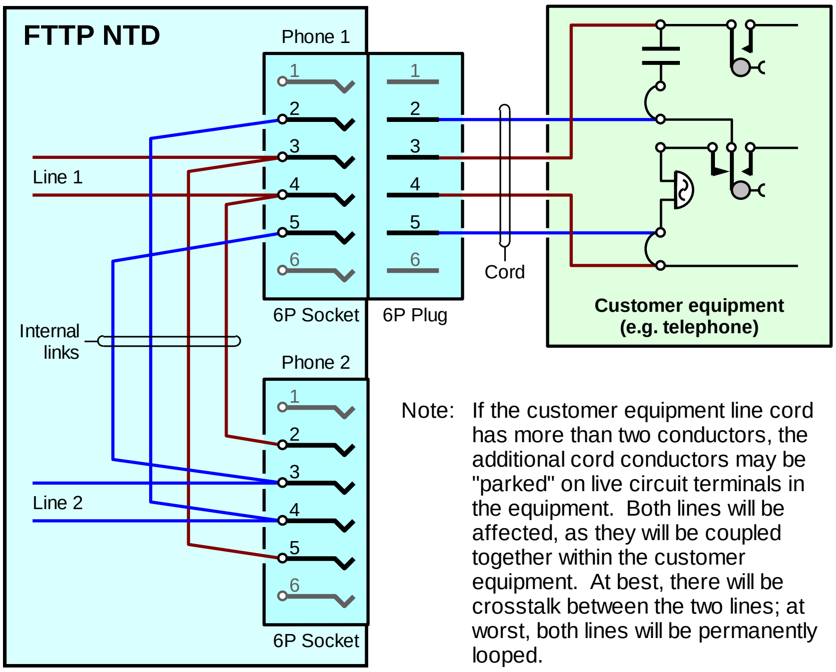
Figure 145 Possible fault due to commoning of the telephone/voice ports inside the NTD

(a) Fault due to switching relay contacts in Mode 3 or Mode 5 equipment



Note: When the Mode 3 or Mode 5 equipment is idle, Line 1 is shorted to Line 2 via the contacts of the "line grabber" relay.

(b) Fault due to additional line cord conductors in the customer equipment



Note: If the customer equipment line cord has more than two conductors, the additional cord conductors may be "parked" on live circuit terminals in the equipment. Both lines will be affected, as they will be coupled together within the customer equipment. At best, there will be crosstalk between the two lines; at worst, both lines will be permanently looped.

10.4.8.7 "Breakout" ("splitter") leads for multiple services over a single cable

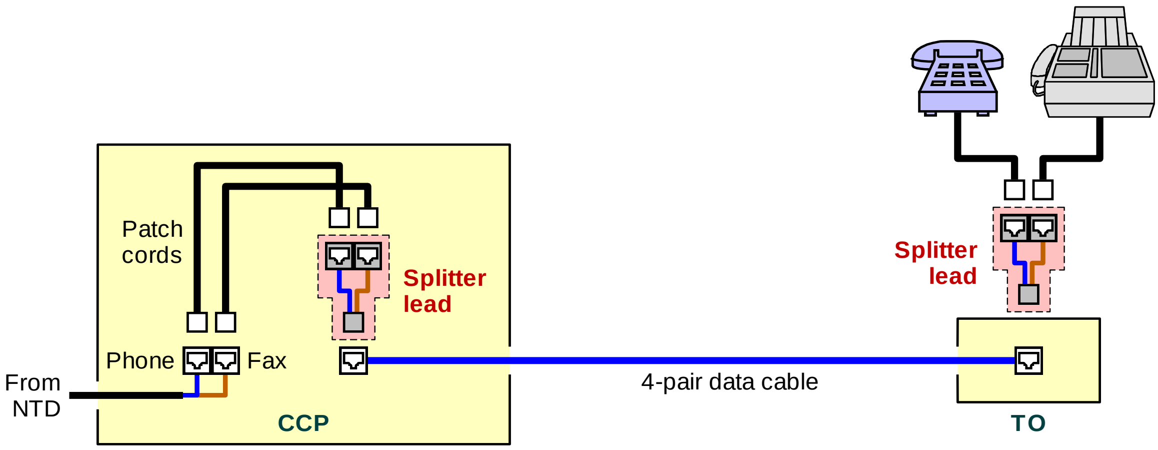
With generic cabling, even though the TO cable contains four pairs, it is not intended to be used for connection of more than one service simultaneously, i.e. it is normally used for connection of one telephone service, or one data (e.g. ADLS) service, or one Ethernet connection, at any one time. Nevertheless, it is possible to use one cable for the connection of two or more services using suitable modular plug/socket adaptors (if available) or "splitter" leads.

Examples of splitter leads are:

- for connection of two to four 2-wire circuits (e.g. telephone lines)
- for connection of one or two 2-wire circuit(s) (e.g. telephone lines) and a Fast Ethernet (10/100 Mbps) device (**this should only be tried as a last resort**).

Refer to Figure 146 and Figure 147.

Figure 146 Using splitter leads for sharing of a 4-pair data cable

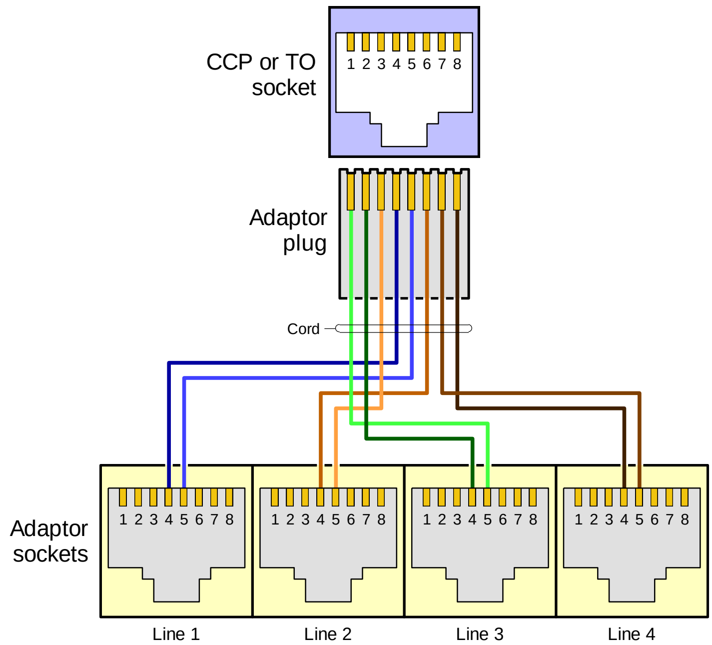


Notes:

1. Identical splitter leads are required at each end of the connection.
2. In the above example, a splitter lead is used to connect two telephone services via a single data cable.
3. For typical splitter lead wiring, see Figure 147.

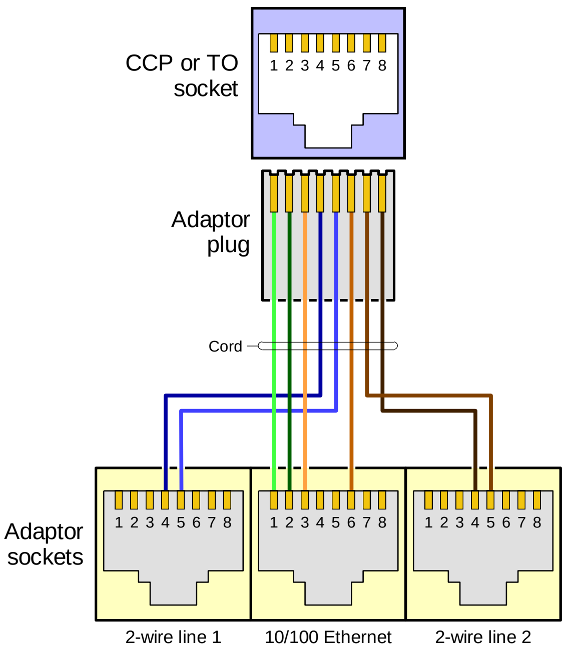
Figure 147 Examples of splitter leads for sharing of a 4-pair data cable

(a) Splitter lead for two to four 2-wire circuits (e.g. telephone lines)



Sockets for connection of 2-wire circuits (e.g. telephone or ADSL services) (Note 1)

(b) Splitter lead for one or two 2-wire circuits (e.g. telephone lines) and 4-wire (10/100) Ethernet



Sockets for connection of 2-wire circuits and Ethernet (Note 2)

Notes:

1. Running filtered telephone and ADSL services in the same cable is not recommended and may degrade ADSL performance. However, using the same cable for carrying multiple telephone services is acceptable practice.
2. Running telephone services in the same cable as 10/100 Ethernet is not recommended but may work satisfactorily in some cases. An ADSL service should **not** be run in the same cable as Ethernet.
3. Identical splitter leads are required at each end of the cable (see Figure 146). These leads should only be used for carrying a mixture of **analogue** and **digital** services **as a last resort**.

10.4.9 Powered equipment

Where possible, the powered equipment should be located at the CCP to provide a centralised location for end-user monitoring of status lamps, service testing or installing/changing any backup batteries.

10.4.10 Power outlets

At least one double-socket power outlet should be provided within 1 m of the CCP for powering of equipment. The installation of two double-socket power outlets is recommended (see 9.1 on page 111). These power outlets do not require their own final sub-circuit. The power outlet/s may be located inside the CCP enclosure as long as the fixed telecommunications and power wiring and connections are separated in accordance with Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*.

10.5 Telecommunications Outlet (TO) cabling

10.5.1 What is a TO?

A Telecommunications Outlet (TO) is a wall plate or a small plastic box (“surface-mount box”) containing one or more sockets for connection of customer equipment such as telephones, modems or personal computers and other Ethernet devices.

10.5.2 Socket type

8-position 8-contact (8P8C) modular sockets (commonly called “RJ45”) should be used for all voice/data TOs to ensure compatibility with consumer Ethernet equipment (other types of socket are available but may not be compatible with RJ45 plugs). The TO sockets should be rated to match or exceed the cable rating (e.g. if Category 6 cable is installed, the sockets should be rated at Category 6 or Category 6_A).

Notes:

1. 6-position (6P) modular sockets (commonly called “RJ11” and used for telephone equipment connections) should not be used as these will negate the generic nature (flexibility) of the cabling system.
2. If the cable runs will not exceed a length of, say, 30 m, if necessary it may be possible to use a socket with a lower rating than the cable (e.g. Category 5/5e sockets on Category 6 cable) and still achieve the higher performance class for the permanent link. However, this may need to be confirmed by certification or qualification testing in accordance with 14.2.

If a TO has more than one socket, each socket should be colour-coded as shown in Figure 148 (subject to compatibility with the decor) or marked in a way that its corresponding socket at the CCPcan be readily identified. Figure 148 shows a typical TO with different coloured sockets.

The sockets should be mounted on their wall plates with the **contacts at the top** and should be fitted with a shutter to minimise the exposure of contact surfaces to dust and other airborne particles.

Any 8P8C (“RJ45”) socket that is **within the reach of small children** should be **fitted with a shutter** to prevent access or discourage them from probing the socket with their fingers.

Note: The socket aperture is large enough to enable a child to touch the contacts with a finger. It is possible to get a small electric shock from these contacts under certain conditions. Fitting of mechanical protection to prevent finger access to the socket contacts is recommended in homes.

Figure 148 Typical modular sockets and a typical TO with two colour-coded sockets

Flush-mount socket

Keystone socket

A TO with two sockets fitted with shutters

10.5.3 Power outlets

At least one double-socket power outlet should be provided within 1 m of each TO for powering of customer equipment such as cordless telephones and computer equipment.

10.5.4 TO cabling method

TOs should be “star wired” (cabled individually) from the CCP with a socket terminated at each end of the cable — one at the TO and one at the CCP as shown in Figure 105 to Figure 115.

No more than one socket should be terminated on any cable at either the CCP or the TO, i.e. if a TO has two sockets, then two cables are required between the CCP and the TO.

The cabling needs to be installed with care in accordance with 10.5.8.2.

10.5.5 Cable type

TO cables should be solid-conductor UTP (Unscreened Twisted Pair) data cables of the appropriate category (Category 6 cable is recommended — see 4.14.5.2 on page 39). It is not normally necessary to use STP (Screened Twisted Pair) cables in homes. Refer to 4.14.4 (page 34) for more information about cable categories and types.

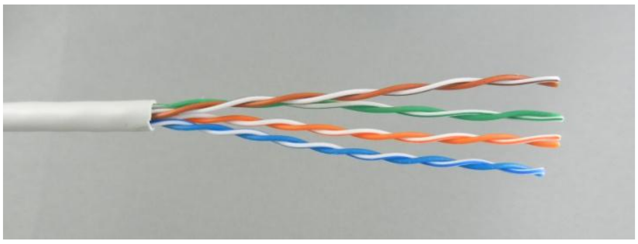
Do not use any cable with stranded conductors for the TO cabling, as such cables have inferior performance to solid-conductor cables. However, patch cords and equipment connecting cords (“fly leads”) should use stranded conductors due to their flexible properties.

See Figure 149 for comparison of Category 5, Category 6 and Category 6_A UTP cables.

Figure 149 4-pair Unscreened Twisted Pair (UTP) data cables

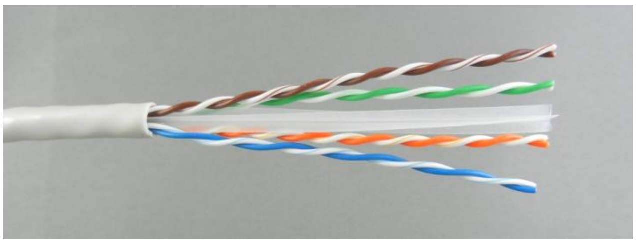
Category 5 (“5e”)

- approx. 5 mm diameter
- 0.51 mm diameter (24 AWG) conductors
- rated to 100 MHz
- supports Gigabit Ethernet
- cheap
- obsolescent, not recommended



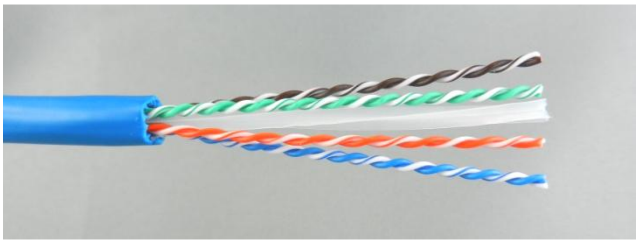
Category 6

- approx. 6 mm diameter
- 0.57 mm diameter (23 AWG) conductors
- higher pair twist rate
- pair separator
- rated to 250 MHz
- supports 10G Ethernet to 50 m
- slightly dearer than Category 5
- recommended for homes



Category 6_A

- up to 8.5 mm diameter
- 0.59 mm diameter (23 AWG) conductors
- even higher pair twist rate
- pair separator
- rated to 500 MHz
- supports 10G Ethernet to 90 m
- expanded sheath, elliptical or special core configuration to reduce alien crosstalk
- expensive, not worth the extra cost for most homes



Note: Compared to Category 5 cable, Category 6 and 6_A cables contain a pair separator, use thicker conductors and their conductors have a higher twist rate. Category 6_A cable has an expanded or oval-shaped cable sheath or special core design to reduce alien crosstalk (i.e. noise induction from other cables where cables are grouped together). All of these cable categories use slightly different twist rates for each cable pair to reduce crosstalk between the pairs.

10.5.6 Cable colour and marking

There are no mandatory requirements for cable sheath colours. However, cables with **red** sheath should not be used, as red is normally associated with fire detection/alarm systems. Also, cables with **orange**, **white**, **pink** or **violet** sheath should be avoided as they may be mistaken for power cabling or cabling associated with power control (“home automation”).

It may be beneficial to the installer to use cables with different sheath colours (e.g. blue, grey, yellow, green) to cable different sockets on the same TO. Alternatively, the cable sheaths may be marked at each end with the TO socket colours, e.g. “Blue” and “White”, for the corresponding socket colours if different coloured sockets are to be used at each TO. In addition, mark the TO cables at each end by room designation (e.g. “Kitchen”, “Family”, Bed 1”, etc.) or in numerical sequence (i.e. “1”, “2”, “3”, and so on). The TO wall plates and the corresponding patch panel sockets at the CCP should be coloured and designated in the same manner so that the end-user will be able to readily identify them.

10.5.7 Cable length

While the generic cabling standards allow fixed cabling up to a length of 90 m for commercial premises, for homes the total length of fixed cabling between the CCP and any TO should not exceed **50 m** to support 10G Ethernet if Category 6 cable is used (see 4.14.4.5 on page 38) and to ensure compatibility with some equipment that may use the data cabling for distribution of audio/video (A/V) signals from a TV appliance (see 10.8.6.5 on page 206). The 50 m limit is not likely to be exceeded in most homes. The total length of equipment connecting cords and patch cords per channel (see Figure 21 on page 35) should not exceed **10 m**.

Note: For a home networking system in a large home, it is recommended that the CCP be located such that the 50 m limit won't be exceeded for any TO — as long as the 25 m cabling limit or the 40 m cabling limit, as applicable, between the PCD and the CCP is not exceeded (refer to 10.3.3 on page 124).

10.5.8 Cable installation

10.5.8.1 General

Data cables must be installed in accordance with the minimum mandatory requirements of Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)* (or its replacement). For a description of the key requirements of the wiring rules and other cabling information, refer to 10.9.4 (page 232).

10.5.8.2 Cable integrity

Data cables must be installed with care to ensure maximum performance. Stretching, sharp bending, kinking, crushing or jointing of the cable must be avoided to ensure that the pair twist and conductor spacing are maintained for the full length of the cable.

When installing data cables:

- Keep at least 50 mm (preferably more) away from power cables and appliances whether or not there is an interposing barrier. Where it is necessary to cross power cables, cross at right angles.
- Avoid excessive tension when pulling cables in and don't allow any kinks or knots to form in the cable.
- Ensure that a bend radius of at least **8 times the cable diameter** (for UTP cable) or **10 times the cable diameter** (for STP cable) is maintained **while pulling in cables** (e.g. through conduits or around corners) and a bend radius of at least **4 times the cable diameter** (for UTP cable) or **5 times the cable diameter** (for STP cable) is maintained in the **installed cable**.
- Ensure that the cable is evenly supported, protected from crushing or trampling during and after installation, and that the cable sheath is not appreciably distorted by mechanical protrusions, cable ties, clips or other securing devices.
- Do not staple the cable using conventional staples. If the cable needs to be supported or restrained within a building cavity (e.g. to keep it out of harm's way or to maintain separation from other services), use loose fitting devices such as conduit or conduit saddles. For surface runs on walls, use plastic trunking, conduit, plastic clips or insulated staples to support the cable.
- Make each run of cable as short and direct as possible while ensuring that the above requirements are met. Allow for **200 mm to 500 mm of slack cable** to be left at each end **after termination** of the cable.
- Don't joint/splice the cables. If any cable is damaged or too short, replace the full length of cable rather than repairing/extending with a joint/splice.
- Don't tee or tap off any cable. Only connect one socket to each end of the cable.

Use conduit to protect cables in accessible roof space or for pulling additional or replacement cables through inaccessible areas (see Figure 20 on page 33).

10.5.9 Number of TOs required

10.5.9.1 General

The number of TOs required will depend on the consumer's requirements and the cabling budget. Refer to 10.3 on page 124 for guidance.

10.5.9.2 Number of TOs connected to a telephone service

There is no specific limit on the number of TOs that can be simultaneously connected to a standard telephone service. However, the total length of cable between the NTD and any TO that is to be used to connect telephone equipment is limited.

For **FTTP networks**, the maximum length of cable supported is determined by the design of the NTD. For Telstra NTDs, the total length of cable between the FTTP NTD and any **telephone** TO should not exceed **300 m**. This limit is normally only significant for high-rise apartment buildings if the telephone port of an FTTP NTD is used to supply a lift phone service where the length of the travelling cable for the lift car may be quite long.

To avoid ringing problems, no more than **three telephones or ringing devices** should be connected to a telephone service at any one time.

Note: This assumes that each telephone or ringing device has a Ringer Equivalence Number (REN) of 1. Telephone networks (including telephone services originating from an FTTP NTD) will support a total REN of 3. This means that if some or all of the connected telephones and other ringing devices have a REN of less than 1, more than three of them may be able to be connected to the same telephone service.

To avoid transmission problems, no more than two telephones should be off-hook at the same time — although some telephones will not work at all if another telephone is off-hook during a call.

Note: Telephones rely on the DC current fed from the telephone line to operate. When more than one telephone is off-hook, this current must be divided between the telephones and there may be insufficient current available to ensure that all telephones will operate satisfactorily.

10.5.10 TO location

10.5.10.1 Damp locations

TOs must not be located in any of the damp area restricted zones defined in Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*. Refer to Appendix A of AS/CA S009.

Even outside the damp area restricted zones, any damp location is generally unsuitable for the installation of TOs and customer equipment for both safety and reliability reasons. Moist air and damp surfaces may increase customer exposure to network and surge voltages and, with any socket connected to a DC voltage source (such as a telephone line or Ethernet device), dampness may cause electrolytic corrosion of metallic contacts, terminations and conductors.

Note: Corrosion is less of a problem when only AC voltage is present because electrolytic action is unlikely to occur, so power outlets may usually be installed in damp rooms (such as bathrooms) without corrosion problems. However, the existence of power outlets in damp rooms should not be taken as an indication that the room will also be suitable for the installation of TOs or telecommunications equipment.

Examples of unsuitable damp locations for TOs are:

- bathrooms, shower rooms or wash rooms
- laundries
- toilets
- any room or area containing a sauna, spa or swimming pool
- refrigeration rooms or "hosing down" areas.

Where the installation of a TO in a damp location outside the prohibited zones described in AS/CA S009 is unavoidable, it should be installed in such a way as to minimise the ingress of moisture, e.g. away from towel racks and any other areas where there may be splashing or dripping water, and in a place where steam does not accumulate and condensation is not likely to form. It is recommended that gel-filled sockets and terminations be used (if available) in such locations. Such sockets should also be fitted with shutters to exclude airborne particles that may build up in the socket and retain moisture.

10.5.10.2 Hazardous and noisy locations

Locations where a person using the customer equipment (or accessing the TO to plug in the equipment) is at risk of injury should be avoided; for example:

- behind doors;
- in narrow passageways or stairways; and
- under workbenches.

Areas subject to excessive acoustic noise will make telephone conversation difficult due to the masking effect of normal telephone “sidetone”. Such areas may include rooms exposed to traffic noise and mechanical workshops. Acoustic noise is not a concern for non-spoken communications (e.g. modems, gateways, fax machines, etc.).

10.5.10.3 Outdoor locations

If a TO is to be located outdoors, it must be protected from the weather either by location in a covered area (e.g. veranda or patio) or installation in a suitable weatherproof enclosure. Securing the TO against unauthorised access should also be considered, e.g. by unplugging the connection at the CCP when not required or by installation of the TO in a lockable enclosure.

With outdoor TOs, to reduce the risk of damage or deterioration:

- Ensure that the wall is not likely to get wet due to sprinklers, garden hoses or rainwater leakage.
- Mount the TO on a wall plate and, if installed on a masonry wall, also mount the plate on a mounting block (see Figure 192 on page 231) to provide maximum clearance between the wall (which is likely to be porous and therefore damp) and the TO.
- Where possible, mount the TO out of the reach of pets and small children.
- Avoid mounting the TO directly under overhanging objects where spiders and other insects tend to lurk, e.g. window sills and shelves.
- Where possible, use gel-filled sockets that include gel sealing of the wire terminations to prevent corrosion of the bare (cut) ends of the conductors and the socket terminals.
- Use a socket with a shutter to prevent the ingress of dust and insects.

10.5.10.4 TO height

TOs should be mounted at a sufficient height from any horizontal surface to minimise the ingress of cleaning fluids, dust and debris (the higher the TO, the better). The TO should be no less than 100 mm from the floor or workbench (a minimum distance of 300 mm is recommended from floors).

TOs should be mounted at the same height as the power outlets, which should not be less than 300 mm from the floor. Any TO provided for a wallphone should be mounted about 1300 mm from the floor.

Unless the customer has any special needs (e.g. a person with a disability), the recommended mounting heights for TO wall plates are:

- for TOs near floor level, the same height as adjacent power outlets, otherwise 300 mm (measured from the floor to the bottom of the wall plate)
- for TOs above a workbench (e.g. on a kitchen cupboard), the same height as adjacent power outlets, otherwise 150 mm (measured from the bench top to the bottom of the wall plate)
- for a wall plate used to mount a wallphone, 1300 mm (measured from the floor to the bottom of the wall plate).

For safety reasons:

- The TO should **not** be mounted above or below a power outlet.
- A telecommunications socket must **not** be fitted to the same wall plate as a power socket or switch.

Refer to Figure 184 on page 227 for a pictorial summary of recommended TO heights.

10.5.11 Socket connections

The cable should be terminated on each TO and corresponding CCP socket to Gigabit Ethernet (1000Base-T) specification in accordance with TIA/EIA wiring standard **T568A**. Refer to Figure 150 and Table 6 which are consistent with Appendix C of Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*.

While adherence to T568A wiring is strongly recommended, technically it doesn't matter if sockets are wired to T568B as long as they are wired the same way at each end. However, it **does** matter if pairs are split (even if they are terminated the same at each end) because this will cause crosstalk between pairs and significantly degrade Ethernet performance. A data cable from an outdoor FTTP NTD must be terminated to T568A at the CCP socket to avoid problems, as the carrier or service provider will always terminate cable to T568A within the NTD.

It is recommended to use sockets that include a means of mechanically restraining the terminated cable or conductors from subsequent movement. Some sockets are supplied with plastic caps that may be used to push the conductors into the IDCs (tool-less termination) and that snap into place to retain the conductors in the termination (see Figure 154).

10.5.12 "Mode 3" connection

If any equipment in the home requires a Mode 3 connection, e.g. for a security alarm panel or a personal response (emergency call) system, the CCP should be wired in accordance with one of the methods described in 10.4.7.4 on page 159.

If an 8P8C socket is used for the Mode 3 TO socket, it may be wired the same way as the other TO sockets in accordance with 10.5.11. If a special Mode 3 ("switching" type) socket is used, only the first two cable pairs should be connected to the TO socket as indicated in Figure 156.

10.5.13 Terminating data cable

The data cable should be cut to length prior to termination on the socket such that 200 mm to 500 mm of slack cable will be left in the wall cavity or outlet box **after** the cable has been terminated.

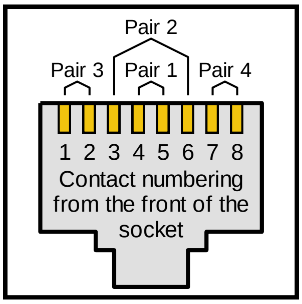
Use a cable sheath stripping tool to cut the sheath without cutting the conductor insulation. Typical cable sheath strippers are pictured in Figure 151. Only sufficient cable sheath should be removed to terminate the conductors on the socket. Refer to Figure 153.

The cable sheath should be maintained as close as possible to the fan-out point and the conductor pairs should remain twisted right up to the termination. For Category 5/5e cables, a pair may be untwisted for up to 13 mm before the termination. However, for Category 6 and higher cables, untwisting of pairs for any length is not recommended and the terminal layout on the socket should be such that virtually no untwisting of any pair is required. Refer to Figure 154.

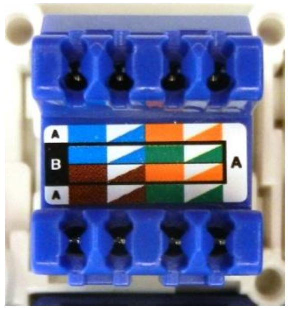
All data sockets use IDC (Insulation Displacement Connector) terminations of which there are several varieties. Two common termination types used in Australia are '110' and 'KRONE'. The correct tool recommended by the manufacturer of the socket should be used to terminate the conductors. Some sockets are designed to support tool-less termination of the conductors, which avoids the risk of damage to the IDCs by using the incorrect tool. Refer to Figure 152.

Figure 150 8P8C socket contact numbering and colour coding of IDC terminals

Socket contact numbering (TIA/EIA wiring standard T568A)



Typical colour coding of socket terminals (Notes 1 and 2)



Notes:

1. 'A' represents the T568A colour code; 'B' represents the T568B colour code. Follow the colours for 'A'.
2. The colour coding on the socket corresponds to the colour coding used for 4-pair data cable (see Table 6).

Table 6
4-pair cable colour code variations and corresponding socket connections (TIA/EIA wiring standard T568A)

Contact no.	Pair no.	4-pair cable colour code variations		
5 4	1	White Blue	White-blue Blue	White-blue* Blue-white*
3 6	2	White Orange	White-orange Orange	White-orange* Orange-white*
1 2	3	White Green	White-green Green	White-green* Green-white*
7 8	4	White Brown	White-brown Brown	White-brown* Brown-white*

* The first-named colour is the predominant colour.

Note: The convention is to connect the coloured mate to the even-numbered contact.

Figure 151 Typical data cable sheath strippers

Basic Category 5/6 cable sheath stripper	Trade quality Category 5/6 cable sheath stripper	Multi-purpose coaxial/data cable stripper (not recommended)
		
For casual use only, subject to skew and may slip off while rotating – often also includes a basic 110 terminating tool	Durable, non-adjustable stripper for professional use with Category 5/5e and Category 6 data cables. Hard to find – may only be available via mail order.	This tool may be used for cutting and stripping various types of coaxial and data cables and has adjustable blades. This type of tool is not recommended for safety reasons (i.e. due to exposed cutting blades on the open handle).

Figure 152 Typical IDC terminating tools

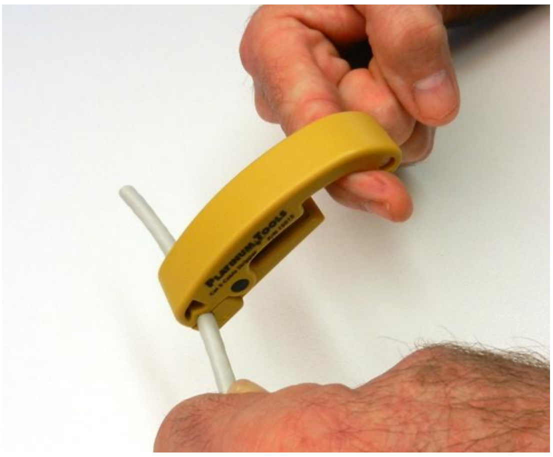
110 terminating tool	KRONE terminating tool
	

Notes:

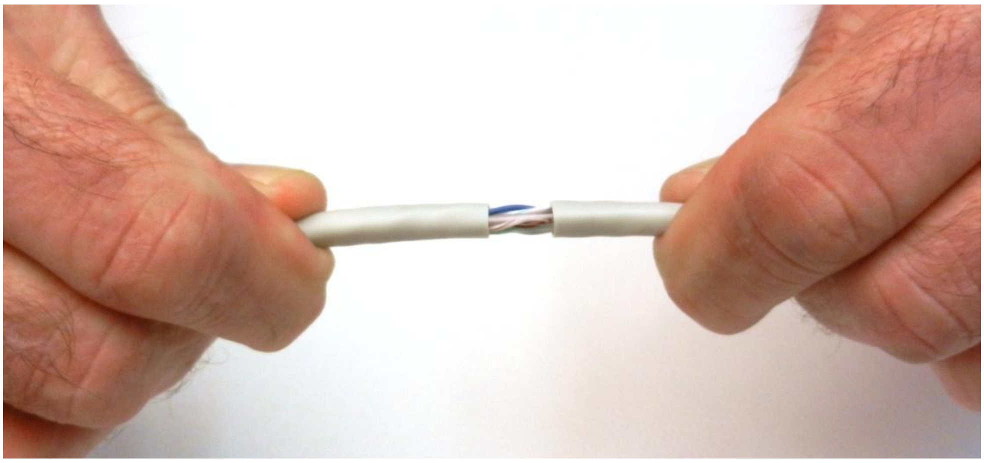
1. Use the correct terminating tool for the type of terminal used on the socket, e.g. a 110 tool for a 110 terminal or a KRONE tool for a KRONE terminal. Check the socket manufacturer's data sheet to verify the type of terminal used.
2. The tools illustrated above trim off the excess conductor as the conductor is "punched down" into the IDC. If a basic terminating tool or terminating caps are used, the excess conductor must be manually trimmed with side cutters before or after termination in the IDC.

Figure 153 Removing the cable sheath

Open the jaws of the stripper and position the cutting blade about 30 mm to 40 mm from the end of the cable.

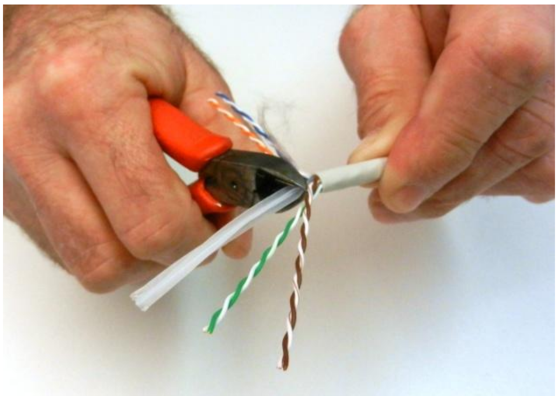


Rotate the tool two to three times. Rotate in one direction only and do not over-rotate.

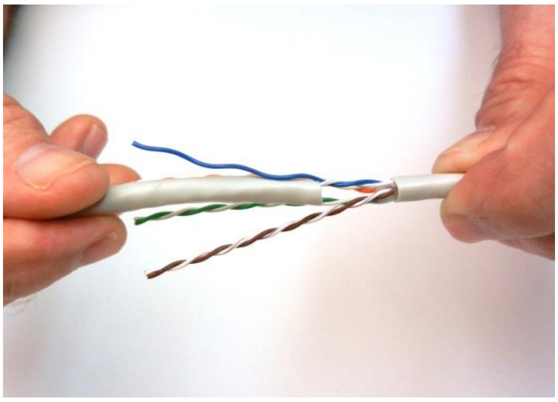


Open the jaws of the tool, remove the cable and then pull the cable sheath off with your fingers. Do **not** use the tool to remove the sheath, as the blade of the tool may scrape some insulation off the conductors.

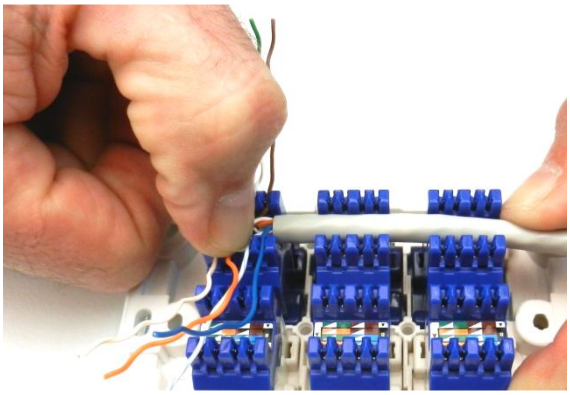
Figure 154 Terminating Category 5 or Category 6 cable on a socket



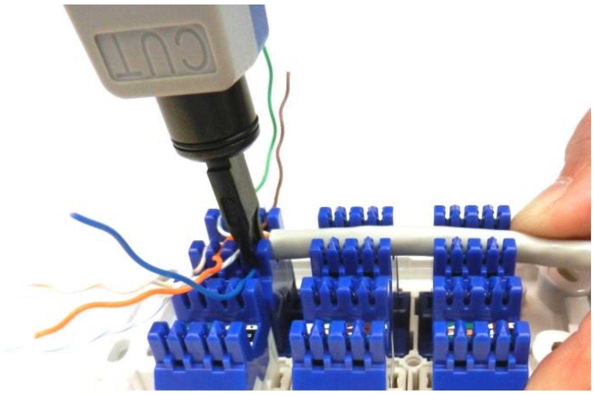
Cut away any draw string and, for Category 6 or 6_A cable, the pair separator, taking care not to nick or cut the conductors.



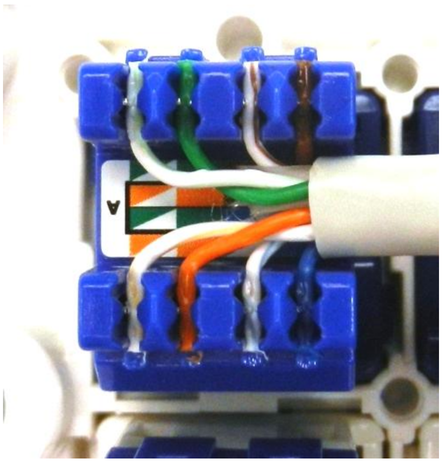
Use the piece of cable sheath you just removed to untwist each pair by winding it down to about 20 mm from the sheath.



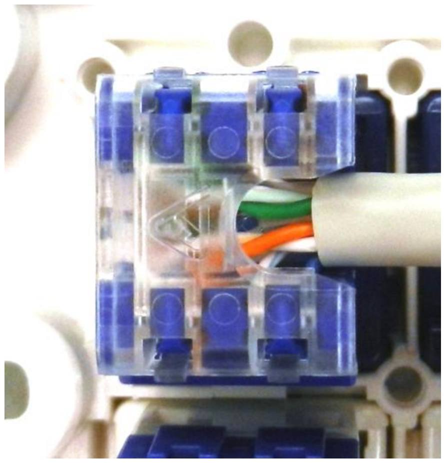
Fan out the conductors and push them into the correct slots with your fingers. Maintain pair twist right up to the termination. Follow the colours marked on the socket for 'A' (refer to Figure 150 and Table 6).



Position the cutting blade of the terminating tool to the outside face of the terminal, ensure that the tool is aligned with the terminal and push the tool into the terminal until it clicks.



The cable sheath should extend all the way to the socket terminals and the twist should be maintained in each pair right up to the termination point.



If the socket is supplied with a cap, fit this cap over the terminations to retain the conductors in the termination, as some conductors may be dislodged if the cable is moved.

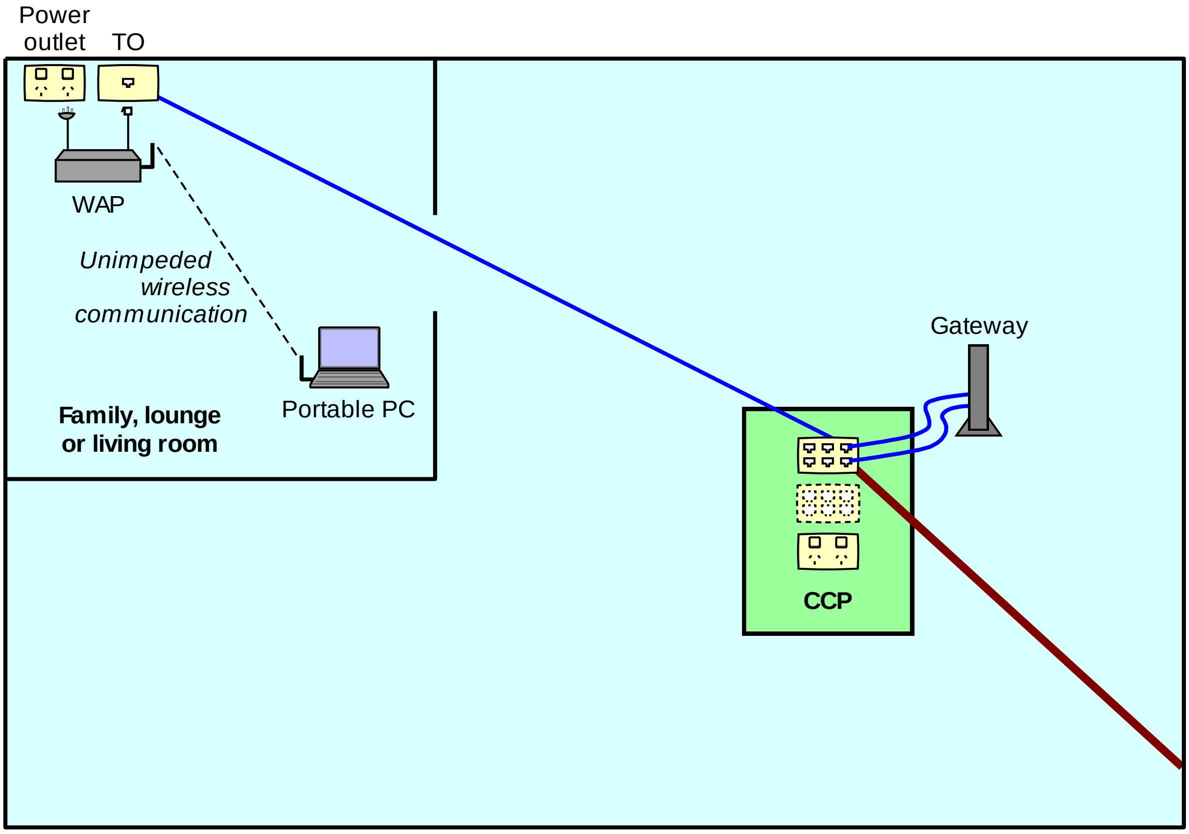
10.6 Wireless access point

With some homes, it may be necessary to install a TO in an open area of the home, such as the family, lounge or living room, to provide for connection of a Wireless Access Point (WAP). While a wireless gateway may be located at the CCP to provide wireless (Wi-Fi) access, the internal walls of the home may attenuate the radio signals (especially masonry walls), reducing the data speed or Wi-Fi availability throughout the home.

The WAP should ideally be positioned in the same horizontal plane as the devices that will be used to access it, e.g. between one and two metres from the floor for a person sitting or standing while using the wireless device. However, for a two-storey home, if only one WAP is installed, it should be positioned as high as possible in the lower floor or as low as possible in the upper floor to maximise coverage to the other floor. Installation of a WAP in the roof space is not recommended.

Unless PoE (Power over Ethernet) will be used for the WAP (PoE is uncommon in homes as yet), a power point will also be required near the TO that is provided for connection of the WAP.

Figure 155 Providing a Wi-Fi access point in the family/lounge/living room



Note: A Wireless Access Point (WAP) located in an open area where portable devices are likely to be used and connected to a LAN port of the gateway located at the CCP will provide optimal Wi-Fi access.

10.7 Connection of other cabling subsystems

10.7.1 Security alarm

Most security alarm systems are cabled separately using special cable with stranded conductors between the alarm panel, keypad(s), activators and motion sensors. A typical security system comprises an alarm panel, motion sensors, audible and visual alarms, and a control console. The alarm panel is the cabling hub for the system and is usually secreted away in a cupboard or robe in a room or in an area that is monitored by one of the intruder motion sensors. If the alarm panel is to be located at the CCP, the CCP should be monitored by a motion sensor. For security systems without wireless remote control, this may preclude location of the CCP in the garage because entry of a vehicle to the garage may activate the motion sensor and the alarm before it can be overridden by the vehicle occupant.

Where a monitored ("back-to-base") security alarm system is to be installed using a "Mode 3" connection, the telephone line should be connected to the alarm panel before it is connected to any other telephone equipment. This may be achieved by one of the methods described in 10.4.7.4 on page 159.

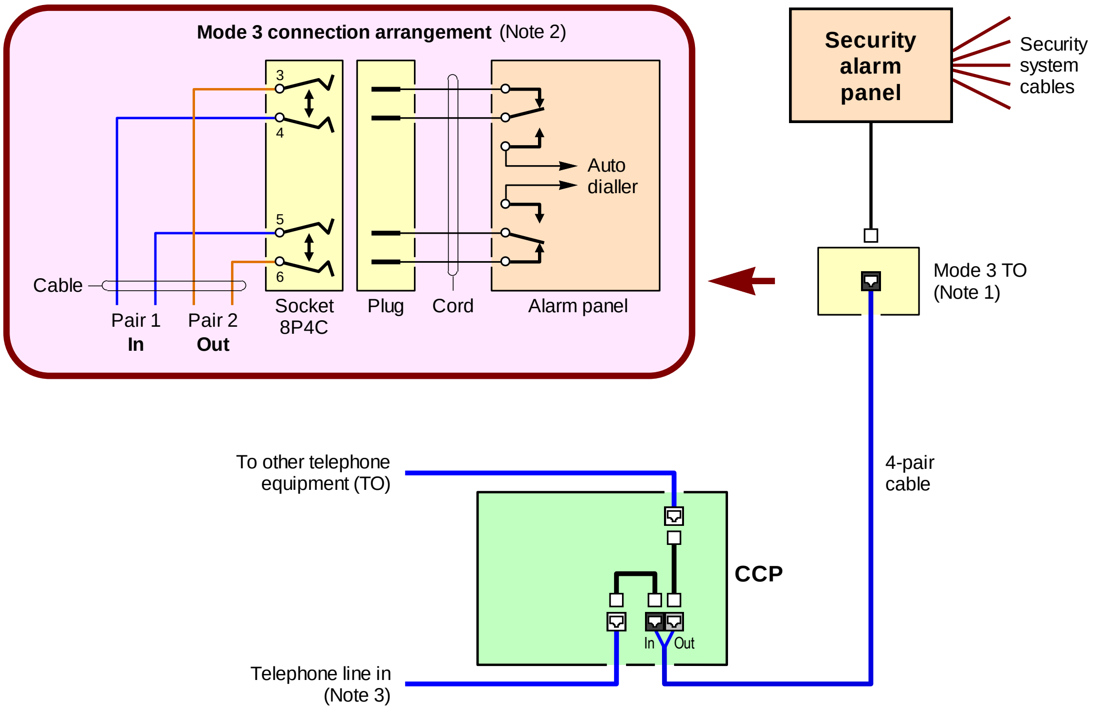
A monitored security alarm should always be connected to the **first telephone line** of any FTTP NTD (whether outdoor or indoor) because any backup battery installed in the NTD power supply may only maintain operation of the first telephone line during a power failure.

The security alarm panel will have battery backup so that it will still operate during power failure or if the power is switched off at the power mains. Therefore, any **FTTP power supply should also be fitted with a backup battery** so that the telephone line will function under the same conditions. However, the FTTP backup battery may not maintain operation of any VOIP-based telephone service (e.g. from a gateway connected to the FTTP NTD) and a separate UPS (Uninterruptible Power Supply) may be required to power the VOIP gateway. Refer to 10.4.7.4 (page 159) for more information.

Some security systems may use the internet for back-to-base signalling, in which case they will require connection to an Ethernet port on the gateway, router or switch and both the FTTP NTD and the gateway/router/switch will need to be powered via a UPS as described above (the backup battery for the NTD does not normally maintain operation of its Ethernet ports during power failure). Other security systems may use the cellular mobile network, in which case no special cabling or power-fail arrangements should be necessary.

Figure 156 illustrates a typical connection arrangement for a "back-to-base" security alarm system.

Figure 156 Interconnection of a monitored ("back-to-base") security alarm system



Notes:

1. The TO may be installed on the wall next to the alarm panel, inside the alarm panel or the alarm panel may be hard wired without a TO. The connection principle is the same in all cases.
2. Where dial-up via the public switched telephone network is used for the alarm monitoring, the alarm panel is connected in "Mode 3" and the CCP should be wired in accordance with one of the methods described in 10.4.7.4 on page 159. Where Ethernet is used for the back-to-base monitoring, the TO cable is terminated on a socket at the CCP in accordance with 10.5.11 on page 184.
3. With a Mode 3 connection, the alarm panel takes priority over the line and disconnects all other telephone equipment when the alarm is activated. It is important that the alarm panel is the first connection point on the telephone line to which it is connected. If a "switching" type socket is used as shown in the above diagram, the line will be automatically connected through to the other telephone equipment if the alarm panel is unplugged.
4. If an 8P8C socket is used for the Mode 3 socket, it may be wired the same way as the other TO sockets in accordance with 10.5.11 (page 184). If a special Mode 3 ("switching" type) socket is used, only the first two pairs of the cable are terminated on the socket as shown above.
5. If an ADSL service is supplied via the same line that is used to supply the telephone service, an ADSL splitter (central filter) must be installed at the NTD or the CCP in accordance with Figure 124 on page 154.
6. A backup battery should be fitted in any FTTP power supply if a monitored security alarm is installed. Moreover, the alarm panel should always be connected to telephone line 1 of any FTTP NTD because any backup battery installed in the power supply may only maintain operation of telephone line 1 during a power failure. A VOIP service should not be used unless the VOIP gateway is powered from a separate UPS (Uniniterruptible Power Supply).

10.7.2 Personal response system

A personal response system (also referred to as a “medical alert” system or an “emergency call” system) is a communications system that facilitates the connection of an end-user requiring assistance to a central monitoring facility (usually via the public switched telephone network) from an automatic dialling device called a “local unit”. The call may be initiated from a trigger device (e.g. located in a bedroom, bathroom or toilet or worn around the neck) or directly from the local unit, which must be readily accessible.

Where a personal response system is to be installed, the local unit must be connected in a “Mode 3” or “Mode 5” arrangement as described in 10.4.7.4 on page 159. This is similar to the connection arrangement shown in Figure 156.

If both a security alarm panel and a personal response system are to be installed, the Mode 3/Mode 5 sockets must be wired in tandem as described in 10.4.7.4.4 on page 160. The personal response system should take precedence over the security alarm, i.e. be the first connection in the connection chain.

10.7.3 Home automation

Home automation, such as “intelligent” lighting and push-button or remote control of electrical appliances, is usually installed as part of the electrical wiring system by the electrician. The control cables for such systems may be bus-wired or star-wired from a central control unit, which may be located near the CCP.

While the home automation wiring is usually totally separate to the cabling described in this document, the home automation control unit may be connected to the CCP to provide remote control of appliances via the public telephone network or the internet. This can be achieved by wiring the control unit to a socket in the CCP for connection to a telephone service or an Ethernet port of the gateway.

10.7.4 Home theatre

Home theatre cabling is generally installed as separate cabling. The loudspeaker wiring is normally point-to-point, heavy gauge, stranded conductor cable, while the audio/video links between the home theatre component equipment may comprise point-to-point HDMI, A/V, S/PDIF, TOSLINK or coaxial cables. Such cabling is outside the scope of this document. However, at least one TO should be provided near each TV outlet to provide for such things as:

(a) an internet (Ethernet) connection for on-line games, internet radio, IPTV or Video on Demand (VoD)

(b) a digital (Ethernet) connection for a network media device (e.g. for music or video “streaming”)

(c) a telephone service or Ethernet connection for interactive pay TV

(d) analogue audio distribution to amplifiers or low-power speakers in each room (e.g. for music)

(e) high-definition audio/video (A/V) distribution of in-house TV channels using data cabling.

Given the likelihood that two or more of the above connections may be required simultaneously in an entertainment area, the installation of **at least four** independently cabled TO **sockets** at the home theatre point is recommended. While an Ethernet switch (see 9.9.1 on page 120) may be installed at the home theatre point to aggregate the equipment Ethernet ports for connection to a single LAN port of the gateway at the CCP via a single data cable, this will not support applications that use the physical cabling rather than IP-based signalling, such as the applications described in (c), (d) and (e) above.

Note: Modern TVs, Blu-ray players, digital video recorders, games consoles, media centres and pay TV set top units — all of which are likely to be located at the home theatre point — have an Ethernet port requiring connection to the internet or a home network for full functionality.

10.8 Coaxial cabling

10.8.1 Introduction

Coaxial cabling may form part of the generic cabling system in accordance with Australian Standard AS/NZS ISO/IEC 15018, *Information technology — Generic cabling for homes*. Some consumer equipment requires connection to both the data cabling described in 10.5 and the coaxial cabling.

Basic coaxial cabling guidance is provided in this document to support pre-wiring for:

- HFC services (e.g. BigPond Cable and FOXTEL Cable), where available
- pay TV (e.g. FOXTEL) or free-to-air TV from an FTTP NTD (e.g. some Telstra FTTP installations)
- satellite broadband (e.g. BigPond Satellite)
- TV antenna cabling as part of an integrated home cabling system.

3G/4G wireless antenna cabling is not included, as this is standalone cabling that is usually installed by the service provider. NBN fixed wireless antenna cable is Category 5 cable, not coaxial cable.

Satellite pay TV cabling is generally out of scope but is included where relevant to the TV antenna cabling. For guidance on cabling homes and apartments for satellite pay TV, refer to the FOXTEL website http://www.foxtel.com.au/support/Getting-Started/Connecting-Cabling/default.htm.

Coaxial cabling should be designed and installed in accordance with Australian/New Zealand Standard AS/NZS 1367:2007, *Coaxial cable and optical fibre systems for the RF distribution of analogue and digital television and sound signals in single and multiple dwelling installations*. This Telstra guideline provides selective, practical information specific to home cabling to complement, and not replace, AS/NZS 1367. Some things have changed since this standard was last published — notably formal declaration of the "digital dividend" arising from the switchover to digital TV (see 10.8.3.2).

10.8.2 Coaxial cabling application

Coaxial cabling is used for connection of "RF" (Radio Frequency) equipment that, for the purpose of this document, is designed to receive or transmit signals at frequencies between 5 MHz and 2150 MHZ. The frequencies used for the types of services that are within the scope of this document are:

- 5 MHz to 862 MHZ for HFC ("Cable") internet or pay TV (closed system*)
- 85 MHz to 862 MHz for FTTP TV/pay TV (closed system*)
- 45 MHz to 820 MHz for analogue and digital free-to-air TV (see Table 7)
  - only 174 MHZ to 694 MHz will be used for digital free-to-air TV
  - part of the 45MHz to 174 MHz frequency spectrum will be reallocated after the switchover to digital TV (FM radio occupies part of this spectrum — see below)
  - all of the 694 MHz to 820 MHz frequency spectrum will be auctioned for telecommunications licences after switchover to digital TV (the so-called "digital dividend")
  - in metropolitan areas, UHF channels will be migrated to VHF after the switchover to digital TV
- 87.5 MHz to 108 MHz for FM radio (currently overlaps with analogue TV channels 3, 4 and 5)
- 174 MHz to 230 MHz for DAB+ (Digital Audio Broadcasting or "digital radio") (overlaps with TV channels 6-12)
- 950 MHz to 2150 MHz for satellite TV (this is the "intermediate" frequency transmitted from the satellite dish transceiver) (closed system*).

  * "Closed system" means the signals are confined to a cabling system and should not interfere with airwave broadcasts and vice versa.

Screened, twisted pair cabling, such as Class F or F_A cabling (Category 7 or 7_A components) is sometimes promoted as a substitute for coaxial cabling. However, this is not supported by many RF experts. Some broadband service providers (including Telstra) will not connect their services to such cabling due to EMI (RF ingress/egress) concerns and due to the service provider's inability to maintain it to the wall plate.

IT'S HOW WE CONNECT

Table 7 Television and radio bands, channel numbers and frequencies

VHF

BAND I		
0	45-52 MHz	
1	56-63 MHz	
2	63-70 MHz	
BAND II (Note 2)		
3	85-92 MHz	**FM radio** 87.5 - 108 MHz
4	94-101 MHz	
5	101-108 MHz	
Special channels (non-broadcast) (Note 3)		
S2	111-118 MHz	
S3	118-125 MHz	
S4	125-132 MHz	
S5	132-139 MHz	
S6	139-146 MHz	
S7	146-153 MHz	
S8	153-160 MHz	
S9	160-167 MHz	
S10	167-174 MHz	
BAND III		
5A	137-144 MHz (out of band)	
6	174-181 MHz	**Digital radio** (DAB+) 174 MHz to 230 MHz
7	181-188 MHz	
8	188-195 MHz	
9	195-202 MHz	
9A	202-209 MHz	
10 (old)	208-215 MHz	
10 (new)	209-216 MHz	
11 (old)	215-222 MHz	
11 (new)	216-223 MHz	
12	223-230 MHz	
Hyperband channels (non-broadcast) (Note 3)		
S11	230-237 MHz	
S12	237-244 MHz	
S13	244-251 MHz	
S14	251-258 MHz	
S15	258-265 MHz	
S16	265-272 MHz	
S17	272-279 MHz	
S18	279-286 MHz	
S19	286-293 MHz	
S20	293-300 MHz	

UHF

Hyperband channels (non-broadcast) (Note 3)	
S21	302-309 MHz
S22	309-316 MHz
S23	316-323 MHz
S24	323-330 MHz
S25	330-337 MHz
S26	337-344 MHz
S27	344-351 MHz
S28	351-358 MHz
S29	358-365 MHz
S30	365-372 MHz
S31	373-379 MHz
S32	379-386 MHz
S33	386-393 MHz
S34	393-400 MHz
S35	400-407 MHz
S36	407-414 MHz
S37	414-421 MHz
S38	421-428 MHz
S39	428-435 MHz
S40	435-442 MHz
S41	442-449 MHz
S42	449-456 MHz
S43	456-463 MHz
S44	463-470 MHz
BAND IV non-broadcast (Note 4)	
20	470-477 MHz
21	477-484 MHz
22	484-491 MHz
23	491-498 MHz
24	498-505 MHz
25	505-512 MHz
26	512-519 MHz
27	519-526 MHz
BAND IV broadcast	
28	526-533 MHz
29	533-540 MHz
30	540-547 MHz
31	547-554 MHz
32	554-561 MHz
33	561-568 MHz
34	568-575 MHz
35	575-582 MHz

BAND V broadcast	
36	582-589 MHz
37	589-596 MHz
38	596-603 MHz
39	603-610 MHz
40	610-617 MHz
41	617-624 MHz
42	624-631 MHz
43	631-638 MHz
44	638-645 MHz
45	645-652 MHz
46	652-659 MHz
47	659-666 MHz
48	666-673 MHz
49	673-680 MHz
50	680-687 MHz
51	687-694 MHz
52	694-701 MHz
53	701-708 MHz
54	708-715 MHz
55	715-722 MHz
56	722-729 MHz
57	729-736 MHz
58	736-743 MHz
59	743-750 MHz
60	750-757 MHz
61	757-764 MHz
62	764-771 MHz
63	771-778 MHz
64	778-785 MHz
65	785-792 MHz
66	792-799 MHz
67	799-806 MHz
68	806-813 MHz
69	813-820 MHz
BAND V reserved channels (non-broadcast) (Note 3)	
70	820-827 MHz
71	827-834 MHz
72	834-841 MHz
73	841-848 MHz
74	848-855 MHz
75	855-862 MHz

Notes:

1. Channels shaded in blue are analogue and will be discontinued from the end of 2013.
   The frequency spectrum shaded in pink will be reallocated after 2013 (the "digital dividend").
2. Band II will continue to be used for FM radio after 2013.
3. Non-broadcast channels may be used in a closed cabling system for RF modulation or for transmodulation of satellite programs. Many radio systems also use these frequencies.
4. Channels 20 to 27 are suitable for RF modulation in most homes (e.g. for CCTV cameras).

10.8.3 Analogue and digital RF services

10.8.3.1 General description

The switchover from analogue to digital free-to-air (FTA) TV commenced in 2010 and will be completed nationally by the end of 2013. Other broadcast TV services such as Cable and Satellite pay TV are already broadcasting in digital format, which will leave FM radio as the only RF service described in this document that will be broadcasting analogue signals after 2013.

Digital TV broadcasts comply with a group of standards developed by an international consortium called the "Digital Video Broadcasting (DVB) Project". Standards are set out for the various transmission media used for broadcasting purposes and a suffix is applied to the "DVB" acronym accordingly (see the list below). A form of digital radio broadcasting defined in ETSI standards, known as DAB (Digital Audio Broadcasting), is currently being trialled in mainland capital cities. The version of this technology used in Australia is DAB+. DAB+ occupies the same frequency spectrum as TV broadcasts and therefore it is included in this document. At this stage, DAB+ is only broadcast from earth-based (terrestrial) antennas.

The acronyms used for the various forms of digital RF transmission described above are:

- DVB-T Digital Video Broadcasting — Terrestrial
- DVB-C Digital Video Broadcasting — Cable (HFC) (Note 1)
- DVB-S Digital Video Broadcasting — Satellite
- T-DAB Terrestrial Digital Audio Broadcasting (Note 2)

Notes:

1. The DVB-C bandwidth overlaps the DVB-T bandwidth, so they require totally separate cabling systems. DVB-C may also be used for pay TV or FTA TV supplied via the RF port of an FTTP NTD.
2. While T-DAB shares some of the FTA TV bandwidth, it requires a separate cabling system (see 10.8.6.4).

10.8.3.2 DVB-T (FTA TV) characteristics

Analogue and digital FTA TV are broadcast in 7 MHz channels in VHF and UHF radio frequencies. The radio frequency ranges for TV broadcasts are divided up into "bands", designated by roman numerals, i.e. Band I, Band II, Band III, Band IV and Band V. These bands and the allocated channel frequencies are set out in Table 7.

Analogue FTA TV is currently broadcast in VHF Bands I, II and III, and UHF Bands IV and V. However, digital FTA TV will not be broadcast in Bands I and II and will only occupy VHF Band III and UHF Bands IV and IV. Digital TV uses the frequency spectrum more efficiently and the switchover to digital FTA TV will free up spectrum that may be allocated for other purposes. This imminent availability of valuable frequency spectrum is referred to as the "**digital dividend**" (refer to Table 7).

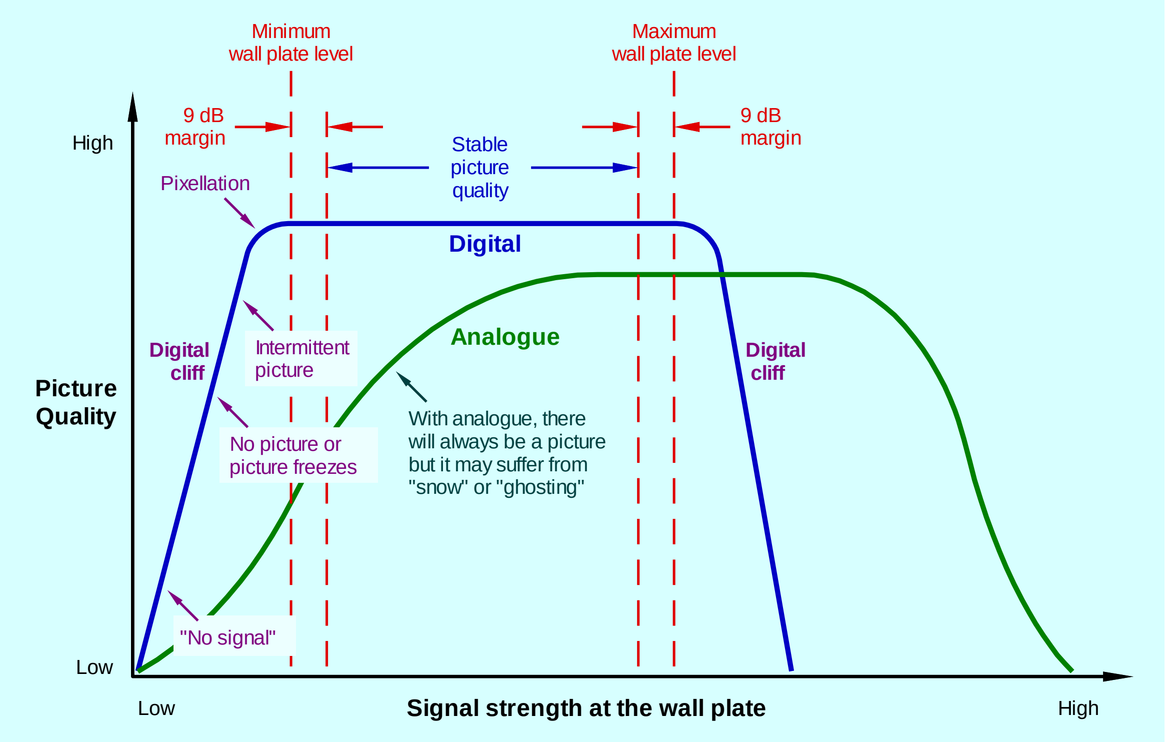
Digital TV provides many other benefits, including:

- ghost-free reception
- the ability to broadcast several programs within a single channel
- the programs may include high-definition and widescreen pictures and surround sound
- supports electronic program guide (EPG)
- supports closed captions (e.g. optional captioning for the deaf or hard-of-hearing).

With analogue FTA TV, a single program occupies virtually all of the channel bandwidth and is accessed on a TV receiver by tuning into that channel. With digital FTA TV, several programs can be broadcast over a single channel and the broadcaster can assign program numbers that a digital TV receiver uses to identify the individual programs. The consumer can then access a particular program by selecting the number assigned to that program. The program number does not necessarily correspond to the actual channel over which the programs are being transmitted. For example, in capital cities ABC 2 is broadcast in analogue on channel 2 (until the end of 2013 at least) whereas ABC 2 is broadcast digitally on channel 12 and contains several programs that are designated as "channels" 2, 21, 22, 23 and 24. Similarly, digital SEVEN Network programs are actually broadcast on channel 6, digital NINE Network programs are broadcast on channel 8 and digital TEN Network programs are broadcast on channel 11.

With analogue TV, as signal strength or quality decreases, the picture and audio fade until they are totally swamped by noise. One of the advantages of digital TV is that it is able to correct data errors caused by interference from other sources as the signal strength decreases to maintain a perfect picture until the interference becomes too great for the error correction to cope. When this happens, the picture may break up into small blocks (called "pixellation"), freeze or disappear altogether and "low signal", "weak signal" or "no signal" may be displayed. Only a relatively small change in signal strength or quality is required for the picture to change from being perfect to disappearing completely. This phenomenon is called the "**digital cliff**", which is described pictorially in Figure 157.

Figure 157 The "digital cliff"



Notes:

1. With analogue TV, a weak signal will produce a picture but it may suffer from snow, herringbone, bars, ghosting or audible noise. If the signal level is too high, this may cause bars to appear travelling across the screen.
2. With digital TV (DVB-T), if the signal level is too low, the TV reception will suffer from broken pictures and sound ("pixellation"), no picture at all or the receiver will display "No signal" or similar (intermittently or continuously). If the wall plate level is too high, the picture may disappear intermittently or continuously.
3. With digital TV, theoretically the picture will be perfect within the minimum and maximum wall plate levels specified in the standards. However, the signal level may fluctuate under certain conditions (e.g. inclement weather) and if the signal level is designed into the "9 dB margin" area shown above (in other words, too close to the "digital cliff"), occasionally the picture quality may deteriorate or the picture may disappear altogether. The coaxial cabling installer should strive to maintain at least a 9 dB "quality margin" between the minimum and maximum signal levels specified for wall plates in 10.8.5.4 of this document.

10.8.3.3 DVB-C characteristics

10.8.3.3.1 HFC

HFC (Hybrid Fibre-Coax) is a cabling system that uses a combination of optical fibre and coaxial cabling to distribute pay TV and internet services to consumers. Optical fibre is used to distribute the signals to the HFC headends and the services are supplied to customer premises via coaxial cables. While HFC uses the same radio frequency spectrum as FTA TV, the HFC signals are confined to the cabling so that they don't interfere with FTA signals and vice versa. It is for this reason that DVB-C and DVB-T TV signals must be kept separate and cannot share the same coaxial cabling.

The lower frequency spectrum (5 MHz to 65 MHz) is generally used for the broadband internet return (upload) path while the upper frequency spectrum (85 MHz to 862 MHz) is used for the broadband internet forward (download) path and broadcasting of pay TV programs. A cable modem supplied by the internet service provider is required to decode and convert the broadband internet signals. A modem that is not registered in the service provider's system (i.e. not supplied by them) will not usually work. A set top unit supplied by the pay TV operator is required to decode the pay TV signals and any retransmitted FTA TV signals. Third party set top boxes will not work.

10.8.3.3.2 FTTP

With some FTTP networks, the 1550 nm optical wavelength is used for the broadcast of pay TV and FTA TV, and the RF signals are supplied via an RF port on the FTTP NTD. Unlike HFC, there is no return path because broadband internet is supplied separately via an Ethernet port on the NTD. If access to DVB-T is separately provided from an antenna, as with HFC separate coaxial cabling systems must be provided for DVB-T from the antenna and DVB-C from the FTTP NTD because they use the same bandwidth in different ways.

The NBN FTTP network does not support RF distribution but will support IPTV multicasting via the Ethernet port of the NTD.

10.8.3.4 DVB-S (satellite TV) characteristics

Satellite TV broadcasts are transmitted from a geostationary satellite approximately 37,000 km above the equator. Satellites focus their transmissions on particular geographic areas that are referred to as "footprints". Different satellites are used for different purposes. For example, satellite internet transmissions are made from a different satellite than TV transmissions and each type of transmission may use different carrier modulation and data encoding techniques.

The satellite signals are transmitted at between 12.250 GHz and 12.750 GHz, and are converted to an intermediate frequency (IF) of 950 MHz to 2150 MHz by the receiving antenna (LNB) at the satellite dish. These lower frequencies are more manageable for distribution within the premises using coaxial cabling.

10.8.3.5 T-DAB (digital radio) characteristics

Digital radio (commonly described as DAB+) is currently only in use in capital cities and occupies the same VHF Band III spectrum used by FTA TV channels 6 to 12. Until analogue TV broadcasts are terminated after 2013, the only bandwidth available for T-DAB transmission is that allocated for channel 9A (see Table 7).

T-DAB is a different technology to FM radio which is analogue and is broadcast in VHF Band II. T-DAB broadcasts are vertically polarised and will not be picked up by horizontally polarised TV antennas (see 10.8.7.2.8 for a description of polarisation). Where there is a need to install an external antenna for T-DAB, the coaxial cabling to the wall plate will normally need to be separate to the FTA TV cabling.

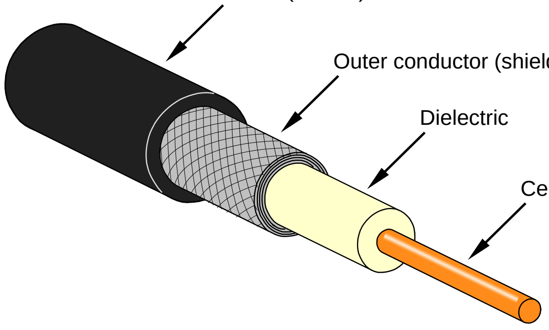
10.8.4 Coaxial cable description

Coaxial cable consists of a centre conductor and an outer conductor (shield) separated by insulation (called the "dielectric") encased in an outer plastic jacket (sheath). It is described as "coaxial" because all cable elements are circular in cross-section and share the same axis. The coaxial cable used in customer premises is referred to as "flexible" cable because it can be easily bent. The other type of coaxial cable used within HFC networks is called "hard line" and is rigid cable.

Coaxial cable is an "unbalanced" cable because the outer conductor is bulkier and, therefore, has a lower DC resistance per metre, than the smaller centre conductor. Where coaxial cable is to be connected to a "balanced" circuit such as a TV antenna or data cable, it must be connected via a transformer called a "balun" (**bal**anced to **un**balanced).

Coaxial cable is manufactured in many forms and the various types of cable are general described by a number prefixed by the letters "**RG**". It is really not quite certain what "RG" stands for but popular opinion is that it is an abbreviation for "Radio Guide" based on a US military specification produced decades ago but which no longer exists. The three types of coaxial cable described in this document are **RG6**, **RG11** and **RG59**. Refer to 10.8.7.2.3 for more information.

Figure 158 Coaxial cable elements



10.8.5 General principles

10.8.5.1 Units of measurement

10.8.5.1.1 RF power level

Coaxial cabling is used to carry signal frequencies which are so high that signal loss (attenuation) becomes a consideration for relatively short lengths of cable and certainly where the signal is to be shared between several access points (e.g. wall plates). With coaxial cabling, it is necessary to measure the strength of the source signal and calculate signal loss through the various components of the cabling system to ensure that there is sufficient signal power ("RF power level") at each wall plate to produce satisfactory video and audio quality.

The base unit of measurement used for video and audio signals is the decibel (dB), which is a logarithmic value for any variation in signal levels that resembles human perception of that variation. The decibel also enables simple mathematical calculations to be made (using addition and subtraction) to determine signal loss (or gain). If two points of measurement are at the same level, the variation is 0 dB. If one point is ten times higher in level than the other point, the variation is 10 dB. However, if one point is half the level of the other point, the difference is 3 dB — a difference that, while significant, for audible signals is hardly perceptible to the human ear.

Losses are expressed in the negative (e.g. –3 dB) whereas any gain (such as through an amplifier) is expressed in the positive (e.g. +8 dB). Values expressed in dB (with or without a suffix — see below) can be simply added or subtracted to determine the gain or loss between two points.

In this document, the following decibel units are used:

- dB — the loss ("insertion loss") produced by a component or string of connected components, often expressed as negative (e.g. –3 dB), or the gain produced by a component (e.g. an amplifier), often expressed as positive (e.g. +10 dB)
- dBmV — a voltage relative to 1 mV across an impedance of 75 ohms (used for HFC networks)
- dBµV — a voltage relative to 1 µV across an impedance of 75 ohms (used for FTA TV cabling). To convert dBmV to dBµV, add 60 (i.e. 0 dBmV = 60 dBµV).

Thus if a signal measured at 85 dBµV (e.g. on the coaxial cable from a TV antenna) is to be split four ways and the splitter incurs a loss of 8 dB between the input and each output, the signal measurement at each output to the splitter should be 85 – 8 = 77 dBµV.

10.8.5.1.2 Signal quality

RF power level (e.g. in dBμV) only provides a measure of signal strength and is not a measure of the signal quality. The signal being measured may include spurious noise or, in the case of digital signals, bit errors.

The three common measurements used in field strength meters to indicate signal quality are:

- Carrier to Noise ratio (C/N) — measured for both analogue and digital RF transmission, this is the ratio of the received signal power to the received noise power and is expressed in decibels (dB). For analogue FTA TV, the reading should not be less than 46 dB at any wall plate. For digital FTA TV, the reading should not be less than 33 dB at any wall plate.
- Modulation Error Ratio (MER) — measured for digital RF transmission only, this is used to quantify the performance of a digital signal and is expressed in decibels (dB). For digital FTA TV, the MER should not be less than 25 dB at any point in the cabling system.
- Bit Error Ratio (BER) — measured for digital RF transmission only, this indicates the proportion of error bits in a signal bit stream and is usually expressed as an exponential number. For digital FTA TV, the BER should be better than 1×10^{-6} ("1.0E-6"), which means there should be less than one bit error for one million bits received.

10.8.5.2 Insertion loss

"Insertion loss" is a term used to describe any loss in RF power level between two points. Another commonly used term is "attenuation". However, "attenuation" tends to be used to describe a gradual reduction in signal strength over distance (e.g. down a length of cable) whereas some components (such as a splitter) incur an immediate signal loss and the expression "insertion loss" is used in such cases. In practical terms, attenuation and insertion loss have the same meaning and are interchangeable.

Higher frequencies attenuate more than lower frequencies, so losses are generally described for a particular frequency or for the range of signal frequencies (bandwidth) to be carried by the particular component. It is necessary to consider system losses for the whole bandwidth to ensure the correct signal levels are maintained for all RF channels. A technique called "equalisation" may sometimes be necessary although in such cases an RF amplifier will normally be required and the amplifier may incorporate equalisation, i.e. higher frequencies may be amplified more than the lower frequencies.

Insertion loss is expressed in decibels (dB) — refer to 10.8.5.1.1 for an explanation.

10.8.5.3 RF source power levels

RF power levels are generally expressed in dBμV but may be expressed in dBmV for HFC networks (see 10.8.5.1.1). All RF power levels used in this document are expressed in dBμV to avoid confusion. Typical levels from various RF sources are as follows:

- HFC network (on the customer side of the network isolator)................................... 61 – 65 dBμV
- FTTP NTD
  - Outdoor NTD (at the F-connector port in the NTD).. 62 – 83 dBμV
  - Indoor NTD (at the F-connector port on the NTD) .... 72 – 83 dBμV
- TV or FM radio antenna (at the output of the balun).. 45 – 80 dBμV
- Satellite dish (at the F-connector on the LNB) .... 58 – 94 dBμV

The above information may be used as a basis for preparation of the initial design of a coaxial cabling system for the home but the actual RF power levels should be confirmed by measurement. Refer to 10.8.5.5 for sample designs.

10.8.5.4 Wall plate RF power levels

RF power levels required at the wall plate are as follows:

- HFC network (for connection of a Cable modem or pay TV set top unit)
  - 64QAM (internet and FOXTEL pay TV) .... 50 – 65 dBµV
  - 256QAM (internet and FOXTEL free-to-air TV) .... 54 – 69 dBµV
- Digital TV supplied from an FTTP NTD
  - COFDM channels for digital free-to-air TV.. 45 – 80 dBµV
  - 64QAM or 256QAM channels for pay TV (FOXTEL) .... 54 – 69 dBµV
- Digital TV supplied from an external TV antenna (COFDM channels) .... 45 – 80 dBµV
- FM radio supplied from an external TV/FM radio antenna .... 45 – 80 dBµV
- Analogue TV from an external TV antenna or an internal RF modulator................. 60 – 86 dBµV
- Satellite TV (QPSK channels)... 50 – 86 dBµV
- DAB+ digital radio supplied from an external antenna .... 30 – 74 dBµV

Notes:

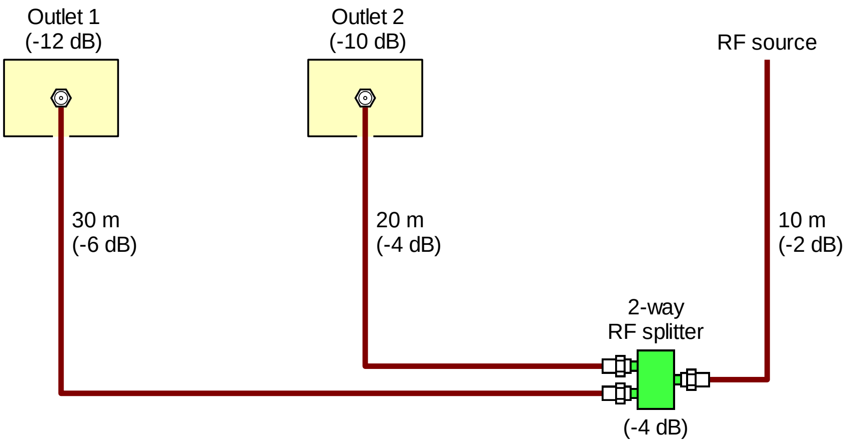
1. If access to analogue TV or FM radio is specifically required, the wall plate level should be confirmed for both analogue and digital RF signals to ensure compatibility with both analogue and digital services.
2. The stated RF power levels are the minimum and maximum required for all available RF channels.
3. 55 dBµV is the preferred minimum RF power level at the wall plate for virtually all digital RF signals.
4. If the wall plate level is too low, for analogue signals TV reception will suffer from snow, herringbone, bars, ghosting or audible noise. For digital signals, the TV reception will suffer from broken pictures and sound (“pixellation”) or the receiver will display “No signal” (intermittently or continuously). If the wall plate level is too high, for analogue signals this may cause bars to appear travelling across the screen whereas, for digital signals, the picture may disappear intermittently or continuously.

10.8.5.5 Working out system losses

Examples are provided below of typical home coaxial cabling systems to demonstrate how system losses are calculated and the components that may be required to ensure wall plate RF power levels are within specification. The losses for individual components are added together to work out the total loss between the RF source and each wall plate. This is then subtracted from the RF power level at the source to give the expected level at the wall plate.

Actual power levels and signal quality should be confirmed by measurement using a field strength meter (refer to 10.8.7.1.1).

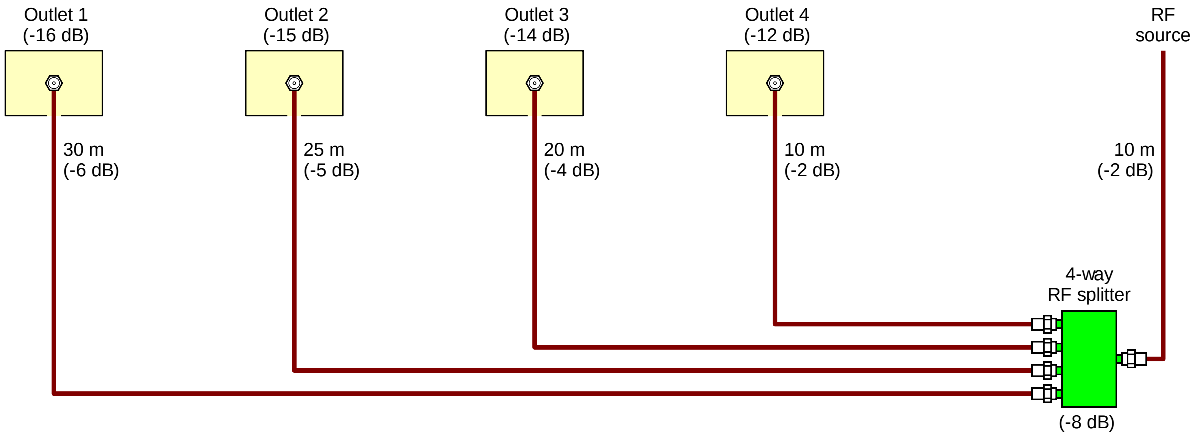
Figure 159 Two TV outlets connected to an FTTP NTD or external TV antenna



Notes:

1. Assuming an RG6 coaxial cable loss of 0.2 dB per metre (rounded up to include F-connector losses — see Table 8 and Table 12) and a splitter loss of 4 dB (see Table 9), the total insertion loss of the cabling between the RF source and Outlet 1 will be 12 dB while the total loss between the RF source and Outlet 2 will be 10 dB. Remember that loss is expressed in the negative, i.e. by using a minus (-) sign.
2. If the RF power level at the source is 74 dBµV, deduct 12 dB to give a wall plate level of 62 dBµV at Outlet 1 and deduct 10 dB to give a wall plate level of 64 dBµV at Outlet 2. In this case, the levels at both wall plates will be within specification for both digital and analogue TV reception (refer to 10.8.5.4).

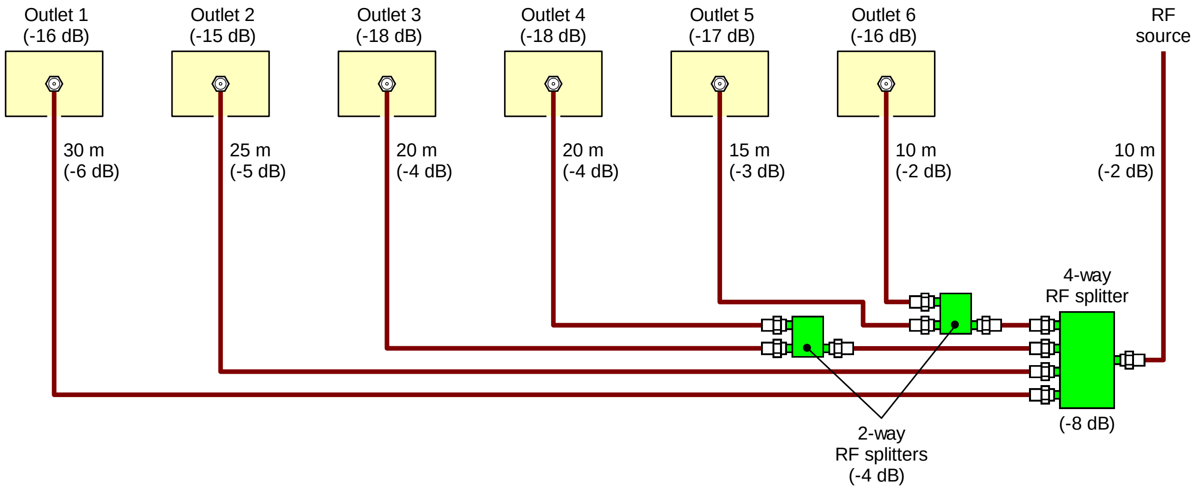
Figure 160 Four TV outlets connected to an FTTP NTD or external TV antenna



Notes:

1. Assuming an RG6 coaxial cable loss of 0.2 dB per metre (rounded up to include F-connector losses — see Table 8 and Table 12) and a splitter loss of 8 dB (see Table 9), the total insertion loss of the cabling between the RF source and Outlet 1 will be 16 dB while the total loss between the RF source and Outlet 4 will be 12 dB. Remember that loss is expressed in the negative, i.e. by using a minus (-) sign.
2. If the RF power level at the source is 74 dBµV, deduct 16 dB to give a wall plate level of 58 dBµV at Outlet 1 and deduct 10 dB to give a wall plate level of 64 dBµV at Outlet 4. In this case, the levels at all wall plates will be within specification for digital RF sources (refer to 10.8.5.4) but RF amplification will be required for satisfactory analogue TV reception.

Figure 161 Six TV outlets connected to an FTTP NTD or external TV antenna

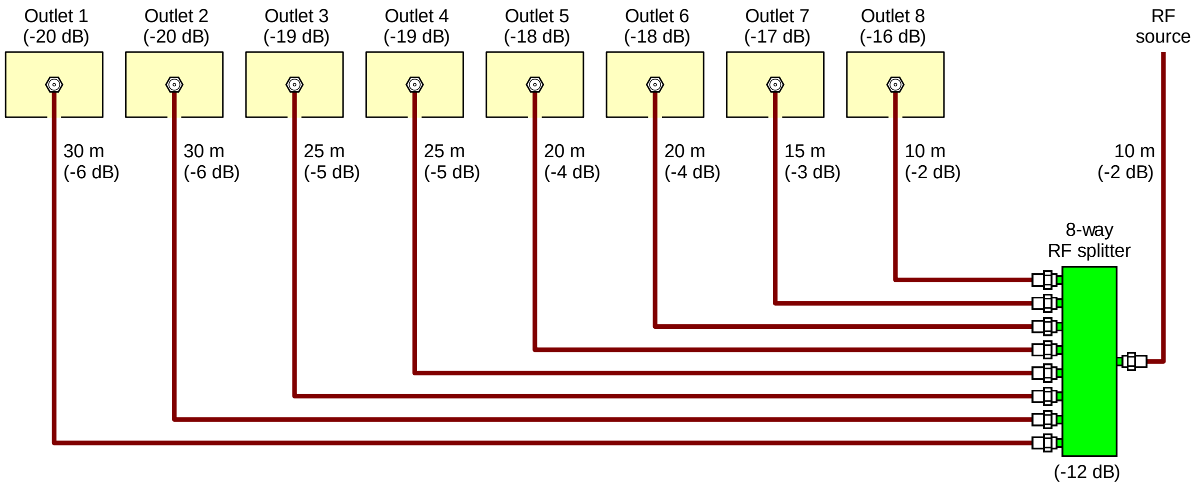


Notes:

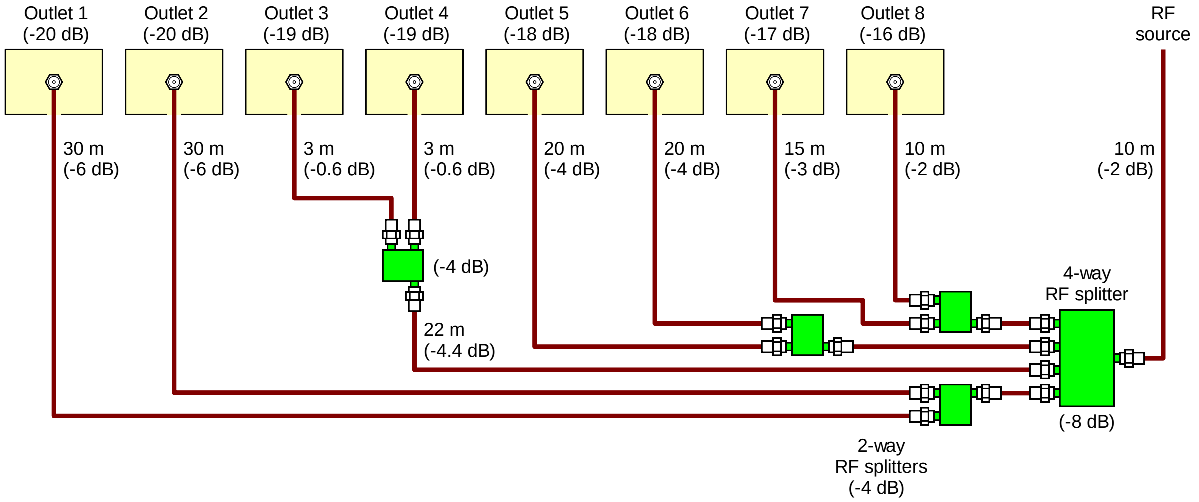
1. A combination of 4-way and 2-way splitters may be used to provide six outlets. The 2-way splitters should be connected in the shortest cable runs to ensure a reasonable balance in RF power levels between outlets.
2. The highest insertion loss (between the RF source and Outlets 3 and 4) will be 18 dB while the lowest loss (Outlet 2) will be 15 dB. If the RF power level at the source is 74 dBµV, the lowest wall plate level will be 56 dBµV at Outlets 3 and 4 and the highest wall plate level will be 59 dBµV at Outlet 2. Therefore, all wall plate levels will be within specification for digital RF sources (refer to 10.8.5.4) but RF amplification will be required for satisfactory analogue TV reception.

Figure 162 Eight TV outlets connected to an FTTP NTD or external TV antenna

(a) Using an 8-way splitter



(b) Using 4-way and 2-way splitters



Notes:

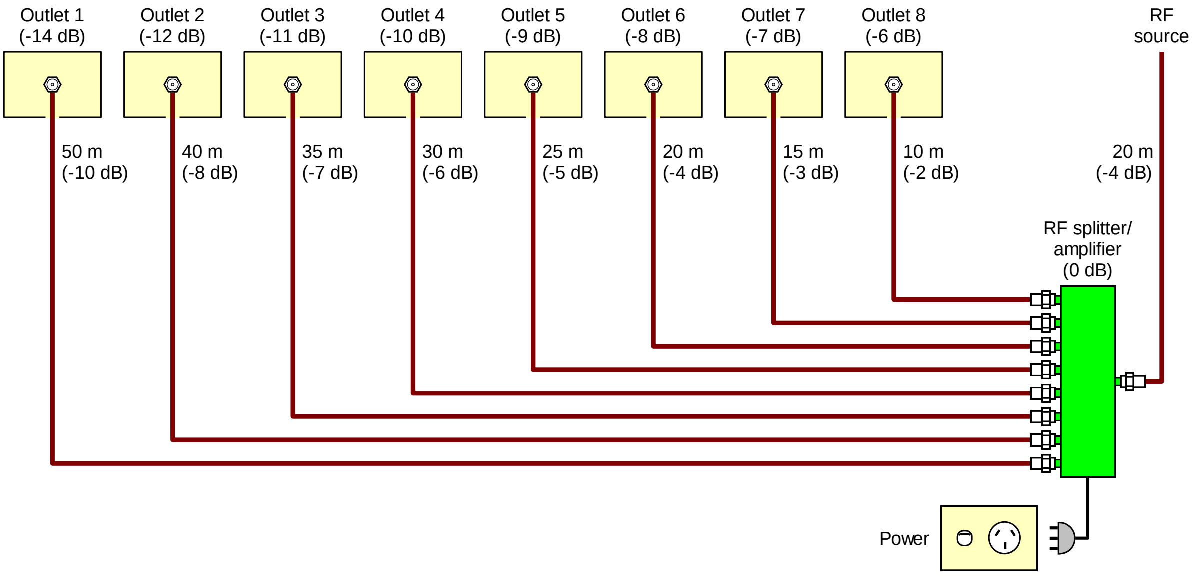
1. Assuming an RG6 coaxial cable loss of 0.2 dB per metre (rounded up to include F-connector losses — see Table 8 and Table 12) and a splitter loss of 12 dB (see Table 9), the total insertion loss of the cabling between the RF source and Outlet 1 will be 20 dB while the total loss between the RF source and Outlet 8 will be 16 dB. Remember that loss is expressed in the negative, i.e. by using a minus (-) sign.
2. If the RF power level at the source is 74 dBµV, deduct 20 dB to give a wall plate level of 54 dBµV at Outlet 1 and deduct 16 dB to give a wall plate level of 58 dBµV at Outlet 8. In this case, the levels at all wall plates will be just within specification for all digital RF sources (refer to 10.8.5.4). However, if the RF power level at the source is lower than 74 dBµV (as will likely be the case if the RF source is an FTTP NTD), an RF amplifier will be required.
3. Identical results can be achieved using either an 8-way splitter, as shown in (a), or a combination of 4-way and 2-way splitters as shown in (b). In the latter case, some cabling economy may be achieved by running a single coaxial cable to feed two outlets and locating a 2-way splitter at the end of the run (e.g. for two adjacent outlets) as shown for Outlets 3 and 4. However, method (a) is recommended for future upgrade/repair reasons.

10.8.5.6 Amplification and equalisation

Where cabling losses are excessive or the RF source signal is too weak, it will be necessary to install an RF amplifier to boost the signal to an acceptable level. For multiple TV outlets, a combined splitter and amplifier may be used as shown in Figure 163. Combined splitter/amplifiers usually have a zero gain or a low gain (which may be adjustable) between the input and the outputs because the amplifier merely boosts the signal to offset the losses of the built-in splitter. If using an amplifier that has variable gain control, it is important to select an amplifier for the installation that will operate at a minimum of 75% of its rated gain.

The amplifier may incorporate equalisation to compensate for greater attenuation at higher frequencies as described in 10.8.5.2.

Figure 163 Use of an RF amplifier to offset cable and splitter losses



Note: If the splitter/amplifier has a 0 dB gain and the RF power level at the source is 74 dBµV, deduct 14 dB to give a wall plate level of 60 dBµV at Outlet 1 and deduct 6 dB to give a wall plate level of 68 dBµV at Outlet 8. In this case, the levels at all wall plates will be within specification for both analogue and digital RF sources (refer to 10.8.5.4). Without the RF amplifier, the RF power level at outlet 1 with the added insertion loss of 12 dB using a passive 8-way splitter would be 48 dBµV, which would be too low for good analogue TV reception and marginal for digital RF sources.

10.8.6 Cabling method

10.8.6.1 General

Coaxial cables must be installed point-to-point from the RF source to the TV outlet or, where more than one outlet is required, they must be star wired (cabled radially) from an RF splitter (or a splitter/amplifier) that is connected to the RF source.

In the case of HFC, the splitter or amplifier is located in the outdoor isolation box and is installed by the service provider (a special amplifier with “active return” is required). In other cases, the splitter or amplifier may be located at the CCP for accessibility for repair or system alterations by a repairer or installer. However, if the CCP is not centrally located in the building such that there will be a combination of very long and very short cable runs to the TV outlets, it may be necessary to install attenuators in the shorter cable runs or install the splitter/amplifier in a central location to provide better balancing of the cable run lengths.

If the splitters and amplifiers are not installed at the CCP location, they should be installed where they can be easily accessed for testing or repair (e.g. near the access hole if located in the roof space).

10.8.6.2 Cable length limits

The total length of coaxial cable should not exceed:

- 25 m between an HFC isolation box and any wall plate (unless an RF amplifier is installed in the isolation box by the service provider)
- 30 m between an FTTP NTD and any wall plate (unless an RF amplifier is installed by the cabler)
- 45 m between an IR (Infra-Red) emitter and an IR target where the IR signals are modulated via the coaxial cabling (e.g. Clipsal StarServe®)
- 50 m in all other cases.

10.8.6.3 Number of outlets

The maximum number of outlets that may usually be provided are as follows:

- for HFC networks — 3 without an RF amplifier (an amplifier may be required for 4 or more outlets)
- for FTTP networks — 4 without an RF amplifier (an amplifier may be required for 5 or more outlets)
- for FTA TV networks — usually 4 without an RF amplifier but, depending on signal strength from the antenna, up to 8 outlets may be possible without the need for an RF amplifier for digital TV reception.

10.8.6.4 Combining RF sources

Some RF sources may be combined ("diplexed") into the same coaxial cabling system to reduce the amount of cabling required. In some cases, there is little advantage in combining the RF sources in a home because the services must be connected to separate equipment at the outlet anyway. Examples of separate RF sources that may be combined for access by common equipment at the TV outlet are:

- a TV antenna and an FM radio antenna (although these are usually connected to separate equipment, e.g. TV equipment and an FM radio/tuner)
- a Band III (VHF) antenna and a Band IV / V (UHF) antenna pointed in different directions or with different polarisation (e.g. fringe/rural areas)
- closed circuit TV (CCTV), e.g. security cameras
- modulated RF from the A/V output of a video player such as a DVR or STU (see 10.8.6.5)
- satellite TV (this requires the use of a "multiswitch" such as the one pictured in Figure 176).

The following RF sources must be connected to separate, dedicated coaxial cabling systems:

- DAB+ antenna cabling (Note 1);
- HFC ("Cable") internet or pay TV cabling (Note 2);
- satellite internet cabling; and
- 3G/4G wireless external coaxial antenna cabling (this is normally provided by the service provider anyway).

Notes:

1. While TV, FM radio and DAB+ co-exist in free air, DAB+ is always vertically polarised but TV/FM may be either horizontally or vertically polarised. Therefore, separate antennas will need to be used in mainland capital cities and in some regional areas. The DAB+ antenna may pick up some TV signals, in which case combining the TV and DAB+ antenna outputs may cause unreliable TV and digital radio reception.
2. HFC operates in the same bandwidth as free-to-air TV and some radio bands but is an enclosed system, so it will not interfere with, or be interfered by, other RF systems as long as it is kept totally separate from such systems.

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10.8.6.5 Injection of local RF sources

A locally generated RF signal (e.g. a channel from a CCTV camera or a home entertainment system) may be injected into the TV cabling, as long as the locally generated signal is transmitted on a non-broadcast channel (refer to Table 7) that is spaced at least two channels apart from any other active channel (see the Note below). The RF signal may be generated by a device called an "RF modulator" that converts the audio/video signals from a set top box or a video player/recorder to an RF channel that can be accessed by a TV receiver tuned into that channel.

Notes:

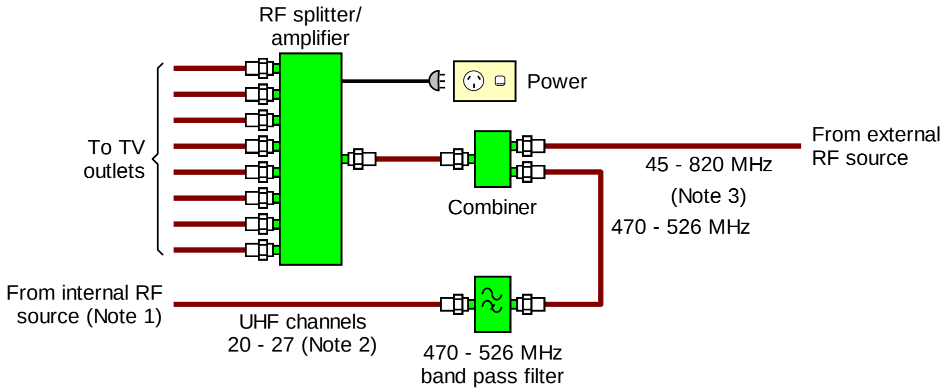
1. At present, most internal RF sources such as CCTV cameras and RF modulators will only generate analogue TV signals. It may be some time before consumer equipment that generates digital TV signals will be available but, even then, the signal may not be high definition. Therefore, for the present at least, the TV receivers must have analogue tuners to be able to view the internal RF channels.
2. The internal RF source may introduce additional noise into the cabling system. Due precautions need to be taken to ensure that the RF source does not inject noise into the system.

The local RF signal may be injected into the cabling system using a combiner, diplexer or directional coupler in conjunction with a suitable band-pass filter as shown in Figure 164. Alternatively, a suitable diplex filter may be used that incorporates the appropriate band-pass filter on the local signal input port. The band-pass filter should have a stop band rejection greater than 20 dB. The local signal can then be picked up by any TV set in the home by simply tuning in to the relevant channel.

The additional loss introduced by combining a local signal with other RF signals will usually necessitate the use of an RF amplifier and the RF amplifier may incorporate one or more diplexers or "RF modulator" inputs as shown in Figure 175 (b) and Figure 176.

Another option is to use high-definition audio/video (HDAV) or HDBaseT streaming over UTP data cables as shown in Figure 165. These devices will require the installation of additional data cables but they have the advantage of being able to distribute program content in high definition.

Figure 164 An example of injection of locally generated TV channels (e.g. CCTV or an RF modulator connected to an A/V output of the home entertainment system)



Notes:

1. At present, most internal RF sources such as CCTV cameras and RF modulators will only generate analogue TV signals. It may be some time before consumer equipment that generates digital TV signals will be available but, even then, the signal may not be high definition. Therefore, for the time being at least, the TV receivers must have analogue tuners to be able to view the internal RF channels. An alternative option is to use high-definition audio/video (HDAV) or HDBaseT streaming over UTP data cables as shown in Figure 165.
2. The channels generated by internal RF sources must be vacant channels to avoid interference with channels from the RF source. In general, channels 20 to 27 may be used if the RF equipment is capable of generating these channels and the TV receivers are capable of receiving them (most modern TV equipment can be tuned to some of the non-broadcast channels listed in Table 7). Where the RF source is a Telstra FTTP NTD, only channels 0, 1 and 2 can be used (these channels are frequency-shifted to other channels at the FTTP headend).
3. The input RF power levels to the combiner should be similar. The difference should be no more than 4 dB between any channels.

Figure 165 Distribution of locally generated TV signals using UTP data cables

Clipsal HDAV main unit front

Clipsal HDAV main unit rear

Clipsal HDAV remote unit (“balun”) front

Clipsal HDAV remote unit (“balun”) rear

Notes:

1. This type of equipment has the capacity to provide high-definition audio and video distribution from an internal RF source at reasonable cost. The above devices use two Ethernet cables for each distribution leg.
2. These are **not** Ethernet devices but use Ethernet (e.g. Category 6) cables for distribution of the audio/video signals.
3. A possible alternative technology is HDBaseT — refer to www.hdbaset.org for more information.

10.8.6.6 Patching of coaxial cables

End-user patching of coaxial cables at the CCP is not recommended for safety and technical reasons.

Note: The outer conductor of coaxial cable is a live conductor and an electrical shock hazard may be present on the metallic body of any coaxial connector under certain conditions. Also, poor coaxial connections (such as loose connectors) can degrade system performance and allow the egress of RF signals creating electromagnetic interference (EMI).

10.8.7 Cabling tools and practices

10.8.7.1 Tools

10.8.7.1.1 RF field strength meter

RF field strength meters are an essential tool to test signal strength ("RF power level") and signal quality at the RF source, wall plates and intermediate points where necessary. Different meters are generally required to measure HFC (Cable internet/pay TV), TV antenna (and FTTP NTD) and satellite signals — although some meters are available that are capable of testing more than one type of RF source.

Figure 166 Typical RF signal strength meter ("field strength meter")

Meter with a monochrome LCD display

Meter with a miniature colour TV screen

10.8.7.1.2 Cable cutter

Coaxial cable should be cut squarely prior to termination using a cutting tool that does not appreciably distort the end of the cable so that it may be properly prepared using a cable stripper designed for the purpose. Coaxial cable cutters have concave cutting jaws that tend to slice, rather than crush, the cable.

Figure 167 Coaxial cable cutter

Cheaper cable cutter (usually for copper only)

This type of cutter will usually be damaged if used to cut coaxial cable with a copper-clad steel inner conductor.

Cutter for use on copper-clad steel

This cutter has a specific notch for cutting the copper-clad steel inner conductor

Notes:

1. This type of cutter has concave cutting jaws to minimise distortion of the cable at the cutting point.
2. The centre conductor of RG6 and RG11 coaxial cables consist of copper-clad steel. Most coaxial cable cutters do not support cutting of steel conductors and this may be marked on the cutter, e.g. "CUT COPPER ONLY" or "NOT FOR STEEL". However, cutters designed to cut copper-clad steel are available but they are more expensive, hard to get in Australia and may only be available by mail order.

10.8.7.1.3 Cable stripper

A coaxial cable stripper has two appropriately spaced cutting blades to prepare the cable for termination in the connector.

A coaxial cable stripper may have adjustable blades for use with different types of cable. A stripper with incorrect blade settings can score the centre conductor or remove excess outer conductor and degrade cabling performance. A stripper with fixed blades designed exclusively for use on the type of cable being installed is recommended.

Figure 168 A typical coaxial cable stripper

Notes:

1. The above stripper has adjustable blades for different types of cable (e.g. RG59 and RG6) but will damage the cable if it is not adjusted correctly.
2. A correctly prepared coaxial cable for termination on an F-connector (see 10.8.7.2.4) will remove 6 mm of dielectric and 6 mm of cable sheath, as described in 10.8.7.4, and will not cut any braid conductors of the shield or score the inner conductor.

10.8.7.1.4 Compression tool

Compression tools are necessary to fit compression type F-connectors (see 10.8.7.2.4) to coaxial cable. A range of compression tools are available to terminate connectors on various types of coaxial cable.

It is important to use a tool that is compatible with the brand of connector being used.

Figure 169 A typical compression tool

Note: The compression tool must be compatible with the brand of compression connector used. Check the tool manufacturer's information for a list of compatible connectors.

10.8.7.1.5 F-connector spanner

F-connectors are used for coaxial cable connections and are described in 10.8.7.2.4. An F-connector spanner is handy for fitting a connector in a tight space and for finger-tightening the connector as described in 10.8.7.5.

Figure 170 F-connector spanner

10.8.7.1.6 Torque wrench

A loose connector can cause excessive signal loss and noise in a cabling system. Connectors must be firmly tightened and yet not overtightened, otherwise the connector or the equipment that is being connected may be damaged. Torque wrenches are available for use with F-connectors (see 10.8.7.2.4) and are recommended.

Figure 171 Torque wrench

Note: The correct tension for tightening F-connectors is 20-30 inch pounds. With the above type of torque wrench, when the correct tension is reached, the tool "clicks".

10.8.7.2 Cable and components

10.8.7.2.1 Nominal impedance

All cable and components used for RF distribution as described in this document have a nominal impedance of 75 ohms. For an explanation of nominal impedance, refer to 4.14.4.3 on page 36.

Note: Cable and components with a nominal impedance of 50 ohms are commonly available. These are generally for data (LAN) or amateur radio applications and should not be used for TV cabling.

10.8.7.2.2 Bandwidth

Coaxial cable and components used for satellite TV should be rated for frequencies between 950 MHz or lower and 2.15 GHz or higher, while cable and components for all other RF services should be rated between 5 MHz and 862 MHz or higher. Any components used for satellite TV must be able to pass DC power from the set top box to the LNB and transceiver at the satellite dish.

Cable and components are often rated for both satellite TV cabling and terrestrial TV cabling (i.e. for 5 MHz to 2.15 GHz) and may be used for either purpose.

10.8.7.2.3 Cable

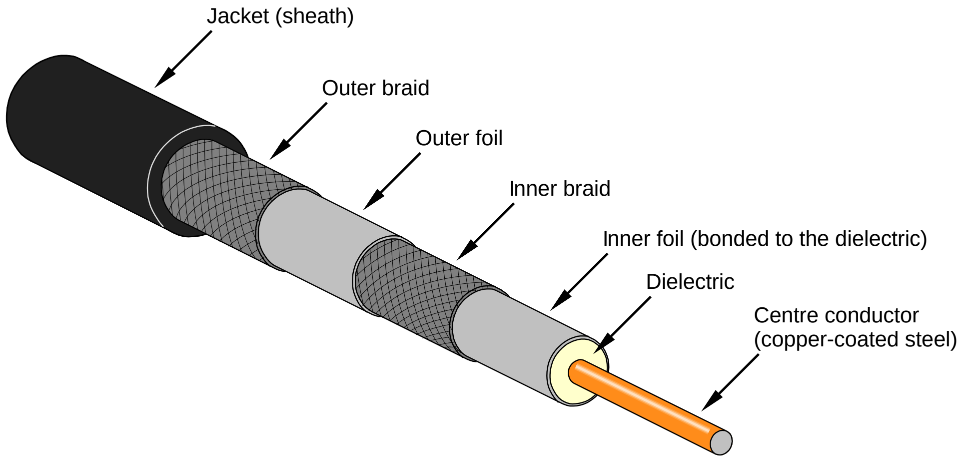
The two types of cable that may be used for coaxial cabling installations described in this document are commonly referred to as "**RG6**" (7 mm - 8 mm diameter) and "**RG11**" (10 mm – 11 mm diameter). Like the "RJ" (Registered Jack) designations used for modular plugs and sockets, the "RG" (Radio Guide) designations have no formal status and care needs to be exercised when selecting cables purported to be "RG6" or "RG11". Service providers such as Telstra and FOXTEL specify their minimum performance requirements for coaxial cable and components that are to be used to connect their services, so it is important to select products that meet these requirements (see 10.8.12) or, for FTA TV or satellite TV, the requirements set out in Australian Standard AS/NZS 1367, *Coaxial cable and optical fibre systems for the RF distribution of analogue and digital television and sound signals in single and multiple dwelling installations*.

RG6 cable is available as "quadshield" (with four shield layers) or "trishield (with three shield layers). **RG6 quadshield** coaxial cable should be used (while trishield is acceptable to some service providers, quadshield is recommended due to its superior shielding performance). RG11 cable is only available as quadshield and may be used for reducing cable loss in some circumstances but it is expensive and difficult to install. The use of RG11 coaxial cable is not recommended in homes.

RG6 and RG11 cables have a copper-clad steel centre conductor and alternate layers of foiled and braided aluminium for the outer conductor. The inner and outer conductors are separated by a dielectric usually made of solid, gas-expanded polyethylene material. The four shield layers of quadshield coaxial cable comprise a lapped tape foil bonded to the dielectric providing 100% coverage, a braid that provides at least 60% coverage, another lapped tape foil providing 100% coverage, and another braid that provides at least 40% coverage. The cable jacket (sheath) should be made of black PVC for indoor or outdoor (antenna) use. Refer to Figure 172.

Another type of coaxial cable that may be used specifically for connection of closed circuit television (CCTV) cameras is **RG59**. This type of cable has only one layer or two layers of shielding (outer conductor) and is quite thin (5 mm – 6 mm diameter), which makes it easier to terminate on a BNC type connector commonly used for domestic CCTV cameras. These cameras usually operate on a single analogue VHF or UHF channel and don't require the higher performance RG6 coaxial cable. RG59 cable should not be used for any other part of the coaxial cabling system.

Figure 172 Quadshield coaxial cable



Note: Trishield coaxial cable does not have the outer braid.

10.8.7.2.4 Connectors

Coaxial connectors should be suitable for the type of cable used.

The standard connector for use with RG6 and RG11 cables used for generic cabling systems is the F-type connector ("**F-connector**"). This connector has a threaded body (for the outer conductor connection) and uses the centre conductor of the coaxial cable as the centre pin of the male connector. The body of the female connector is threaded while the centre pin connection comprises a pair of "fingers" designed to clasp onto the centre conductor of the cable terminated in the male connector. Only the male connector is designed to terminate coaxial cable. The female connector is usually mounted on a wall plate or on the equipment or forms part of an adaptor.

There are two styles of male F-connector commonly available — the newer compression type connector and the older hex-crimp type connector (see Figure 173). Hex-crimp connectors are fastened to the cable by a tool that produces a six-sided crimp, applying pressure at six points around the cable. A compression connector uses a conical compression technique that provides even pressure around the entire circumference of the cable, maintaining the integrity of the cable structure and the impedance of the connection while providing superior pull-out resistance and shielding performance.

There are also two connector categories — internal and external (indoor and outdoor). External type connectors must be used for outdoor connections such as at a TV antenna, satellite dish or within any outdoor enclosure. External rated connectors have special seals to inhibit the entry of moisture. However, irrespective of the connector design, any connection that may be exposed to the weather or moisture should be further protected against the ingress of water (particularly around the threaded section) by the use of self-amalgamating tape that is stretched and wrapped around the connection and covered by a suitable rubber boot or UV-resistant heat-shrink tubing.

The most common coaxial connector currently used for TV antenna **wall plates** in homes and on **TV appliances** is the **PAL** or **Belling-Lee** connector. This is a low-performance, friction-fit connector that has a nominal impedance of around 50 ohms and should not be used for new coaxial cabling. All new connections and wall plates should use F-connectors and, where necessary, adaptors or adaptor fly leads should be used to connect consumer equipment with PAL connectors to the coaxial cabling system. Nevertheless, if the customer insists on the use of PAL connectors on wall plates (which is allowable for FTA TV antenna cabling only), a wall plate connector ("mech") should be used that has an F-connector on the cable (cavity) side of the wall plate (see Figure 177).

Figure 173 F-type coaxial connectors (F-connectors)

Female (barrel) connector | **Compression type male connector** | **Hex-crimp type male connector**

Note: Only compression type male F-connectors are approved by some internet or pay TV service providers and they are recommended in preference to hex-crimp type connectors for digital TV installations. FOXTEL-approved connectors have "FOXTEL" marked on them. While hex-crimp connectors are readily available, many are of poor quality and should not be used. Good quality hex-crimp connectors that comply with AS/NZS 1367 or that meet service providers' specifications are increasingly hard to get as the manufacturers are ceasing manufacture of them.

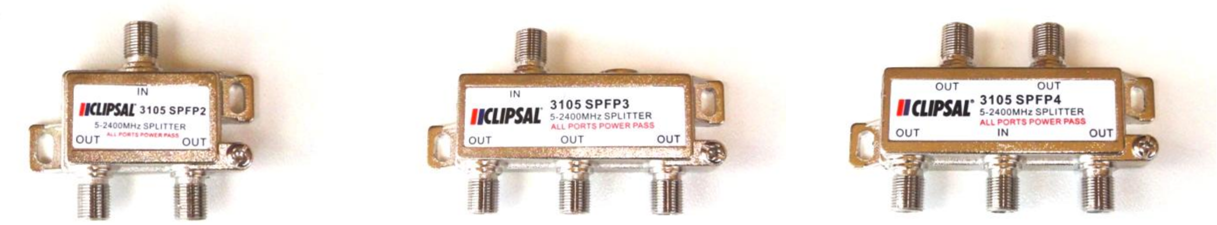
10.8.7.2.5 Splitters and diplexers

Splitters are used to provide two or more access points (outlets) in the home. Cables to multiple outlets cannot be simply connected together like telephone cables, as this will cause impedance mismatches, signal reflections and excessive signal loss. Splitters provide a proper termination for each cable, maintain impedance balance and also provide some isolation (called "RF isolation" or "mutual isolation") between the outputs of the splitter to prevent mutual interference between the output cables and the equipment connected to them.

Because splitters divide the signal, they incur signal loss between the input and each output leg. For example, if the signal is split two ways, each output leg should get half the input signal level, which equates to a 3 dB loss between the input and the output (see 10.8.5.1). In reality, some signal energy is absorbed by the splitter circuitry, so the real loss between the input and each output of a 2-way splitter is somewhere between 3.5 dB and 4 dB.

Figure 174 Typical RF splitters

2-way splitter | **3-way splitter** | **4-way splitter**



Note: Splitters should include a screw terminal connection on the body for earthing purposes (refer to 10.8.8.2).

10.8.7.2.6 Amplifiers

Where cable and splitter losses are so high that the proper RF power level will not be available at one or more outlets (wall plates), it will be necessary to install an RF amplifier. Some amplifiers are combined with splitters and diplexers and merely compensate for the losses incurred by the splitters, in which case they may be referred to as an “active splitter”, “splitter/amplifier” or “zero gain amplifier”. Some amplifiers have a fixed gain while others may have variable gain adjustable by the installer. It is important to select an amplifier for a particular installation that will operate at a minimum of 75% of its rated gain. Most amplifiers incorporate “equalisation” or “slope” to compensate for higher signal losses at higher frequencies.

Masthead amplifiers

In some cases, the RF signal may be so low at the TV antenna that it is necessary to install an amplifier on the antenna mast (called a “masthead amplifier”) to compensate for expected signal loss along the length of cable before it gets to an access point inside the building. The amplifier is powered via the coaxial cable from a “power injector” located inside the building and which is inserted in the coaxial cabling at a convenient point where a power point is available. If a splitter is used between the amplifier and the power injector, the power injector must be connected to a “power pass” port of the splitter.

A masthead amplifier should be placed within 600 mm of the antenna on the mast and connected directly to the down lead from the antenna balun. Most masthead amplifiers have separate input connections for separate VHF and UHF antennas but will allow a single connection from a combined VHF/UHF antenna. It is important to use an amplifier that is fully contained within a shielded enclosure like the one shown in Figure 175 (a). The shielding will prevent the ingress of impulse noise to the amplifier and the egress of RF signals that may disturb other systems or equipment.

HFC amplifiers

Amplifiers used for HFC (cable) must provide a “return path” for data transmission from the modem or gateway to the internet. These amplifiers are installed by the service provider.

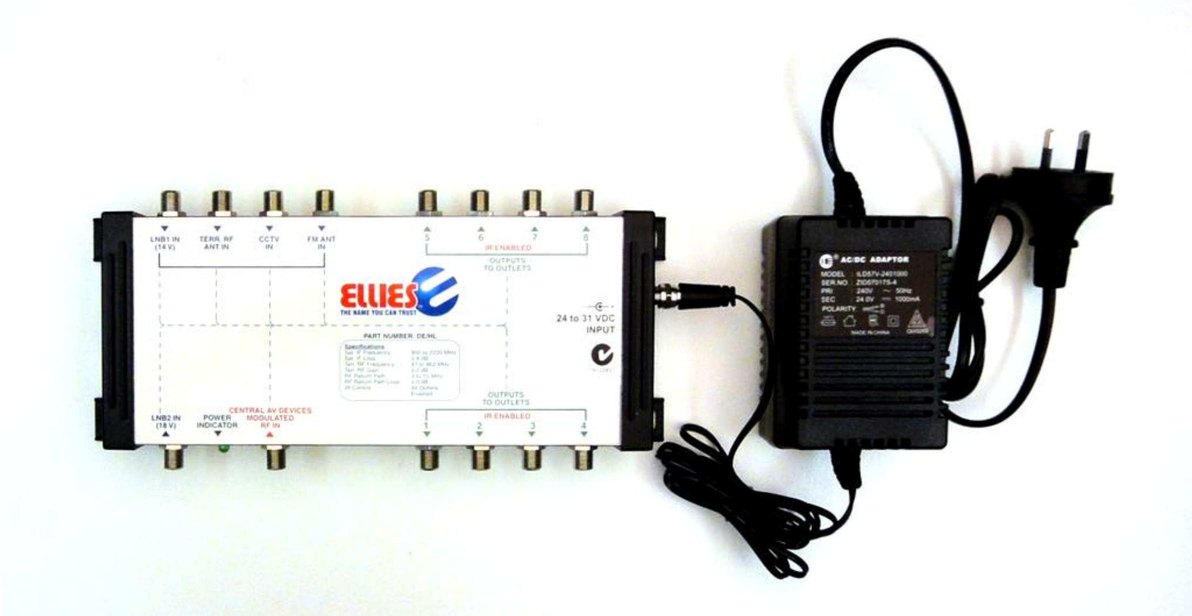
Figure 175 Typical RF amplifiers for terrestrial free-to-air TV

(a) Masthead amplifier **(b) Indoor splitter/amplifier**

Notes:

1. It is important to select an amplifier for a particular installation that will operate at a minimum of 75% of its rated gain.
2. A masthead amplifier should only be used where there is a weak signal at the antenna. A masthead amplifier is exposed to the elements, susceptible to interference from impulse noise and may radiate RF signals to the neighbourhood if not properly shielded or has a loose connection.

Figure 176 A domestic "multiswitch" for distribution of satellite TV and other RF sources



Note: This type of device makes it relatively easy to combine multiple RF sources, including satellite TV, for distribution to multiple outlets over a common cabling system. However, it is **not** suitable for HFC.

10.8.7.2.7 Wall plates (outlets)

A wall plate is an access point for consumers and contains one or more coaxial connectors. All coaxial wall plates should use F-connectors as shown in Figure 177 (a). The F-connector on a wall plate uses a threaded connection on both the front and the rear of the socket, as shown in Figure 177 (b).

PAL (Belling-Lee) connectors are invariably used on TV appliances and on the fly leads supplied with those appliances, so a customer may insist on the installation of PAL connectors on wall plates for convenience. However, F-connectors have superior performance and should be used for all coaxial cable connections where possible (see 10.8.7.2.4). PAL connectors must **not** be used for HFC or satellite connections. Where PAL connectors are used, they should be the type that has an F-connector on the rear for connection of the fixed coaxial cabling as shown in Figure 177 (c).

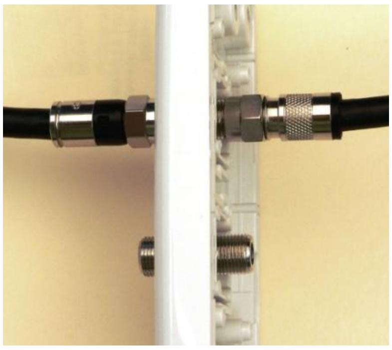
The wall plate may be shared with other connecting devices, such as data sockets, but it is recommended that no more than four connecting devices be fitted to any wall plate that has coaxial connections (see 10.8.7.6).

A coaxial outlet (wall plate) is called a "Broadcast Outlet" (BO) in AS/NZS ISO/IEC 15018 but this is not a well-known term, so it's just called a "TV outlet", "coaxial outlet" or simply a "wall plate" in this document.

Figure 177 Coaxial wall plate

(a) A typical dual-socket TV outlet

(b) F-type coaxial cable connectors



(c) PAL socket with rear F-connector

10.8.7.2.8 Antennas

TV antennas are designed to receive all or selected television bands and may need to be horizontally or vertically polarised, depending on how the signal is transmitted from the broadcasting antenna (see Figure 178). FM radio antennas are specifically designed to receive the FM radio band (87.5 MHz to 108 MHz in VHF Band II) and may need to be installed separately, e.g. if the radio transmitter is in a different direction or has different polarisation to the TV transmitter.

While there is no such thing as a "digital antenna" per se (because analogue and digital channels are broadcast in the same bandwidth), digital TV will only be transmitted in Band III (VHF) and Bands IV and V (UHF), so digital TV antennas don't require the larger elements needed to receive analogue VHF Band I/II (channels 0 to 5). Band III is mainly used in state capital cities but is also used in some regional areas. Band IV tends to be used for local community stations whereas Band V is generally used for retransmission of programs in rural areas. As most cities are already transmitting digital TV, if an FM radio antenna is not required, it may only be necessary to install a Band III/IV antenna in state capital cities and applicable regional areas, and a Band IV/V antenna in most regional and rural areas.

Television bands, channels and frequency ranges are set out in Table 7 on page 194.

TV antennas have an impedance of 300 ohms, so they must always be connected to the coaxial cabling via a matching transformer called a "balun". Balun is short for "**bal**anced-**un**balanced", meaning it connects a 300 Ω balanced antenna to 75 Ω unbalanced coaxial cable. Some antennas incorporate a balun which means one doesn't have to be provided separately.

Figure 178 TV antenna polarisation

Horizontal polarisation

Vertical polarisation

Note: Horizontal polarisation is used in mainland capital cities and some regional areas.

10.8.7.3 Cable installation

Coaxial cables must be installed with care, as described in 10.9.4 (page 232), to ensure maximum performance. Stretching, sharp bending, kinking or crushing of the cable will permanently change the cable geometry and thus its impedance at the point where it is damaged, causing additional loss and signal reflections.

Coaxial cables should not be bent to a radius less than:

- **5 times** the cable diameter when **installed**; or
- **10 times** the cable diameter when **pulling** around corners or through conduit.

Notes:

1. Some Australian standards and handbooks specify a minimum bend radius of 10 times the cable diameter for installed coaxial cable. This may be an editorial error, i.e. the intent may have been to specify a bend **diameter** of 10 times the cable diameter. AS/NZS ISO/IEC 15018:2005, *Information technology — Generic cabling for homes*, specifies a minimum bend **radius** of 4 times the cable diameter for coaxial cable when installed and a minimum bend **radius** of 10 times the diameter for coaxial cable when pulling cable in.
2. Refer to Figure 200 on page 244 for an example of the actual bend diameter for RG6 coaxial cable.

All coaxial cable connections should be made using compression type F-connectors. Cables should be prepared with the correct coaxial cable stripping tool and connected with the correct compression tool.

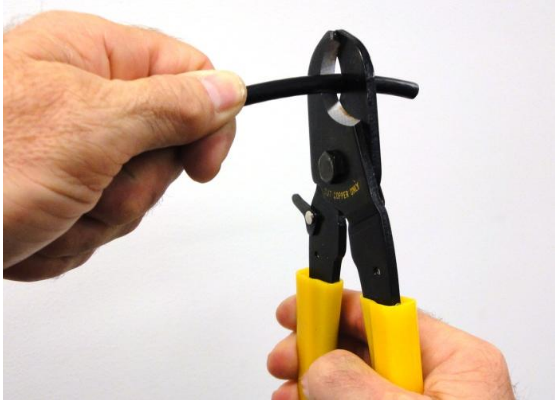
If a coaxial cable gets damaged, it should not be repaired (e.g. by jointing in a new length of cable to replace the damaged section) but should be totally replaced.

10.8.7.4 Terminating connectors

Terminate a compression type F-connector on quadshield RG6 coaxial cable as described below. The industry is moving away from the use of hex-crimp type connectors and good quality hex-crimp connectors are becoming hard to get, so procedures for fitting these are not included in this document.

Tool-less (e.g. "twist-on" type) terminations should **not** be used, as these are unreliable and do not provide the required shielding performance.

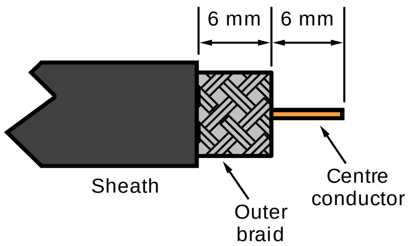
Preparing the cable



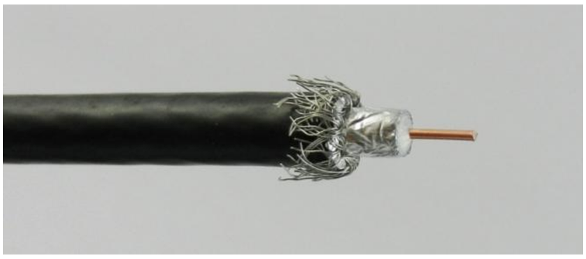
Cut the cable squarely using special coaxial cable cutters that minimise flattening of the cable during cutting (see 10.8.7.1.2).

Use an RG6 cable stripper or a properly adjusted multi-purpose coaxial cable stripper to remove the correct amount of dielectric and cable sheath.

- Open the jaws of the stripper, insert the cable to align the end of the cable with the edge of the stripper, then close the jaws on the cable.
- Hold the cable close to the stripper with one hand and rotate the stripper for three rotations around the cable with the other hand and then one rotation backwards.
- With the jaws of the stripper still closed, pull it away from the cable along the axis of the cable.
- Remove any loose material and ensure that the centre conductor hasn't been scored by the stripper blade and that no braid conductors of the shield have been cut.
- If the cable is trishield, it is acceptable for the outer foil to be cut, as it should be removed prior to termination anyway.



A properly stripped cable should have 6 mm of centre conductor and 6 mm of the outer conductor exposed as shown at right. It is important not to nick or scratch the centre conductor, as the thin copper cladding carries most of the signal due to "skin effect" at radio frequencies. A cut or scratch could increase the conductor impedance, increase cable loss and cause signal reflections.



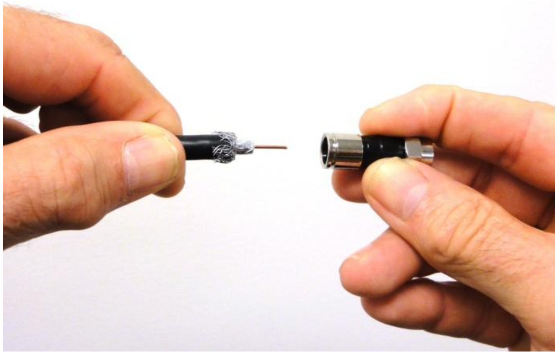
With your fingers, fold the braid back over the cable sheath.

- With trishield cable, the outer foil should be removed before folding the braid back.
- With quadshield cable, it is usually necessary to remove the outer foil before folding the inner braid back.

Fitting the connector

Inspect the prepared cable:

- Ensure that the inner foil bonded to the dielectric has remained intact.
- Examine the centre conductor closely to ensure that there is no trace of outer conductor (e.g. a piece of braid or slither of foil) shorted to the centre conductor and there is no dielectric sticking to it. If there is, scrape it off with your fingernail — do not use a knife or any other sharp object that may scratch the conductor.
- Try not to touch the centre conductor with your fingers, as the chemicals in the skin may lead to oxidation of the copper.

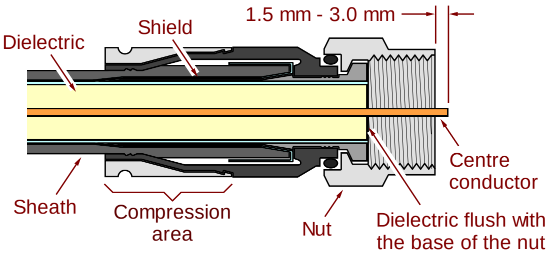


Push the prepared cable firmly into the connector until the dielectric is flush with the base of the threaded nut (see the images below right).

Insert the connector and cable in the compression tool along the axis of the plunger and squeeze the handle of the tool down as far as it will go. Then open the tool and remove the finished termination.

If necessary, trim the end of the centre conductor so that it protrudes between 1.5 mm and 3.0 mm past the edge of the connector, depending on the length of the threaded section of the nut (refer to the connector manufacturer’s instructions).

- If the manufacturer’s requirements are unknown, a suitable compromise is to cut the centre conductor 2.5 mm past the edge of the connector.
- Cut the conductor squarely using precision cutters that do not produce a bevelled cut (normal side cutters are unsuitable for this purpose).



10.8.7.5 Making connections

For all connections other than on consumer equipment, the male F-connector should be tightened to the female connector using a torque wrench set to 20-30 inch pounds.

If a torque wrench is not available, first hand-tighten the connector and then lightly turn it a further 0.5 mm to 1 mm (measured at the circumference of the nut) with a spanner.

F-connectors should only be finger-tightened on consumer equipment to avoid damaging the equipment (the connectors may be soldered to a relatively fragile printed circuit board inside the equipment).

10.8.7.6 TV outlet (wall plate) installation

The wall plate containing the coaxial connector should be mounted at the same height as the power outlets and TOs, which should not be less than 300 mm from the floor.

Coaxial connectors may be mounted on the same wall plate as data sockets but it is recommended that no more than three coaxial connectors be fitted to any wall plate.

Notes:

1. It is difficult to fit a number of RG6 coaxial cables, each with 200 mm to 500 mm of slack, behind the wall plate in most wall cavities and outlet boxes.
2. If an F-connector and a modular socket are to be fitted one above the other on the same wall plate, position the F-connector **above** the modular socket so that the end-user will have suitable finger access to the retaining clip at the bottom of any modular plug connected to the socket.

10.8.7.7 Adaptors

Various F-type adaptors are available for different applications. Examples are shown in Figure 179. It is important to refer to the manufacturer's data sheet for such adaptors to ensure that they comply with AS/NZS 1367, *Coaxial cable and optical fibre systems for the RF distribution of analogue and digital television and sound signals in single and multiple dwelling installations*, or the relevant service provider's specifications. Inferior adaptors can seriously degrade system performance.

Figure 179 Some F-type adaptors

Right-angle adaptor for use if there is insufficient space for a cable bend	PAL adaptor for connection to equipment that has a PAL socket	In-line attenuator to reduce the signal level at a particular TV outlet	BNC adaptor for connection of RG6 cable to a CCTV camera	75 ohm terminator for terminating unused ports on splitters/amplifiers

10.8.8 Earthing of the coaxial cabling system

10.8.8.1 Antennas

In accordance with Australian Standard AS 1417.1, *Receiving Antennas for Radio and Television in the Frequency Range 30 MHz to 1 GHz Part 1 — Construction and Installation*, to minimise static electricity charges and for lightning protection, the antenna mast, boom and any supporting structure should be earthed. The earthing connection should be made by the most direct route via a green/yellow insulated copper conductor with a minimum cross-sectional area of 2.5 mm² to one of the following points:

(a) directly to the external electrical earth electrode;

(b) if the electrical switchboard is located on the external wall of the building, to a common equipotential bonding point adjacent to the switchboard; or

(c) to a separate earth electrode complying with AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*, which should be separated from any other earth electrode or earthing conductor by a distance of at least 2 m.

Notes:

1. Connection of copper earthing conductors to galvanised steel or aluminium masts, booms or other structures will be extremely susceptible to corrosion, especially if exposed to the weather. Such connections need to be properly sealed against the ingress of moisture, including humid air.
2. In areas of high lightning activity, if the highest extremity of any part of the antenna, including the cable connected to it, is less than 2 m below the apex of the roof or more than 1.5 m from the building, a copper earthing conductor with a minimum cross-sectional area of 6 mm² should be used.

To reduce the severity of any atmospheric (lightning) discharge coming down the cable feed from the antenna to the equipment, an inductive loop (typically 3 turns of cable approximately 200 mm in diameter) should be formed in the outdoor portion of the cable feed (e.g. near the antenna connection).

10.8.8.2 Cable shields

The outer conductors (shields) of coaxial cables and coaxial components (e.g. connectors) are “live” conductors (i.e. they carry signals) and may be touched by end-users, especially at wall plates. Any live conductor that may be touched by the end-user has the propensity to deliver an electric shock which, at the very least, may be unpleasant. Earthing of the outer conductors is generally recommended to:

(a) ensure that no hazardous voltages are present on any cable, connector or accessible metalwork of any equipment due to accidental contact with 230 V AC power or faulty powered equipment;

(b) prevent voltage differences from occurring between separately earthed equipment; and

(c) bleed induced voltages and currents resulting from static discharge and the accumulation of leakage currents from powered equipment.

Note: Earthing of outer conductors will not totally eliminate the risk of minor electric shock caused by mains current leakage in unearthed (“double-insulated”) TV appliances when connecting or disconnecting coaxial fly leads.

Earthing of the outer conductors of coaxial cables may be achieved by means of a single green/yellow insulated, copper earthing conductor with a minimum cross-sectional area of 2.5 mm² connected between a Communications Earth Terminal (CET) or other earthing terminal to the metallic body of the RF splitter or RF splitter/amplifier to which the feeder cable from the antenna is connected. See section 11 for more information.

Notes:

1. The CET should be installed in accordance with the requirements of Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*, and should be located immediately under the electrical switchboard in accordance with Figure F3 of AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*. An additional earthing terminal should be located at any CCP patch panel whether or not the coaxial cabling emanates from the patch panel (refer to section 11).
2. Coaxial cabling from an FTTP NTD is earthed at the NTD and does not need to be separately earthed.
3. HFC cabling is separate, does not form part of the TV antenna cabling system and should **not** be earthed.

10.8.9 Testing of the coaxial cabling system

DC continuity and insulation resistance should be tested using a multimeter on each length of terminated coaxial cable (i.e. between F-connectors) to ensure that there are no open-circuits or short-circuits. The cable under test should be disconnected from any splitter, amplifier, balun or equipment before testing as these may provide a resistive termination that will falsely indicate a short-circuit on the cable under test.

The completed installation should be tested at the wall plates with an RF field strength meter for all channels that will be received, including any RF-modulated channels, to check signal quality (see 10.8.5.1.2) and to verify that the RF power levels are within the limits described in 10.8.5.4. For FTA TV (DVB-T), the RF power level should not vary by more than 4 dB between channels at any wall plate.

Note: For HFC and satellite broadband or pay TV cabling, there will be no RF source signal until the service is connected. The RF power levels listed in 10.8.5.3 may be used as a guide to calculate or simulate RF power levels at the wall plates.

10.8.10 Termination of unused splitter/amplifier ports and outlet connectors

Unused output (or input) ports of splitters or amplifiers should be terminated with a 75 ohm terminator (see Figure 179) to maintain proper system impedance to avoid signal reflections. It is important to fasten these terminators as described in 10.8.7.5 for the reason stated in (b) below. However, unused connectors on **outlets** (wall plates) should **not** be terminated with a 75 ohm terminator for the following reasons:

(a) This should be unnecessary because the characteristic impedance of any length of coaxial cable over, say, one metre will effectively terminate the connection (refer to 4.14.4.3 on page 36).

(b) A loose terminator will have an antenna effect for the RF signals and may cause disturbance of the RF system or to other systems or equipment in the vicinity.

(c) The customer will need to remove the terminator to connect a TV appliance (which may require the use of a tool if it has been tightened correctly) and fail to reinstate it if the appliance is subsequently disconnected, achieving the same result as if the terminator hadn't been fitted in the first place.

10.8.11 Labelling of cables and outlets

Cables should be labelled at each end to assist fault-finding. Where the wall plate has more than one coaxial connector, the connectors should be labelled to assist the consumer, e.g. "TV" or "FTA", "FM" or "RADIO", "PAY TV" or "FOXTEL".

10.8.12 Coaxial cabling specifications

General performance requirements for coaxial cabling components are set out in Table 8 to Table 12.

Note: These apply for Telstra HFC cabling (for BigPond Cable internet and FOXTEL) and for coaxial cabling from a Telstra FTTP NTD, and may be used as a guide. For requirements specific to digital FTA TV and satellite TV, refer to Australian Standard AS/NZS 1367, *Coaxial cable and optical fibre systems for the RF distribution of analogue and digital television and sound signals in single and multiple dwelling installations*.

Table 8 Telstra coaxial cabling material specifications — Cable

Nominal impedance	RG6 / RG11	75 ohms
RF insertion loss	RG6	Less than or equal to 18 dB / 100 m @ 750 MHz
	RG11	Less than or equal to 12 dB / 100 m @ 750 MHz
Return loss	RG6 / RG11	Greater than or equal to 18 dB in the range 5 MHz to 500 MHz and Greater than or equal to 15 dB in the range 500 MHz to 860 MHz
Screening effectiveness	RG6 / RG11	Greater than or equal to 120 dB in the range 5 MHz to 1000 MHz in accordance with the "GTEM" technique described in SCTE IPS-TP-403 or Greater than or equal to 75 dB in the range 5 MHz to 1000 MHz in accordance with the "absorbing clamp" technique described in Clause 4.2.2.1 of Pr EN 50083-2

Table 9 Telstra coaxial cabling material specifications — RF splitters

Ports		F-type barrel (female connector)
Nominal impedance		75 ohms
Minimum operating bandwidth		5 MHz to 860 MHz
RF insertion loss (input to output)	2-way	Less than or equal to 4 dB at 750 MHz
	3-way	Less than or equal to 7 dB at 750 MHz
	4-way	Less than or equal to 8 dB at 750 MHz
Return loss	2-way	Greater than or equal to 18 dB at 750 MHz
	3-way	Greater than or equal to 15 dB at 750 MHz
	4-way	Greater than or equal to 12 dB at 750 MHz
Mutual isolation between output ports	2-way	Greater than or equal to 22 dB at 750 MHz
	3-way	Greater than or equal to 22 dB at 750 MHz
	4-way	Greater than or equal to 20 dB at 750 MHz
Screening effectiveness	RG6 / RG11	Greater than or equal to 120 dB in the range 5 MHz to 1000 MHz in accordance with the "GTEM" technique described in SCTE IPS-TP-403 or Greater than or equal to 75 dB in the range 5 MHz to 1000 MHz in accordance with the "absorbing clamp" technique described in Clause 4.2.2.1 of Pr EN 50083-2

Table 10 Telstra coaxial cabling material specifications — RF amplifiers

Ports		F-type barrel (female connector)
Nominal impedance		75 ohms
Minimum operating bandwidth		5 MHz to 860 MHz
Channel loading		83 x 8 MHz channels
Response flatness		±0.5 dB
RF gain		Sufficient to produce an RF power level within the limits stated in Table 3 after all cable, splitter and connector losses
Noise figure		Less than or equal to 4 dB
Hum modulation		Greater than or equal to 60 dB
Group delay		Less than or equal to 20 nS
Ambient temperature range		-10° C to +60° C
Electrical safety		Meets EN60065 electrical safety requirements
Distortions CTB/CSO	20 dBmV input for PAL 77 ch (NTSC 110 ch)	Less than or equal to 62 dB for CSO Less than or equal to 69 dB for CTB
Mutual isolation between output ports		Greater than or equal to 24 dB at 750 MHz
Return loss		Greater than or equal to 18 dB in the range 5 MHz to 500 MHz and Greater than or equal to 15 dB in the range 500 MHz to 860 MHz
Screening effectiveness		Greater than or equal to 120 dB in the range 5 MHz to 1000 MHz in accordance with the “GTEM” technique described in SCTE IPS-TP-403 or Greater than or equal to 75 dB in the range 5 MHz to 1000 MHz in accordance with the “absorbing clamp” technique described in Clause 4.2.2.1 of Pr EN 50083-2

Note: RF amplifiers used for HFC cabling must support an RF “return path” for data transmission in both directions.

Table 11 Telstra coaxial cabling material specifications — Outlets

Ports	F-type barrel (female connector) front and rear
Nominal impedance	75 ohms
RF insertion loss	Less than or equal to 0.1 dB in the range 5 MHz to 500 MHz and Less than or equal to 0.2 dB in the range 500 MHz to 860 MHz
Securing to wall plate	Captive nut — the F-type barrel must not be able to spin when the F-connector is tightened
Screening effectiveness	Greater than or equal to 120 dB in the range 5 MHz to 1000 MHz in accordance with the “GTEM” technique described in SCTE IPS-TP-403 or Greater than or equal to 75 dB in the range 5 MHz to 1000 MHz in accordance with the “absorbing clamp” technique described in Clause 4.2.2.1 of Pr EN 50083-2

Table 12 Telstra coaxial cabling material specifications — F-connectors

Nominal impedance	RG6 / RG11	75 ohms
RF insertion loss	RG6 / RG11	Less than or equal to 0.1 dB in the range 5 MHz to 500 MHz and Less than or equal to 0.2 dB in the range 500 MHz to 860 MHz
Return loss	RG6 / RG11	Greater than or equal to 18 dB in the range 5 MHz to 500 MHz and Greater than or equal to 15 dB in the range 500 MHz to 860 MHz
Screening effectiveness	RG6 / RG11	Greater than or equal to 120 dB in the range 5 MHz to 1000 MHz in accordance with the “GTEM” technique described in SCTE IPS-TP-403 or Greater than or equal to 75 dB in the range 5 MHz to 1000 MHz in accordance with the “absorbing clamp” technique described in Clause 4.2.2.1 of Pr EN 50083-2

10.9 General cabling information and practices

10.9.1 General

The home should be pre-wired at the building “frame stage”, i.e. with the roof on but prior to lining of the ceiling and internal walls. The first step in cabling the home is to identify the wall plate locations from the building/cabling plan or in consultation with the client on site. Then it is necessary to select or review the location of the CCP while considering the following:

- its suitability for end-user access
- exposure to EMI, dampness, heat or dust (refer to 10.4.2 on page 148)
- the cabling distance from the outdoor PCD (which should be no more than 25 m)
- the cable length from the CCP to the furthest wall plate (which should not exceed 50 m).

Where possible, all cabling should be concealed in building cavities for aesthetic reasons and for physical protection of the cabling after building completion. This is easy to achieve if the building is pre-wired but cables are susceptible to damage during construction. To allow for such damage, some cablers install extra cables for insurance — because this is cheaper than replacing damaged cables after building completion.

For concealed cabling, stud mounting brackets, wallboard clips or outlet boxes should be used to locate and affix wall plates. Examples of these and their various applications are described in 10.9.2 and 10.9.3.1. For surface cabling (i.e. cabling on the surface of walls), plastic mounting blocks and surface-mount boxes may be used to mount the TOs. For more information, refer to 10.9.3.2.

Data and coaxial cables and connections must be separated from the cables and connections of other services in accordance with 10.9.2.5 and 10.9.4

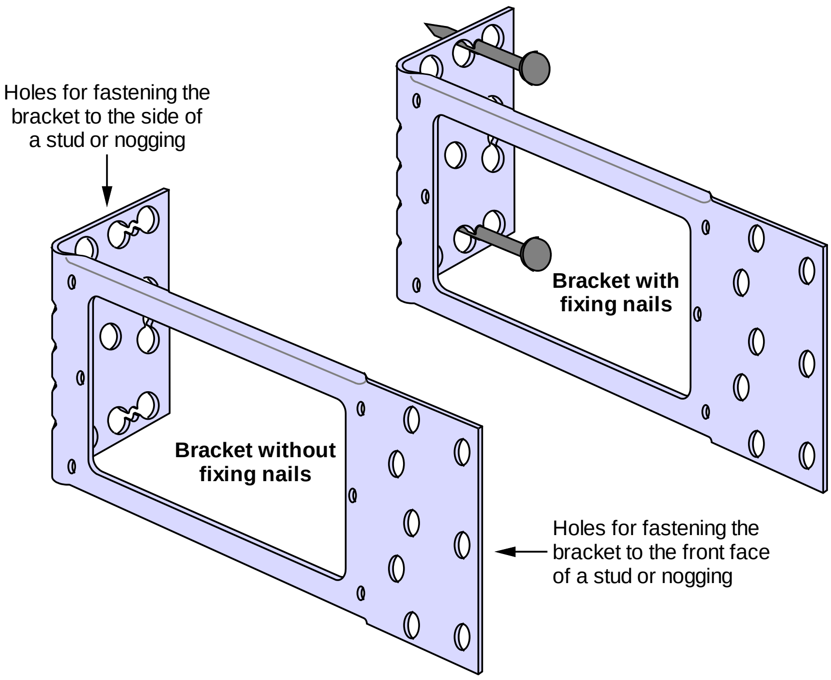
10.9.2 Cavity walls

10.9.2.1 Mounting brackets (“stud brackets”)

Mounting brackets may be used for pre-wiring during construction of the building. The mounting bracket is installed before the wall is lined (e.g. with plasterboard) and is used for establishing the location of the TO and for eventual fastening of the wall plate. The brackets may be nailed or screwed to timber or metal frames and can generally be fastened to either the side or the front of the frame. Typical mounting brackets are illustrated in Figure 180 to Figure 183.

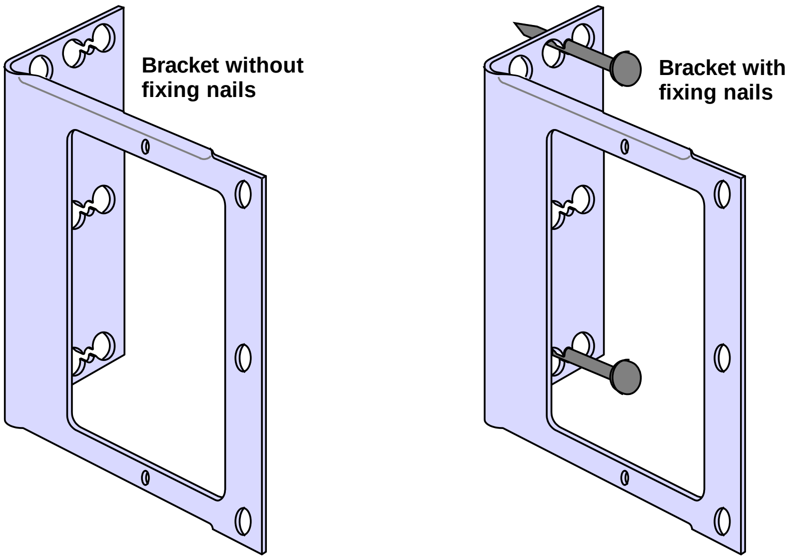
Wall plates are normally installed in horizontal orientation (i.e. long side parallel with the floor) but may be mounted in vertical orientation if this is preferred by the consumer. Wall plates for wallphones should always be installed vertically.

Figure 180 Horizontal pattern mounting bracket



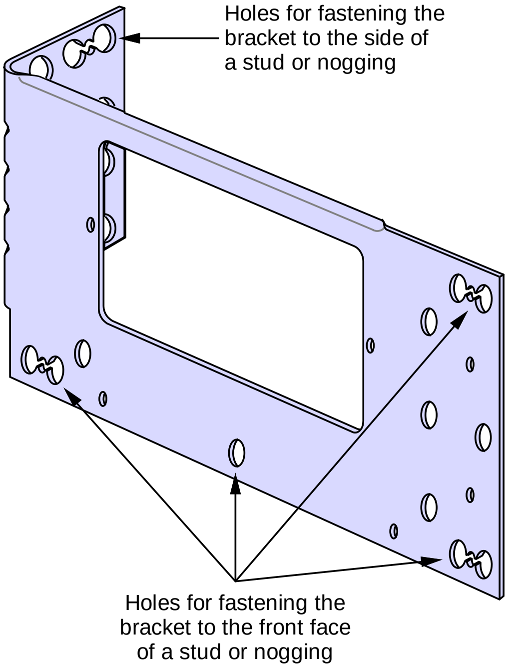
Note: Horizontal pattern mounting brackets are normally used on studs for mounting horizontal wall plates located near floors and above benches. They may also be used on noggings for mounting wall plates for wallphones (see Figure 184).

Figure 181 Vertical pattern mounting bracket



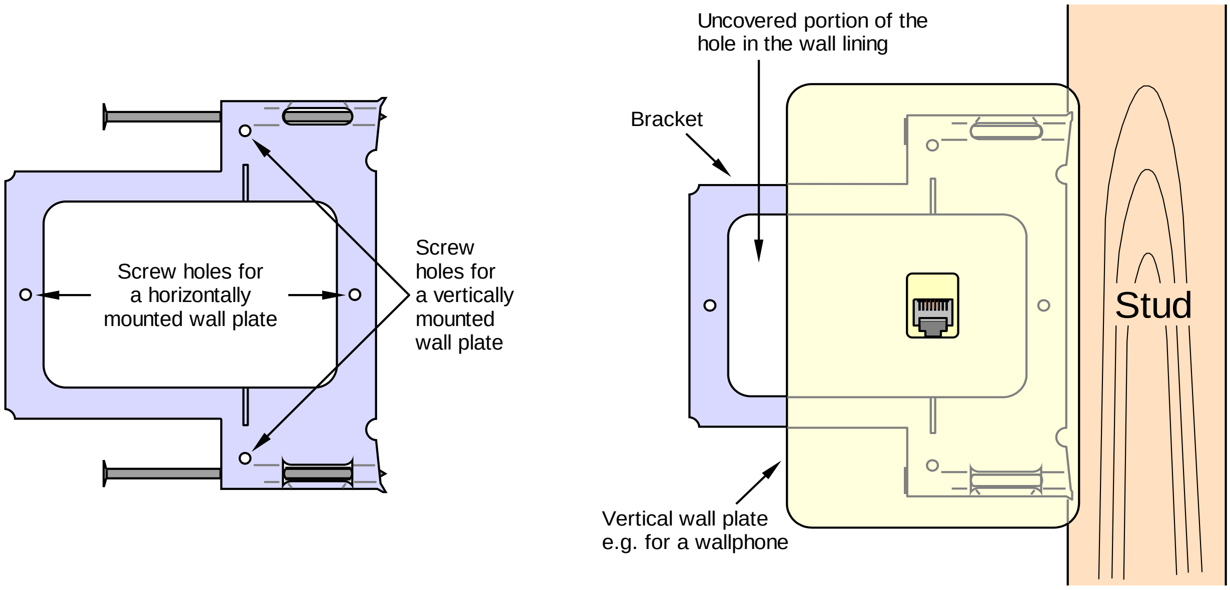
Note: Vertical pattern mounting brackets are normally used on studs for mounting wall plates for wallphones. They may also be used on noggings for horizontal wall plates located above benches.

Figure 182 Horizontal/Vertical pattern mounting bracket



Note: Horizontal/Vertical pattern mounting brackets are available and may be preferred by some installers to avoid the need to carry two types of stud bracket.

Figure 183 Horizontal/Vertical pattern mounting bracket (alternative type — use with care)



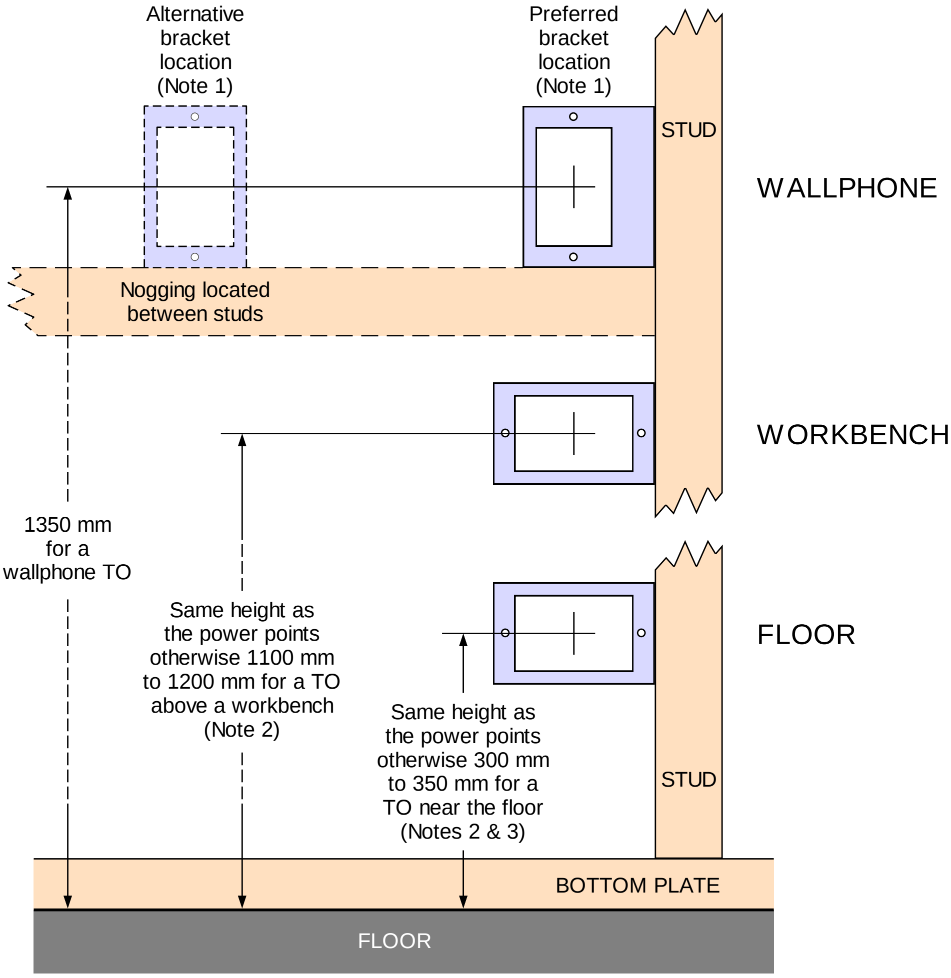
Note: The type of bracket shown above has four screw holes for either horizontal or vertical mounting of the wall plate using the same bracket orientation. However, care should be exercised if using this type of bracket for vertical wall plate mounting (see the diagram on the right). If the horizontal/vertical mounting bracket is used on a stud to locate a vertical wall plate, the hole will not be large enough to accommodate more than one socket and, if care is not exercised when cutting the hole in the wallboard, the plate will not fully cover the hole necessitating repair work to the wall or use of a larger plate to cover the hole.

10.9.2.2 Installing mounting brackets

When pre-wiring the building, mount the TO brackets at the same height as those for the power outlets or, where the power outlet brackets have not yet been installed, mount the TO brackets in accordance with Figure 184. Some installers use a claw hammer to measure the bracket height from the floor (see Figure 185), which is a convenient measuring tool and generally produces the preferred result. Do not mount the telecommunications bracket above or below a power bracket unless a timber nogging is installed between them to separate the telecommunications and power cables and terminations.

For pre-wiring of cavity walls, tie the cables to the rear of the bracket and mark the bracket location on the floor as shown in Figure 198.

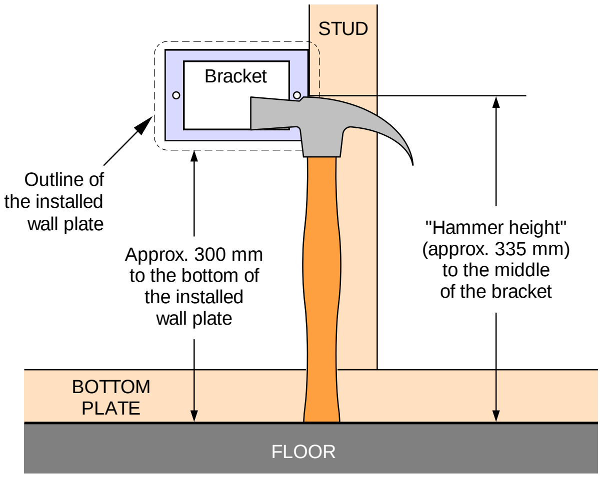
Figure 184 Height of mounting brackets for wall plates



Notes:

1. Use a vertical pattern bracket on a stud for a wallphone TO. Alternatively, if the required location is between studs, use a horizontal pattern bracket on a nogging fastened between the studs at the appropriate height, as shown. As most wallphones in residences are installed in kitchens, a height should be selected to ensure that the TO wall plate doesn't sit half way between tiled and untiled surfaces, and so that there will be sufficient clearance between the plate and any wall cabinet mounted above the workbench to enable the wallphone to slide onto the plate. The risk of encountering such problems is reduced if the wall plate is installed at a height not exceeding 1350 mm measured from the floor to the centre of the plate.
2. The preferred height for TOs near the floor or above a workbench is the same height as the power outlets. These heights may vary from building to building. The bracket heights shown above are recommended where power outlet brackets have not yet been installed.
3. Some installers measure the bracket height with a claw hammer as shown in Figure 185.
4. Mark the location of each bracket on the floor as shown in Figure 198.

Figure 185 A convenient way of measuring mounting bracket height near the floor



The TO brackets should be installed at the same height as the power outlet brackets, which may or may not be installed in accordance with this practice. The electrician may use a hammer to measure the bracket height, but may measure it to the top or bottom of the bracket, in which case the height to the middle of the bracket will vary according to the style of the bracket used.

Measuring the bracket height to the centre of the bracket aperture (e.g. to the threaded screw holes in the case of a horizontal pattern bracket) will produce consistent results no matter what style of bracket is used.

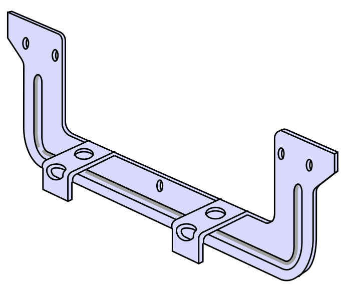
10.9.2.3 Wallboard clips (“C” clips)

Where it is necessary to install a flush-mounted wall plate on a cavity wall after it has been lined (sheeted) and a mounting bracket is not installed, use a wallboard clip to mount the wall plate.

To use the wallboard clip:

- Determine the height of the wall plate to be installed and, using the wall plate as a guide, mark the plate screw mounting holes on the wall with a pencil, nail, screw or brad awl.
- Use the wallboard clip to mark out the hole to be cut in the wall thus:
  - Align the screw holes of the wallboard clip with the holes previously marked using the wall plate.
  - Run a pencil line around the inside edge of the wallboard clip from screw hole to screw hole.
  - Invert the wallboard clip (i.e. rotate 180°), align the screw holes with the holes marked on the wall, and run a pencil around the inside edge of the clip again to complete the marking for the cut-out.
  - Drill the screw holes with an 8 mm (5/16”) drill, then drill several pilot holes along the inside of the pencil line for insertion of a pad saw or hacksaw blade.
  - Using a small pad saw or suitable hacksaw blade, cut around the pencil line to create a rectangular hole as shown in Figure 187.
- Insert the wallboard clip in the cut-out, align it and squeeze the retainers with your fingers against the wall lining to hold the clip in place.

Figure 186 A typical wallboard clip

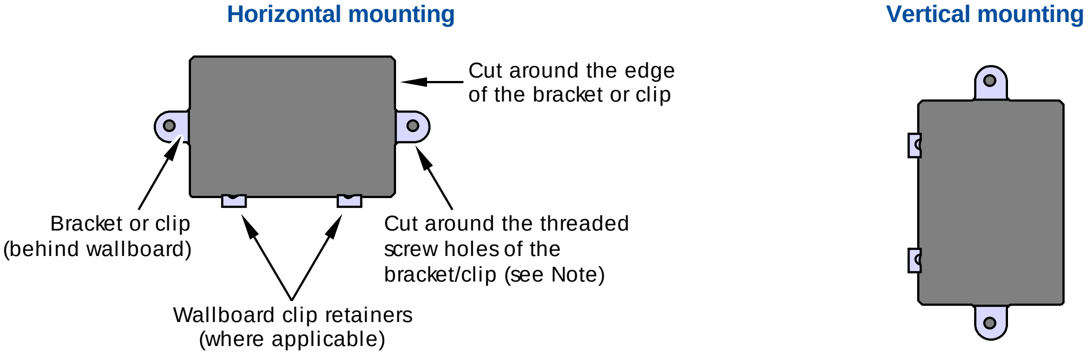


Wallboard clips are generally used for installation of wall plates where a stud bracket has not been previously installed. These types of bracket are made to fit different wallboard thicknesses such as plasterboard, fibre-cement and hardboard sheets.

10.9.2.4 Wall cut-outs

For cavity walls, prepare the cut-out for the TO as shown in Figure 187. It is important to cut around the full aperture of the stud bracket or wallboard clip, particularly for multiple-socket TOs.

Figure 187 Cut-out in a cavity wall for fitting the wall plate



Note: Don't cut out excessive space around the screw mounting holes, otherwise the wall plate may buckle when tightened and, in the case of a wallboard clip, the clip may not retain the wall plate properly.

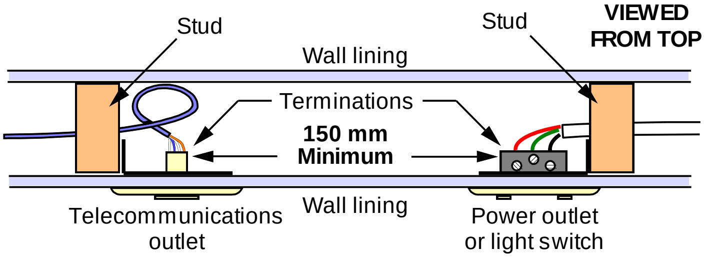
10.9.2.5 Separation from power outlets and light switches

TOs should not be mounted immediately above, below or beside power outlets or light switches to ensure that safety separation requirements are met. TOs and power outlets or light switches must be installed such that their conductors and terminations are separated within the wall cavity by a suitable barrier or a minimum distance of 150 mm (see Figure 188).

The separation requirements will be met if the TO and power outlet or light switch are installed on the opposite sides of a timber stud. Where metal studs are used, the TO and power outlet or light switch should be installed on separate studs altogether. It is always preferable to secure telecommunications and power brackets on a separate stud. Where this is not possible, take care when nailing the bracket to the stud that there is no contact between the power and telecommunications bracket nails (see Figure 189).

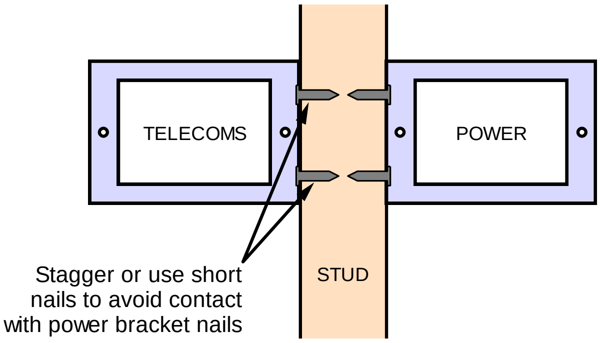
Avoid installing telecommunications and power outlets in the same void in cavity walls. Where this is not possible, locate the outlets at opposite ends of the void as shown in Figure 188.

Figure 188 Separation of telecommunications and power terminations in a wall cavity



Where possible, avoid installing telecommunications and power outlets/ switches and cables in the same void in cavity walls. Where this is not possible, locate the outlets on separate studs to ensure that the cable and termination separations required by Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*, are met.

Figure 189 Telecommunications and power bracket installation on a common stud



Notes:

1. Where power and telecommunications brackets are installed on opposite sides of the same timber stud, take care to ensure that the nails do not make contact within the stud.
2. Do not mount the telecommunications bracket above or below a power bracket unless a timber nogging is installed between them to separate the telecommunications and power cables and terminations.
3. Installation of power and telecommunications brackets on the same stud is not recommended. See Figure 197 for the recommended arrangement.

10.9.2.6 Fire-rated dividing walls

Where a TO is to be flush-mounted on a fire-rated cavity wall (e.g. a dividing wall between living units in a multi-tenant building), a special outlet box, referred to as a “fire box”, must be installed to house the TO to maintain the FRL (Fire Resistance Level) rating of the dividing wall. In such cases, the fire box must be installed in accordance with the manufacturer’s instructions. Restrictions also apply to any cabling run within fire-rated walls and all cable penetrations must usually be fire-stopped using special gaskets or sealants.

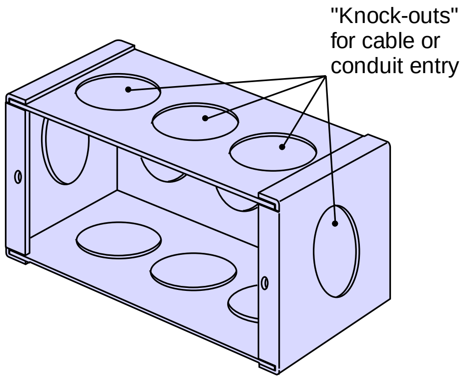
To avoid the need for special materials and practices, the TO may be surface-mounted and surface-cabled on the fire-rated wall. Alternatively, install the TO on an adjacent wall that is not fire rated.

10.9.3 Solid walls

10.9.3.1 Outlet boxes

Outlet boxes (generally called “wall boxes” in the electrical trade) are used for pre-wiring of TOs on brick and other masonry walls. Typical methods for using outlet boxes are shown in Figure 191.

Figure 190 A typical outlet box (“wall box”)

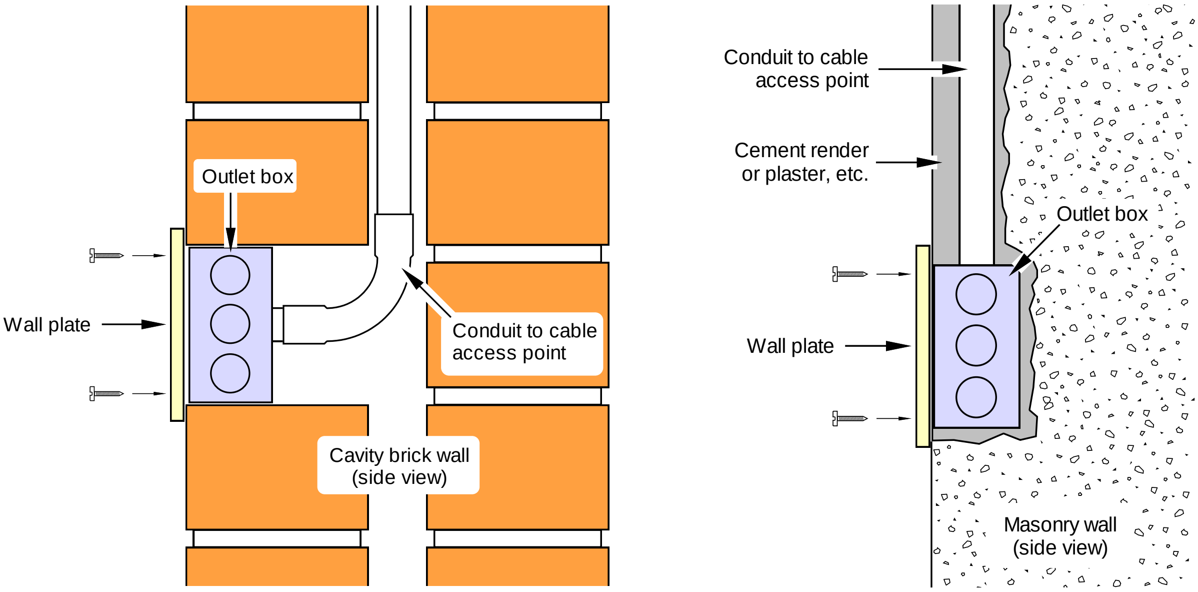


Notes:

1. An outlet box may be known as a “wall box” in the electrical trade. Outlet boxes are mainly used to locate and mount wall plates in brick or masonry walls. These are available in metal or plastic, and generally have “knock-outs” for cable or conduit.
2. See Figure 191 for typical outlet box installations.

Figure 191 Typical outlet box installation

(a) Cavity brick wall (b) Solid masonry wall



Notes:

1. The outlet box and conduit are either bricked into a cavity wall or chased and rendered into the masonry.
2. The outlet box is shown mounted vertically, which may be preferred for standard brick walls because a vertically mounted box fits comfortably between two standard bricks.
3. The outlet box is usually retained in the wall by the mortar/render. Some boxes also have retaining clips on the sides of the box. Do not overtighten the wall plate screws, as this may tend to pull the box out of the wall.

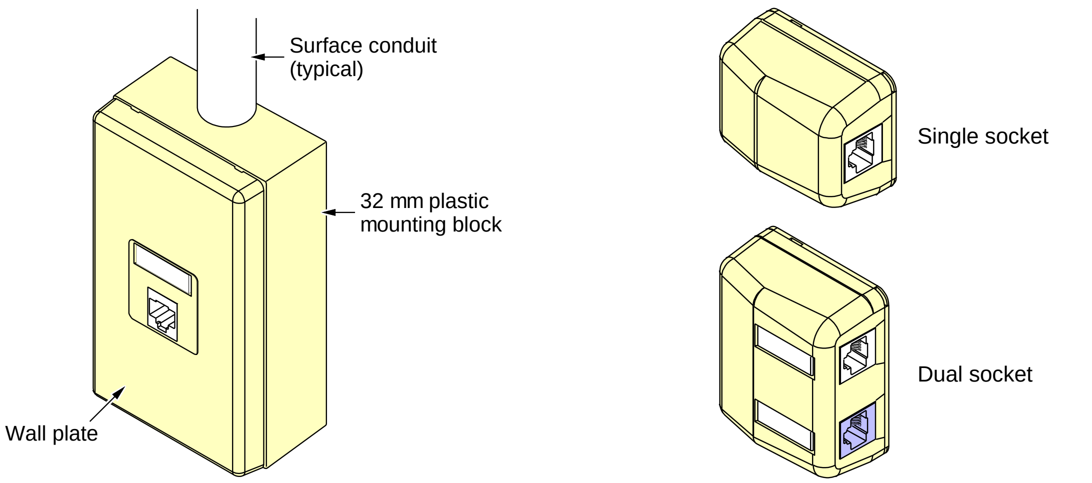
10.9.3.2 Mounting blocks and surface-mount boxes (surface cabling)

For surface cabling, mounting blocks or surface-mount boxes may be used for the TOs. A wall plate may be installed on a 32 mm plastic mounting block. Alternatively, use a surface-mount box to house the socket(s). Refer to Figure 192.

Surface-mount boxes should be mounted sideways, as shown in Figure 192, or with the socket facing downwards, to minimise the ingress of dust (whether or not the socket is fitted with a shutter).

Figure 192 Surface-mounted TOs

(a) Surface mounting of a wall plate using a 32 mm plastic mounting block (b) Typical surface-mount boxes



10.9.4 Cable installation

10.9.4.1 General

All cables should be installed thoughtfully and with care to avoid damage during construction of the building and to ensure maximum performance of the completed installation. Compliance with Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*, is the minimum requirement. A summary of the key AS/CA S009 requirements follows.

10.9.4.2 Separation from Low Voltage (LV) power cables

LV power cables are those cables used to supply 230 V AC single-phase power or 400 V AC three-phase power to appliances and power outlets within a building.

Separation from LV power cables is necessary for safety purposes. The main concern is simultaneous damage to the cable insulation of both wiring systems due to:

- penetration by foreign objects such as nails and screws;
- crushing or abrasion (building movement, trampling, impact, etc.);
- vermin or insect attack;
- overvoltage (e.g. lightning surges); or
- polymeric degradation (due to fire, heat, chemicals, friction, aging, etc.).

Telecommunications cables on or in the building must be permanently separated from LV power cables for safety purposes by:

- a minimum distance of 50 mm; or
- a barrier of durable insulating material or metal (e.g. cable enclosed in conduit); or
- a timber or metal stud, nogging, joist, beam, rafter or roof truss of any thickness.

Notes:

1. When using a metallic barrier it may be required to be earthed. This would be the case if the barrier is also being used to separate LV power and telecommunications terminations. Metal building framing is required to be earthed by building codes.
2. Flexible cords (e.g. equipment fly leads or extension cords) do not require separation unless installed as fixed or concealed wiring (the use of cords for fixed or concealed wiring is not recommended).
3. These separation requirements are summarised in Figure 193.
4. Greater spatial separation from power cables is recommended to avoid electrical interference, e.g. 150 mm.

A telecommunications cable and an LV power cable must not pass through the same bore hole within 50 mm of any securing face of building framework whether or not there is a barrier between the cables. In other cases, telecommunications cable may pass through the same hole (e.g. through the fabric of a floor or wall) as LV power cable if either the telecommunications cable or the LV cable is installed in insulating or metal conduit or suitably designed trunking or ducting that provides a durable barrier between the telecommunications cable and the power cable.

Note: Drills, nails or screws driven into the building framework could penetrate cables passing through bore holes even if the cables are installed in conduit. Simultaneous damage to the cable insulation of both wiring systems may result in the transfer of a hazardous voltage to the telecommunications wiring system.

10.9.4.3 Separation from services other than power

Telecommunications cables on or in the building must be separated from other non-telecommunications services (such as plumbing) so as not to impede access to, or repair of, the other service. Telecommunications cables must not be fastened to plumbing pipes or the conduits of other services.

Note: A minimum clearance of 50 mm is recommended by Australian Standard AS/CA S009 where the telecommunications cabling runs alongside the other service cables, conduits or pipes.

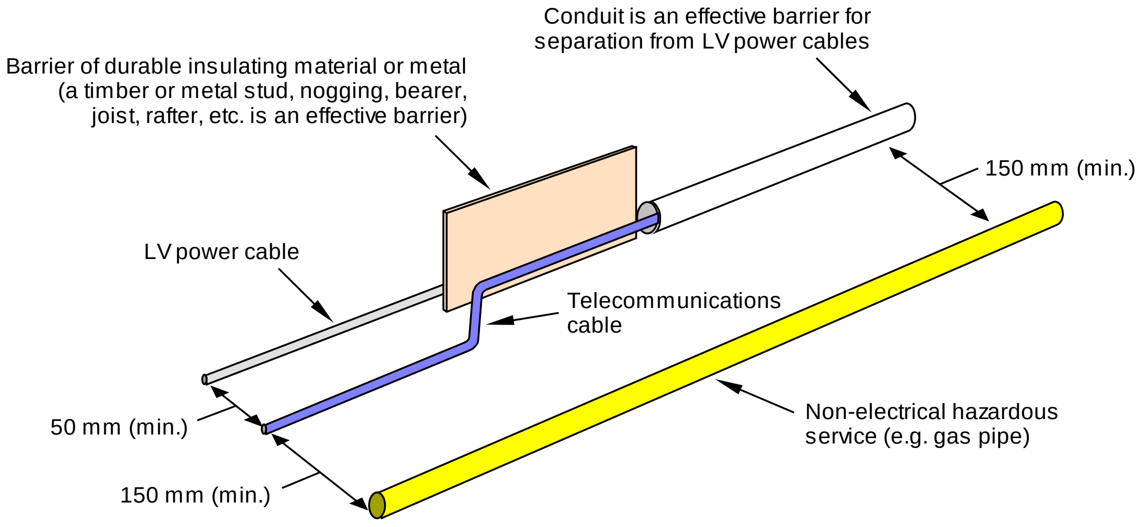
Where the other service is deemed to be hazardous (e.g. gas pipes, oil pipes, steam pipes, hot water pipes exceeding 60°C and compressed air pipes), the telecommunications cable must be separated from the other service by a minimum distance of 150 mm whether or not the cable is installed in conduit.

Note: This separation requirement reduces the risk of damage to the telecommunications cabling or the other service during installation or repair activities, which may cause personal injury or damage to property.

No separation is required between cables of different communications cabling systems, e.g. telephone, data, TV (coaxial), audio (speaker wires), etc.

No separation is required between telecommunications cables and earthing conductors (whether these are associated with telecommunications or power) except for lightning down-conductors (see 10.9.4.7).

Figure 193 Summary of safety separation requirements from LV power cables and non-electrical hazardous services for indoor cabling and outdoor surface cabling



10.9.4.4 Separation from Low Voltage (LV) power terminations

Telecommunications terminations and uninsulated or single-insulated conductors must be physically separated from LV power terminations and uninsulated or single-insulated conductors to prevent:

- electric shock to a telecommunications worker through accidental contact with exposed LV connections or conductors; and
- electrical contact between the telecommunications and LV connections if any conductors come adrift from their terminations.

The required physical and electrical separation may be achieved by suitable shrouding, fixed barriers or appropriate distance. Where shrouds or barriers are not used, a minimum distance of 150 mm is specified for electrical separation; however, this distance may be insufficient to prevent accidental contact by a telecommunications worker accessing the telecommunications terminations, so a greater distance may be required depending on the circumstances. Where a metallic barrier is used, it must be earthed via a minimum 2.5 mm^2 protective earthing conductor.

A TO should not be located in the same void, e.g. a section of wall cavity or wiring space within an enclosure, as a 230 V power outlet or light switch. Where this is not achievable:

- install a permanent, rigidly-fixed barrier of durable insulating material or metal between the telecommunications and LV terminations and conductors (any metal barrier must be earthed); or
- ensure that a shroud of durable insulating material is fixed over the LV terminations and conductors (by the electrician); or
- ensure that there is sufficient distance between the TO and the LV terminations to prevent accidental contact with LV by a cabler when accessing or wiring the TO **and** that the distance between conductors and terminations is at least 150 mm (refer to Figure 188).

10.9.4.5 Separation from High Voltage (HV) power cables

HV power cables are those cables used to supply mains power exceeding 1000 V AC to a power substation (e.g. a transformer) within a premises. In the context of this document, these will normally only be encountered in multi-dwelling complexes such as a block of apartments.

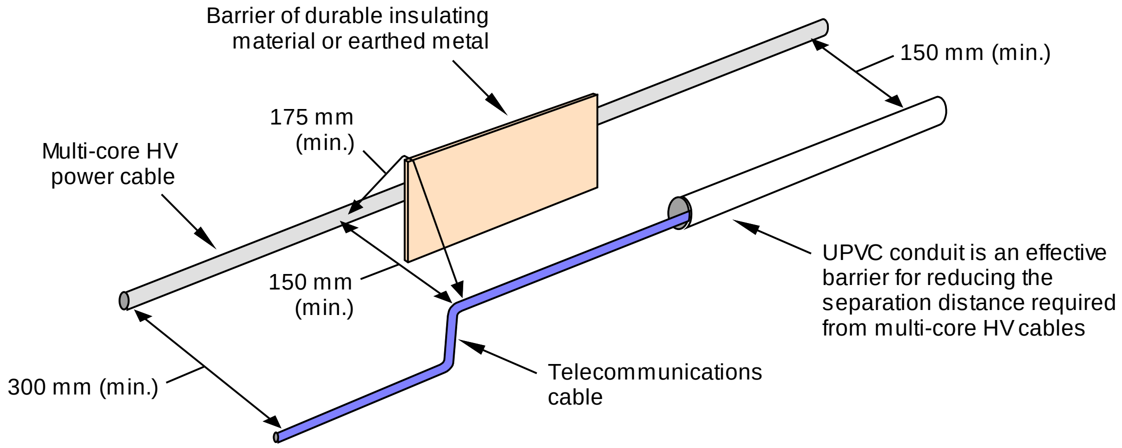
To determine the appropriate separation required from HV cables, it is first necessary to determine whether the HV cables are “single core” or “multi-core”. Where in doubt, assume that the cables are single core and maintain at least 450 mm between them and telecommunications cables, whether or not there is any form of interposing barrier.

If it has been established that the HV power cables are multi-core cables, the telecommunications cables must be separated from the multi-core HV cables by:

- a minimum distance of 300 mm; or
- a minimum distance of 150 mm if:
  - either the HV cables or the telecommunications cables are enclosed in insulating conduit or earthed metallic conduit; or
  - there is an interposing barrier of durable insulating material or earthed metal that is of such dimensions that the distance measured around the barrier between the sheaths of the HV and telecommunications cables is at least 175 mm.

Multi-core HV cable separation requirements are summarised in Figure 194.

Figure 194 Summary of safety separation requirements from multi-core HV cables for indoor cabling and outdoor surface cabling



Note: If the power cable is a single-core HV cable, the minimum separation required is 450 mm whether or not there is any form of barrier between the HV cable and the telecommunications cable.

10.9.4.6 Separation from High Voltage (HV) power terminations

Telecommunications cable conductors and terminations must not be located within the same enclosure as the conductors and terminations of HV power cables. The enclosed conductors and terminations of telecommunications cables must be separated from the conductors and terminations of separately enclosed HV power cables by a minimum distance of 450 mm whether or not there is any form of barrier between them.

10.9.4.7 Separation from lightning down-conductors

Lightning down-conductors are earthing conductors installed between a lightning rod or strip located on the roof of the building to an earthing electrode or earthing mat at the base of the building. These are rarely installed on single dwellings but may be installed on multi-storey apartment buildings. Lightning down-conductors are designed to carry thousands of volts and amperes in the event of a lightning strike. It is important to keep metallic cables well away from such conductors to avoid “side-flashing” which may cause fire or injury.

Telecommunications cabling and connection devices must be separated from lightning down-conductors by a minimum distance of 9 m unless this is impractical, in which case the cabling must be separated from any lightning down-conductor in accordance with the requirements of Australian Standard AS/NZS 1768, *Lightning protection*.

Notes:

1. A separation distance less than 9 m will usually require assessment by a suitably qualified electrical engineer.
2. An earthing conductor for a domestic TV antenna or satellite dish is not classified as a lightning down-conductor.

10.9.4.8 Drilling or notching of timber framework

The building code limits the number and size of holes or notches that may be drilled or cut in wall and floor framing to ensure that the structure is not weakened. The relevant Australian Standards are AS 1684.2, *Residential timber-framed construction — Non-cyclonic areas*, and AS 1684.3, *Residential timber-framed construction — Cyclonic areas*. The basic requirements of these standards for drilling and notching of timber framing are illustrated in Figure 195 and Figure 196.

In any case, when pre-wiring a building try to avoid drilling or notching load-bearing building framework such as studs, plates, beams, bearers, joists, rafters, lintels and roof trusses. This does not apply to noggings, which are not usually load-bearing. In walls, run cables vertically through the top or bottom plate (and noggings where necessary). In floor and ceiling spaces, run the cable lengthways along floor or ceiling joists (see Figure 197).

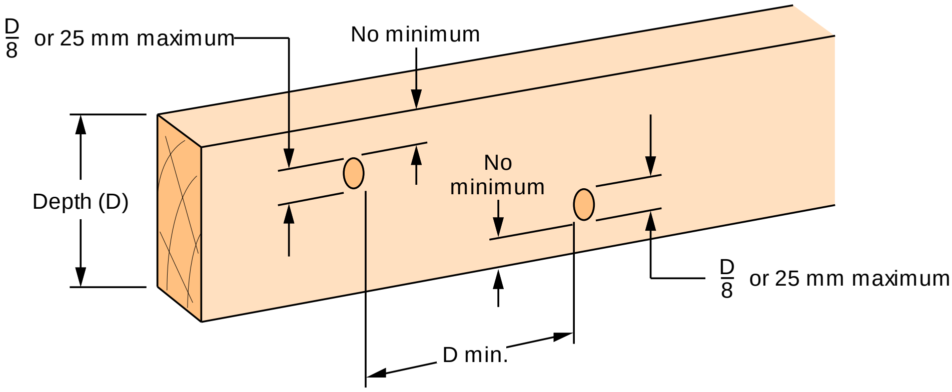
Check with the builder if it is necessary to drill or notch any building framework (except for noggings) to ensure that the building code limits are not exceeded. Only drill holes in building framework to comfortably accommodate the telecommunications cabling. The hole size should not exceed 25 mm diameter.

Always drill holes centrally between the securing faces of top/bottom plates, studs and noggings. Where installation of cables through floor/ceiling joists is unavoidable, drill the holes at least 50 mm from the securing faces of the joist. This is to minimise the risk of damage to the cable from nails or screws used to fasten the lining material to the building framework.

Roof trusses should not be drilled or notched under any circumstances.

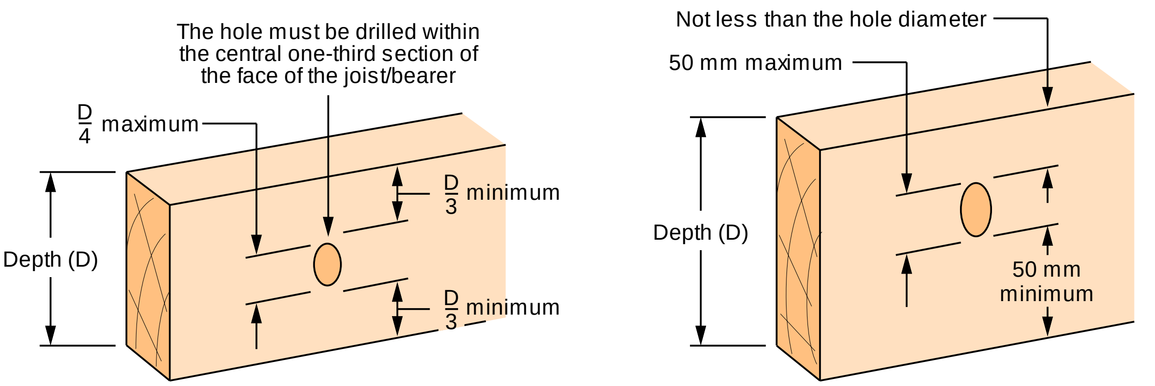
Figure 195 Drilling of holes in timber floor framing (AS 1684.2/AS 1684.3)

(a) Holes not exceeding 25 mm diameter or one-eighth of the beam/bearer/joist/rafter depth



Note: No more than three holes are allowable per 1800 mm of span. Significant imperfections in the timber, such as knots, should be regarded as holes with respect to the hole spacing limitations.

(b) Holes not exceeding 50 mm diameter or one-quarter of the beam/bearer/joist/rafter depth



If Depth (D) is less than 200 mm

If Depth (D) is 200 mm or greater

Note: No more than one hole is allowable per 1800 mm of span. Significant imperfections in the timber, such as knots, should be regarded as holes with respect to the hole spacing limitations.

(c) Holes through the long section of the beam/bearer/joist/rafter

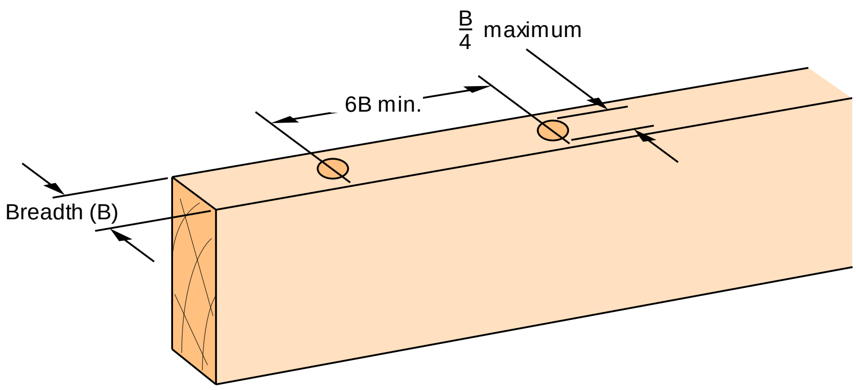
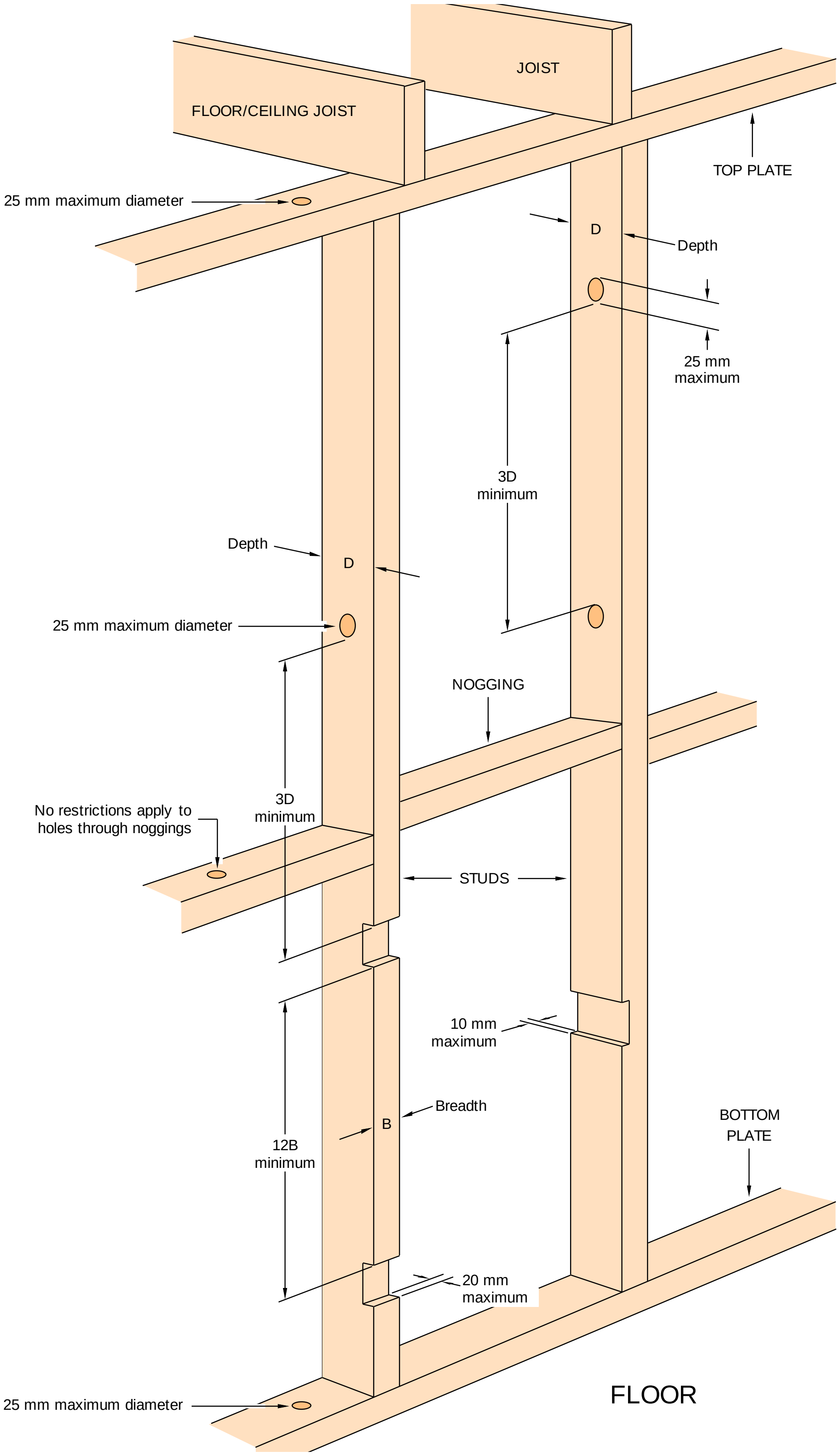


Figure 196 Drilling and notching of timber studs, plates and noggings



Notes:

1. Holes may only be drilled through the middle of the wide face of the stud or plate. Drilling through the narrow face is not permitted.
2. Notching of studs is only allowable for the purpose of attaching bracing and noggings, not for installing cables. However, notching limits are shown because they affect limits for drilling of holes.

10.9.4.9 Metal framework

Similar restrictions may apply to drilling and notching of metal framework to drilling and notching of timber framework. However, some metal framing is supplied from the factory with suitable holes for running cables. Therefore, it may not be necessary to drill holes in metal framework for cabling. Where there is a need to drill or notch metal frames, always consult the builder beforehand.

Holes used for running cables should have rolled edges or otherwise be fitted with a suitable insulating grommet to prevent cable damage. Alternatively, the cable may be run through the holes in conduit. Telecommunications cables should not run through the same hole as power cables or plumbing. Telecommunications cables must be separated from other services within walls as described in 10.9.4.2 to 10.9.4.7.

Where it is necessary to fasten cable or conduit clips to the metal framework, the clips and nails, rivets, screws or bolts used to secure them should be of similar composition as the metal member to which they are secured, e.g. zinc plated steel on zinc plated steel. Contact between dissimilar metals may precipitate corrosion due to electrolytic action.

Building codes require that the metal framework be earthed to the electrical earthing system (by the electrician). Generally, the frame will also be fortuitously bonded to the general mass of earth via the floor slab, footings, bolt fastenings, etc. Metal plumbing is required to be electrically insulated from the framework. Telecommunications cablers must ensure that they do nothing to compromise the integrity of the earthing arrangements or insulation of metal plumbing from the metal frame.

10.9.4.10 Cabling pathways

Cables should be run via accessible roof space, underfloor space or in suitable conduit to support future cable augmentation or replacement. There is no such thing as a “future-proof” cable system (see 4.14.1 on page 32).

In addition, due to workplace health and safety requirements for working at height (e.g. in roof spaces), apply the following practices so that cables may be pulled through building cavities between access points:

- Where possible, run the cables past the ceiling access hole so they can be grabbed from the access hole without the need to bodily enter the roof space.
- Thread the cables through the roof trusses or bearers by the most direct path, avoiding other service cables and potential snag points.
- Do not tie cables together or fasten cables in roof spaces or wall cavities, to enable them to be pulled through from end to end.
- Install the cables in suitable rigid conduit where necessary for protection (e.g. trampling), to maintain the required separation from other services and to minimise cable kinks, sharp bends and snags.

Do not run cable horizontally through the external wall cavity or through holes in internal wall studs unless this is unavoidable. Cable running through wall cavities should **not** be stapled or fastened to studs, noggings, etc. Where the cable needs to be restrained for protection (e.g. from crushing) or for segregation purposes, plastic conduit with a minimum inside diameter of 20 mm should be used and installed such that the cable can move freely within the conduit. Alternatively, use conduit saddles (without conduit) as cable guides.

Cables in roof spaces should be run through the roof trusses such that they are supported out of harm’s way when the ceiling lining is being nailed or screwed to the building framework. Generally, this means the cabling must be installed through the upper truss supports. Do not run the cable between the roof battens and the roofing material unless this is the only space available to run the cable (e.g. low profile roofs or traversing walls between living units in multiple dwellings).

Do not fasten cables in the roof space unless this is necessary to protect the cable from damage or maintain separation from other services. Use conduit or conduit saddles as cable guides in preference to fastening the cables.

Where the roof has metal framing and the roof trusses or joists are spaced greater than 600 mm apart or cannot be walked on due to sharp edges, the cables should be run in such a way that:

- they can be replaced without accessing the roof space; or
- they can be accessed directly from the manhole and replaced without a person bodily entering the roof space; or
- they can be safely accessed from a walk-board fixed to the trusses/joists in the roof space.

Where it is necessary to run the cable along a floor or ceiling joist, fasten the cable no less than 50 mm from the securing face of the joist to minimise the risk of penetration of the cable by stray nails used to fasten the floor boards or ceiling lining to the joist (see Figure 197).

Cabling through FRL-rated walls ("fire walls"), e.g. dividing walls between living units in multi-tenant buildings, must comply with the building code requirements and/or the requirements of the local building/fire authority, as applicable. Seek guidance from the builder about such requirements and comply with any reasonable direction given.

Where the cable is run through the hollow core of masonry blocks or a chase in a masonry wall, conduit should be provided to enclose and protect the cable between a cable access point (such as roof or under-floor space) and the TO.

Note: PVC-sheathed cable rendered directly into a masonry wall (i.e. without conduit) is prone to failure. Only render underground type cable directly into masonry walls if conduit cannot be installed.

Where proximity to power cables is likely (e.g. near power switchboard locations), install the telecommunications cabling in plastic conduit. Be sure to minimise the number of bends and make the bend radius as large as possible so that replacement cables may be pulled through the conduit at some future time. Secure the conduit to minimise movement.

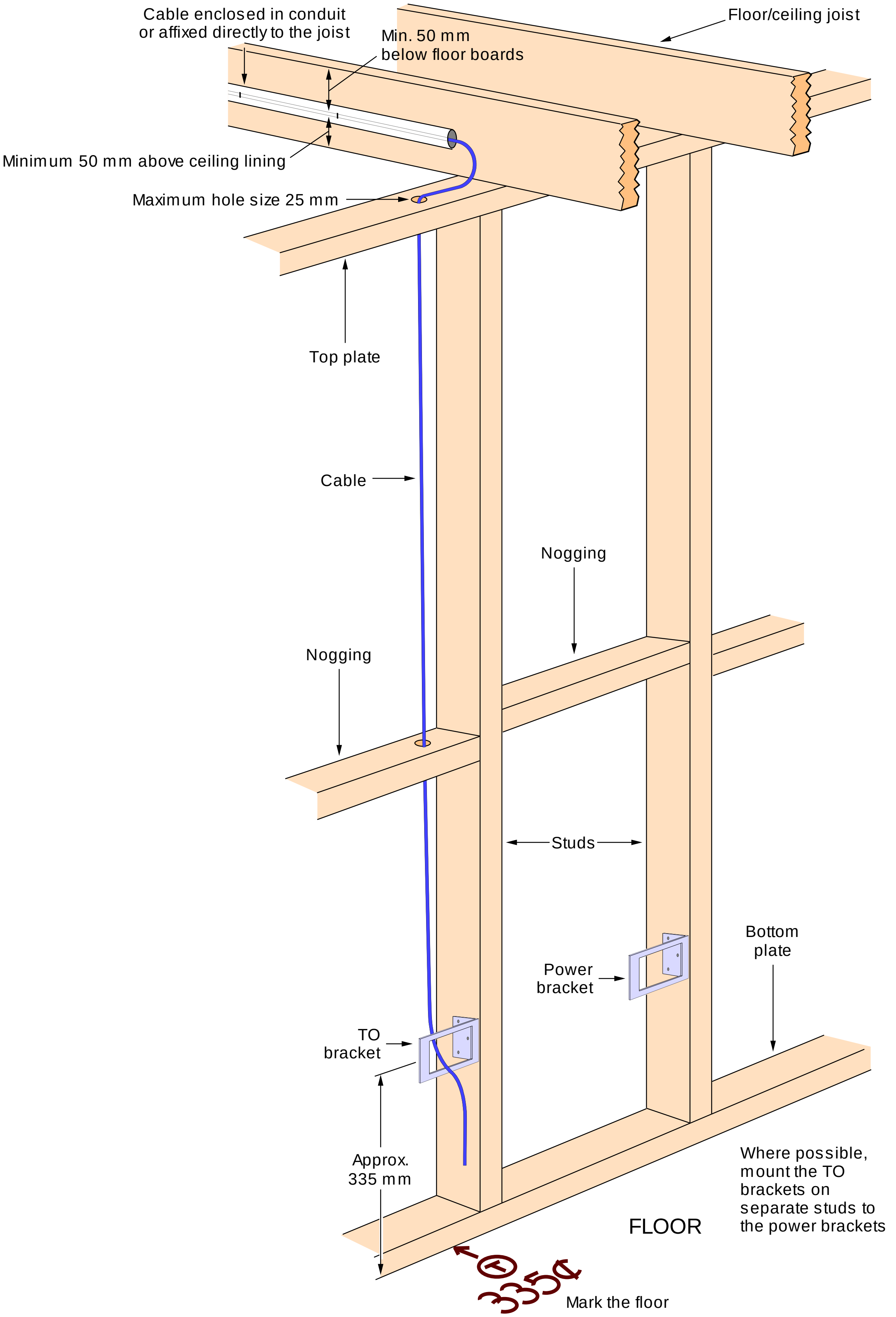
Allowance should be made for approximately 200 mm to 500 mm of slack cable to be left in the wall cavity **after** the TO is terminated to allow the TO to be pulled away from the wall with the cable/s connected for testing or pulling in additional cables.

To minimise the risk of knots forming in the cable within the cavity and to support creation of an effective drip point in outer walls in accordance with Figure 203, excessive slack cable should not be left in the cavity. However, in addition to the 200 mm to 500 mm of slack cable in the wall cavity, at least 1 m of slack cable should be left in each cable run in the roof space, where practical, provided that this space is accessible or there is no risk of the cable snagging on objects within the roof space or getting tangled up with other cables, especially power cables.

10.9.4.11 Marking of bracket locations

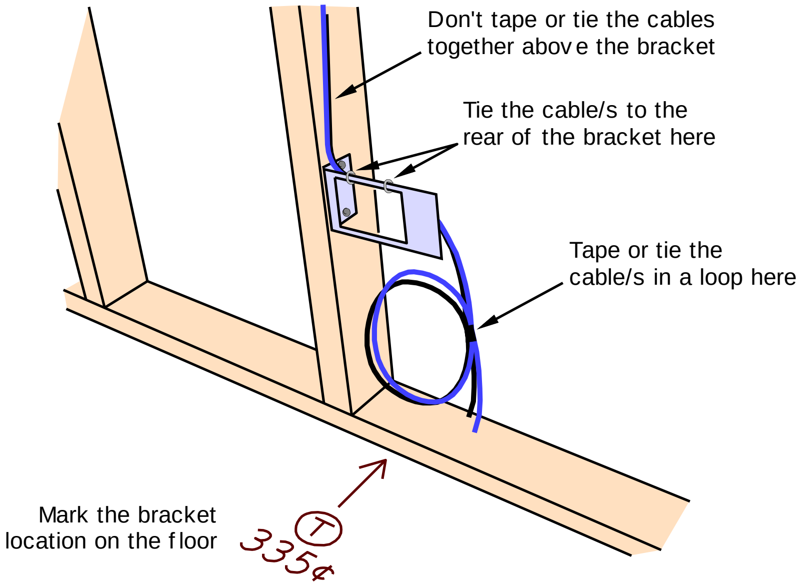
To assist in finding pre-wired TO points at the fit-off stage (in case the plasterer sheets over the stud brackets without leaving a hole in the sheet), it is recommended that the floor be marked to identify the location of each bracket. This may be achieved by marking the floor with a permanent ink felt pen or crayon directly below the bracket, giving the exact measurement between the floor and the centre of the bracket (see Figure 197 and Figure 198). This should only be done on floors that will eventually be covered by carpet or tiles, e.g. concrete or compressed particle board flooring. Naturally, this assumes that the installer will return to fit the TOs before the floor coverings are laid.

Figure 197 Running cable through cavity walls and inter-floor cavities



Note: Run cables vertically between studs and not horizontally or diagonally through holes in the studs.

Figure 198 Securing cables to mounting brackets and marking of bracket locations



Notes:

1. Don't tape or tie the cables together before the bracket so they can be individually replaced or used as a pull-wire at some later time. If the cable needs to be restrained, use conduit or conduit saddles.
2. Tie the cables to the rear of the horizontal bar of the bracket such that the cables will be out of harm's way when the hole is cut in the wallboard. The ties can be cut away with side cutters after the wallboard has been installed and the hole has been cut around the bracket aperture.
3. Leave about 500 mm of slack cable coiled up and taped or tied together under the bracket.
4. Mark the bracket location on the floor as shown above. The above floor markings have the following meanings:

   T Telecommunications

   335 height from the floor in mm

   ¢ centre (i.e. the height is measured to centre of the bracket).
5. Check with the builder or owner before marking timber floors in case they are to be varnished rather than covered with carpet or other floor covering.

10.9.4.12 Post-construction cabling

10.9.4.12.1 General

For post-construction cabling, where safe access is available to the roof/ceiling space or under-floor area, cabling can generally be at least partly concealed. Where the building has brick veneer construction, it may be possible to conceal cabling in the external wall cavity (e.g. by removing a roof tile and "fishing" the cable out of the wall cavity). However, this should only be attempted by experienced installers applying safe working practices.

In order to conceal cables in an established building, the installer needs to have a basic knowledge of building techniques used for the type of building in the era it was constructed, and to be skilled in "fishing" cables in building cavities. However, care needs to be taken when drilling, cutting or "fishing" cavities, as hazards may lurk within, e.g. power cables, asbestos fibres, insect or vermin excreta, dust, pesticides and other chemicals.

With all buildings, new or old, when drilling, rodding or fishing walls, floors or ceilings, take special care to avoid electrocution by use of appropriate safety equipment (double-insulated drills, electrical safety gloves, electrical safety mats, RCD, etc.) and non-conductive rodders, snakes or drop strings.

Several products are available for safe rodding and fishing of building cavities. Some of these are described below.

10.9.4.12.2 Fibreglass rodders

A fibreglass rodder set, which includes several connectable flexible fibreglass rods (4 mm to 6 mm in diameter), a hauling eye and snagging hooks, is useful for rodding in ceilings and underfloor areas, up and down cavity walls, and whipping/jumping across beams in roof and floor cavities.

Where greater rod flexibility is required over shorter distances, use “yellow tongue” rod (see below).

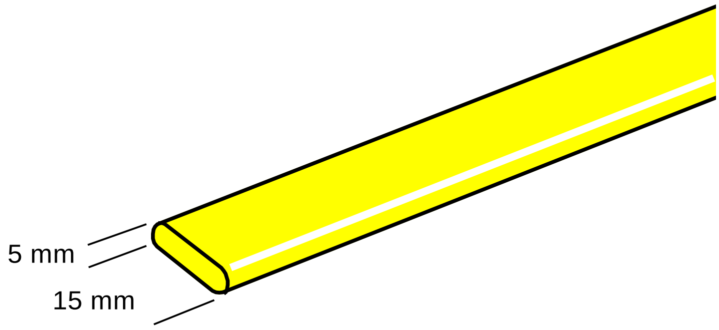
10.9.4.12.3 Yellow tongue

“Yellow tongue” is used in the building industry for joining of flooring material. It is also useful as a flexible, non-conductive rod for rodding and fishing up and down cavity walls, under floors and in ceiling spaces to install or retrieve cable or a drop line. Yellow tongue is 15 mm wide and 5 mm thick (see Figure 199) and is available in 4.0 m lengths.

Where yellow tongue is to be used to fish a cable or drop line out of a building cavity, tape a suitable size metal hook to the end of it.

Where greater rod rigidity is required, use a fibreglass rodder set (or a length of UPVC conduit).

Figure 199 Yellow tongue



Notes:

1. Yellow tongue is available in 4 m lengths and may be used to rod or fish building cavities.
2. Where yellow tongue is to be used to fish a cable or drop line out of a building cavity, tape a suitable size metal hook to the end of it.
3. Where greater rigidity is required, use a fibreglass rodder set (or a length of UPVC conduit).

10.9.4.12.4 Snakes

A “snake” is a coil or roll of semi-rigid rope, spring-steel wire or plastic rod mostly used for rodding conduits and pulling cables through them. However, a non-conductive snake may also be used to fish a cable, wire or string out of a cavity wall over a short distance. A snake may be more useful than “yellow tongue” in some cases because the snake is round or narrow in section and may be twisted more readily to snag the cable, wire or string with an attached hook.

10.9.4.12.5 Cabling in suspended (“false”) ceilings

Suspended ceilings may be used in common areas of apartment buildings and possibly also within the apartments.

Cables installed in suspended ceilings must not be laid on the ceiling tiles or their supports and must not be tied to the ceiling hanger rods. The cables must be secured to tray, trunking, hooks or catenary wires provided for the purpose or must be fastened directly to the underside of the floor above.

Telecommunications cables must be separated from other (non-telecommunications) services within the ceiling space as described in 10.9.4.2 to 10.9.4.7. Cables must also be kept clear of fire sprinkler heads, smoke detectors and emergency lighting.

Cabling through FRL-rated walls (“fire walls”) in the ceiling space must be fire-stopped by a qualified person using material that complies with the requirements of the building codes and/or local building/fire authorities.

10.9.4.12.6 Cabling in tray, trunking or skirting systems

Indoor cabling installed on cable trays or in trunking or skirting should be run in the channel or compartment provided for telecommunications. Where separate channels or compartments have not been provided for telecommunications, power and other services:

- the telecommunications cables must be installed in plastic conduit in or on the tray, trunking or skirting; and/or
- physical separation must be maintained from the other services as described in 10.9.4.2 to 10.9.4.5.

Separation must be maintained between power outlets and TOs fitted to the floor skirting or office trunking as described in 10.9.2.5 and 10.9.4.4. TOs should be fitted to the skirting/trunking using purpose-built fittings or fastened using metal-thread screws. Self-tapping screws should not be used unless the tip of the screw is flat and does not protrude significantly into the cable channel/compartment or a protective covering is fitted over the tip of the screw.

10.9.4.12.7 Cabling on building surfaces

Surface cabling on internal building surfaces should be enclosed in plastic conduit, trunking or ducting. Alternatively, cable may be fixed directly to timberwork (e.g. skirting, architrave) using clips or staples that do not exert enough pressure on the cable to appreciably distort the cable sheath (see Figure 201). However, it will not usually be possible to fasten the cable neatly with clips or staples if the cable is installed correctly because the cable will not be sufficiently restrained to keep it taut and straight.

The cable, conduit, trunking or ducting should be run vertically or horizontally unless it is run in parallel with a sloping building feature (e.g. a raked ceiling), and should be run along or adjacent to suitable building features or fittings so as to be unobtrusive.

Cable should be fixed at the following intervals:

- vertical runs — 500 mm or less;
- horizontal or oblique runs — 300 mm or less.

Conduit or trunking/ducting should be fastened at the following intervals:

- vertical runs — 900 mm or less;
- horizontal or oblique runs — 600 mm or less.

Cable bend radius

When forming bends in surface-run cable, the radius of the bend should not be less than:

- 4 times the cable diameter for UTP data cable
- 5 times the cable diameter for STP data cable
- 5 times the cable diameter for coaxial cable.

Typical bend radius examples are as follows:

- Category 6 UTP (6 mm diameter) ....25 mm
- Category 6 STP (7 mm diameter)..............................35 mm
- RG6 trishield coaxial cable (7 mm diameter) ....35 mm
- RG6 quadshield coaxial cable (8 mm diameter) ....40 mm

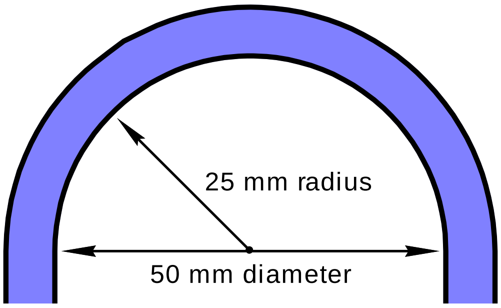
Note: See 10.8.7.3 (page 215) for for comments about coaxial cable bend radius information specified in other documents.

Bend radius can be difficult to judge. The actual bend size required for Category 6 UTP and RG6 quadshield cables can be appreciated from Figure 200. Installers can make a simple guide for each type of cable out of timber ply, plastic or a slither of suitable diameter conduit to ensure that the correct minimum bend radius is maintained in any installed cables. A tight bend or kinked cable, while seemingly innocuous, can significantly degrade cable performance.

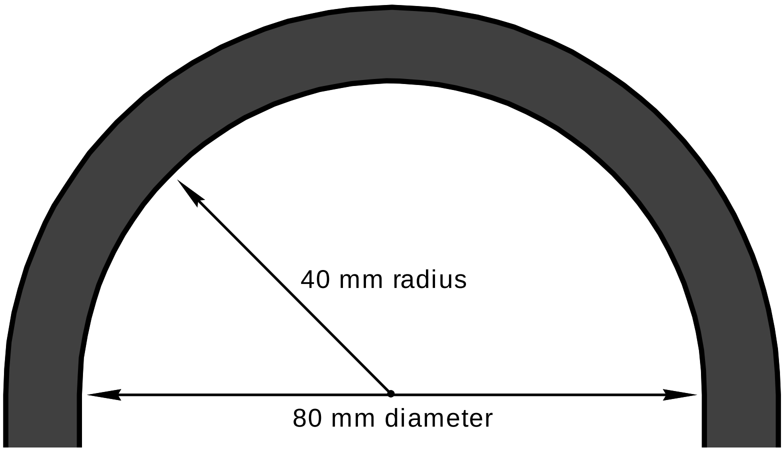
Fasten the cable on each side of the bend as shown in Figure 202.

Figure 200 Actual bend diameter for typical data and coaxial cables

(a) Category 6 UTP data cable



(b) RG6 quadshield coaxial cable

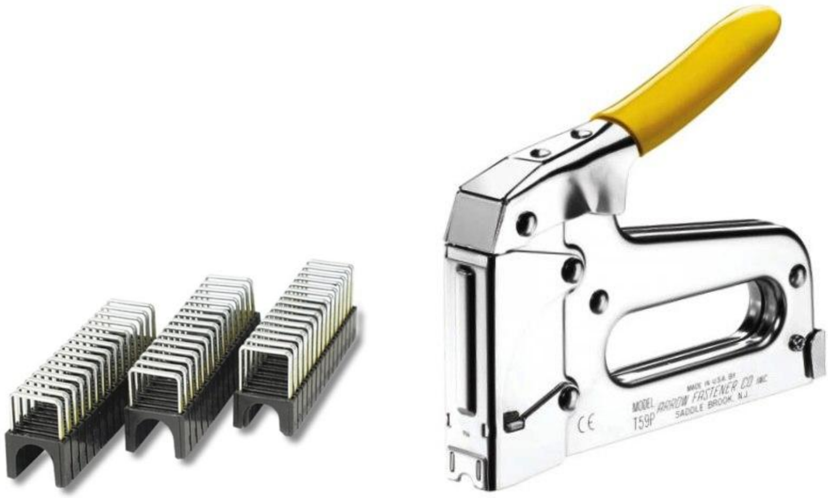


Note: The above drawings may be slightly more or less than actual size when printed on A4 page format.

Figure 201 Suitable cable fasteners

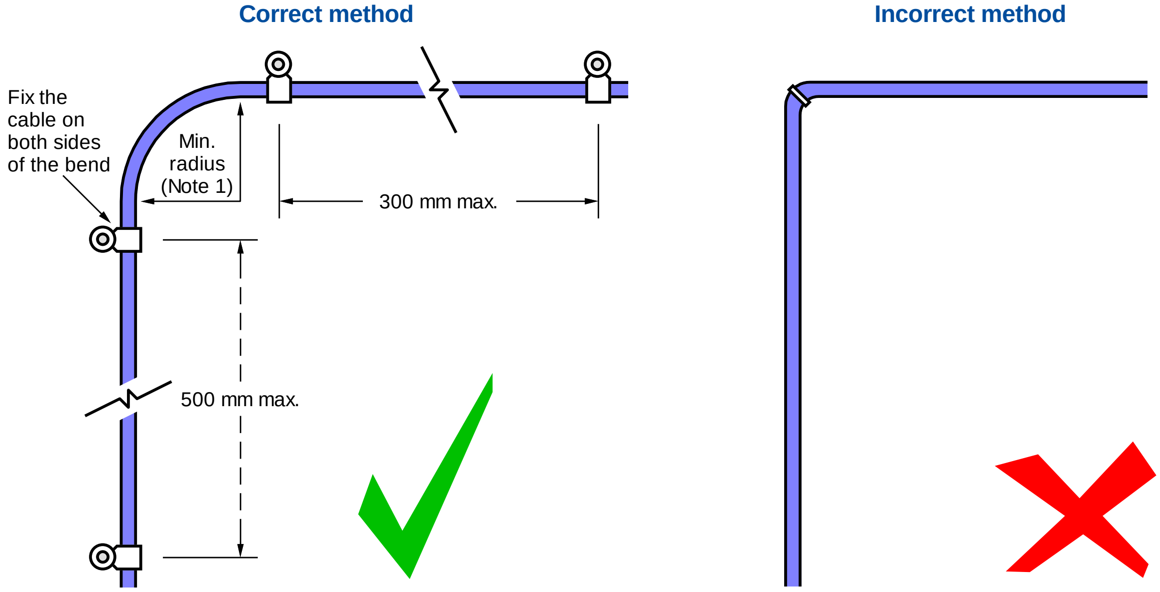
Plastic cable clip

Insulated staples and staple gun (Arrow T59 or equivalent)



Note: Select the appropriate size clip or staple for the type of cable being fastened, e.g. 6 mm (1/4'') for Category 6 UTP data cable or 8 mm (5/16'') for RG6 quadshield coaxial cable. It will not usually be possible to fasten the cable neatly with clips or staples because the cable may not be fastened tightly enough to keep it taut and straight.

Figure 202 Fixing cable at bends



Notes:

1. The bend radius should not be less than:
   - 4 times the cable diameter for UTP data cable (e.g. 25 mm for Category 6 unscreened twisted pair)
   - 5 times the cable diameter for STP data cable (e.g. 35 mm for Category 6 screened twisted pair)
   - 5 times the cable diameter for coaxial cable (e.g. 40 mm for RG6 quadshield).

   See 10.8.7.3 (page 215) for comments about coaxial cable bend radius information specified in other documents.
2. Fix the cable on each side of the bend, not in the middle of the bend. Gun stapling of cables is not recommended unless the stapler and staples are designed to limit the pressure exerted on the cable sheath (see Figure 201).

10.9.4.12.8 Outdoor cabling

Any cable that is run as outdoor surface cabling or aerial cabling and exposed to direct sunlight should be installed in conduit; otherwise outdoor type cable must be used (e.g. cable with a black polyethylene sheath).

Any cable installed underground, whether or not it is installed in conduit, must be designed for underground use. In particular:

- the cable sheath should be made of high-density compound (such as polyethylene); and
- the cable core should be filled with suitable grease, gel, yarn or powder that prevents the movement of any water along the core in the event that water penetrates the sheath.

Note: Not all cables sold as “outdoor” or “indoor/outdoor” cables are suitable for underground use. The cabling provider should verify with the cable manufacturer that a cable claimed to be “outdoor” type is actually designed for underground use (see 4.14.4.6 on page 38).

Cabling that is run along external walls should be installed at least 100 mm above finished ground level and should be enclosed in conduit unless installed higher than 2.4 m or protected from impact or abrasion by an overhang or similar building feature. Cable may be run as surface cabling without enclosure in conduit along a timber beam, soffit moulding, fascia, etc.

Outdoor conduits should be fastened using galvanised saddles or half-saddles. Nickel-plated or zinc-passivated saddles or half-saddles are unsuitable for outdoor use as they will rust in a relatively short space of time. However, nickel-plated or zinc-passivated saddles or half-saddles are suitable for fastening indoor conduits.

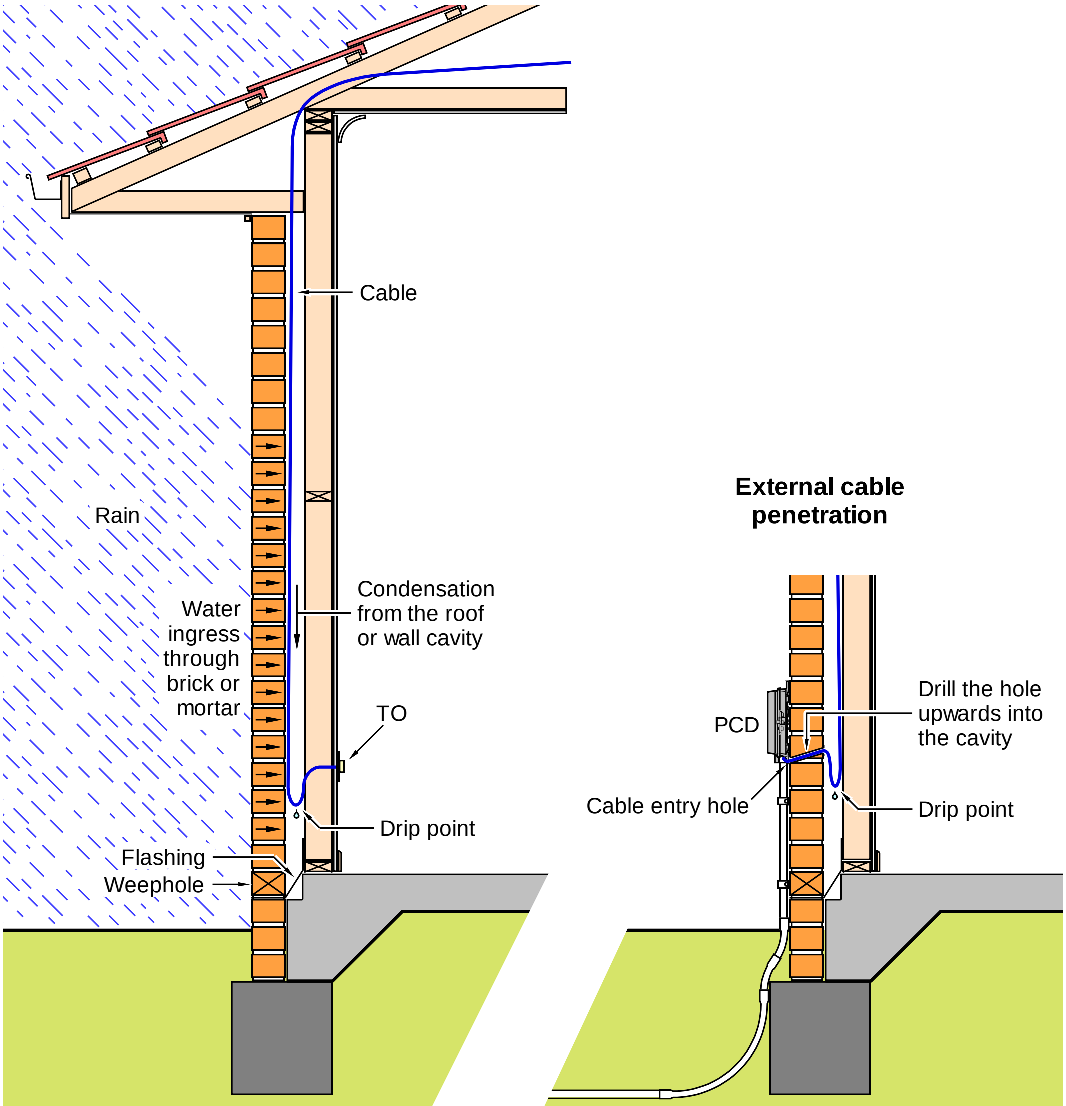
Restrictions apply to cabling between buildings — refer to section 12.

10.9.4.13 Provision of drip points in external walls

Any cable running down the cavity of an external wall should have a "gooseneck" (half loop) formed in it to provide a "drip point" so that any condensation or seepage water flowing down the cable does not run into the telecommunications outlet socket or onto the internal wall lining. Where sarking or panel bracing has been installed between the inner and outer walls, ensure that the drip point is provided on the outside (external wall side) of the sarking membrane or bracing panel.

If it is necessary to drill a hole through external wall cladding for cable entry, drill at an upward angle into the wall cavity to ensure that any water running down the outer wall will not flow through the hole into the building. See Figure 203.

Figure 203 Provision of a drip point within an external wall cavity



Notes:

1. The drip point consists of slack cable (min. 200 mm, max. 500 mm) left in the wall cavity and arranged such that it is looped downwards.
2. The drip point (slack cable) should be located on the outer side of any wall sarking or panel bracing (i.e. between the external brick or external wall cladding and the sarking/bracing).
3. For any external cable penetration to the building, drill the hole upwards into the wall cavity so that any water running down the outer wall will not run through the hole into the building.

Table 13 Telecommunications cabling — minimum separation requirements from other services in or on a building (in mm)

Telecommunications			Electricity: ELV Cable	Electricity: ELV Connection	Electricity: LV Cable	Electricity: LV Connection	Electricity: HV Cable MC[5]	Electricity: HV Cable SC[5]	Electricity: HV Connection[4] MC[5]/SC[5]	Oxygen or flammable gas: Pipe	Oxygen or flammable gas: Connection/ Meter/Cylinder	Water or waste[9]: Pipe/ Connection	Water or waste[9]: Meter/ Pump/Cistern	Heating oil, steam or compressed air: Pipe	Heating oil, steam or compressed air: Connection/ Pump/Tank
Metallic cable	Cable	Unenclosed	0		50[2]	50[2]	300[6]	450		150[7]	150	50	150	150[7]	150
		In conduit			0[2]	0[2]	150					0			
	Connection/TO/joint		0	150[3]	50[2]	150[3]	450			150	See below[8]	150		150	
Optical fibre cable[1]	Cable	Unenclosed	0			150[3]	0		450	150[7]	150	50	150	150[7]	150
		In conduit										0			
	Connection/Splice		0	150[3]	0	150[3]	0		450	150	See below[8]	150		150	

[1] If the optical fibre cable contains any electrically conductive elements (e.g. a metallic strength member or tracer), treat it as a metallic cable (i.e. a cable with electrically conductive elements).

[2] If the cables are separated by a barrier of durable insulating material or metal (including enclosure in conduit), no further separation is required unless the cables are within 50 mm of any securing face of building framework.

[3] Accidental contact with ELV or LV connections by a telecommunications worker must be prevented by effective means (e.g. a shield, shroud or suitable distance). In addition, the telecommunications and ELV/LV connections must be separated by at least 150 mm unless they are separated by a permanent, rigidly fixed barrier of durable insulating material or earthed metal, in which case no further separation is required.

[4] The installation of telecommunications conductors or connections in the same enclosure as any HV conductors or connections is not permitted.

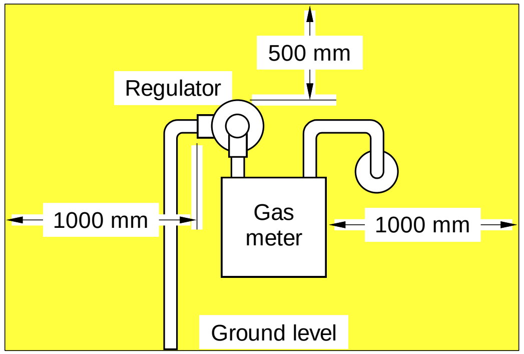
[5] MC = Multi-Core SC = Single Core

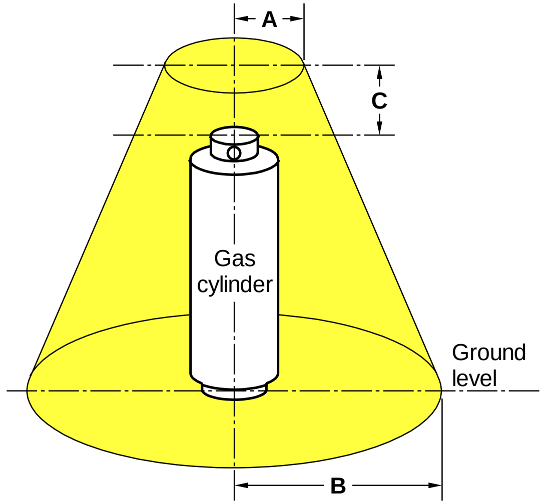
[6] Only 150 mm is required if the cables are separated by a permanent, rigidly fixed barrier of durable insulating material or earthed metal as long as at least 175 mm is maintained between the cables around the barrier.

[7] Separation by a suitable barrier or heat insulation, as appropriate, is acceptable at crossings, within wall cavities or within shared trunking.

[8] Connection devices, telecommunications outlets, joints or splices must not be installed within the shaded zones near gas facilities as illustrated at right.

[9] These are the recommended minimum separation distances to provide adequate clearance to install or access the telecommunications cabling.





	Exchange cylinder	In-situ fill cylinder
A	500 mm	1500 mm
B	1500 mm	3500 mm
C	500 mm	500 mm

NOTE: The clearances in this table are based on AS/CA S009:2013, *Installation requirements for customer cabling (Wiring rules)*

11 EARTHING

11.1 When is earthing required?

11.1.1 PCD

Where the outdoor PCD is an FTTP NTD or an ADSL NTD, an earthing conductor will be required at the PCD location. In the case of an FTTP NTD, the earth is required for electrical safety purposes whereas, for the ADSL NTD, the earth is for lightning surge suppression purposes.

11.1.2 Coaxial cabling

Where a TV antenna distribution system is installed, the outer conductor of the coaxial cabling may be earthed in accordance with 10.8.8.2 on page 219.

Note: HFC coaxial cabling is separate, does not form part of the TV antenna system and should not be earthed.

11.1.3 Data cable screens

If screened data cables are installed, the cable screens should be earthed at the CCP.

11.1.4 Metallic parts

Metallic parts such as cabling or equipment enclosures do not normally need to be earthed but may be earthed for screening purposes or additional safety if required. In such cases, it is important to avoid “fortuitous bonding” (accidental multiple earthing) of components, which may create “earth loop” currents that could cause noise in the cabling system. For example, if cable screens and metallic parts need to be earthed, they should be earthed by a single connection to a common point (such as a metallic enclosure that is earthed) and should not be earthed at any other point (refer to 11.3.1).

11.2 Equipotential bonding

In all cases where earthing is required, the earth should be derived from the electrical earthing system. This is an important safety requirement to ensure that there is no earth differential at or in the building. Earthing should **not** be achieved by driving a separate earth electrode unless that electrode is also bonded (connected) to the electrical earth electrode or is for the sole purpose of providing a lightning protection earth for an external antenna (see 10.8.8.1 on page 219).

Telecommunications earthing is obtained from the electrical earthing system by means of “**equipotential bonding**”, i.e. by “bonding” (connecting) the two earthing systems together to ensure that they are at “equal potential”. The equipotential bonding must be done at the **electrical switchboard** — either inside the switchboard itself by connection to the main earthing bar or main earthing conductor, or outside the switchboard by connection to the main earthing conductor or to the electrical earth electrode. Refer to Figure 4 of Australian Standard AS/CA S009:2013, *Installation requirements for customer cabling (Wiring rules)*. The three allowable methods of equipotential bonding are illustrated in Figure 204.

It is important that there is a **demarcation point** between the electrical earthing system and the telecommunications earthing system so that:

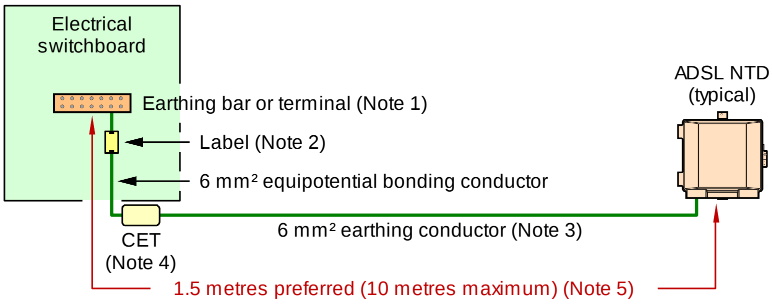
- the telecommunications earth can be isolated from the electrical earth at a single, readily accessible point by either a telecommunications worker or an electrical worker; and
- earthing of telecommunications equipment can be legally performed by a telecommunications worker who is not also a licensed electrical worker.

This demarcation point will be either a **Communications Earth Terminal (CET)** located outside the electrical switchboard or a distinct**, removable connection device on the electrical earth electrode**.

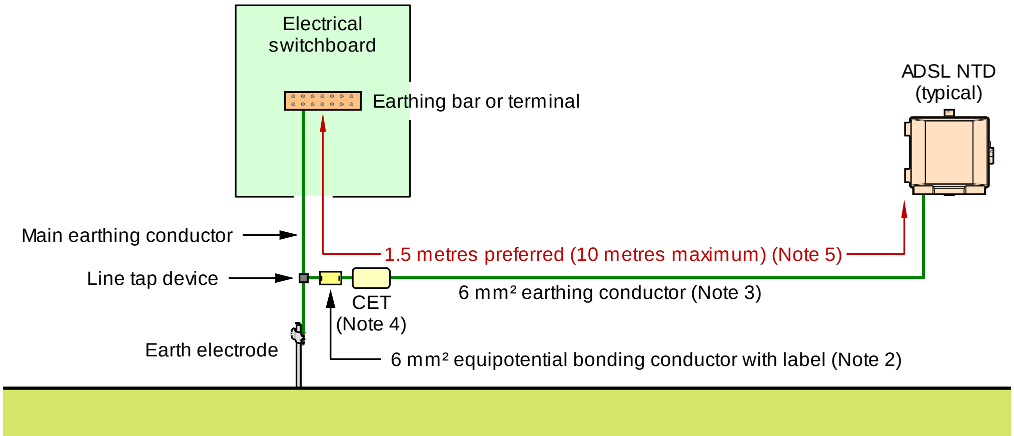
An earthing conductor for telecommunications equipment should not be connected (hard wired) directly to the electrical earthing system even if this is not precluded by the electrical wiring rules (AS/NZS 3000). Furthermore, while telecommunications equipment may use the earth from a power outlet via the power plug and power cord as part of the equipment design, a telecommunications earth should **never** be hard wired from the earthing conductor at the rear of a power outlet.

Figure 204 Equipotential bonding methods

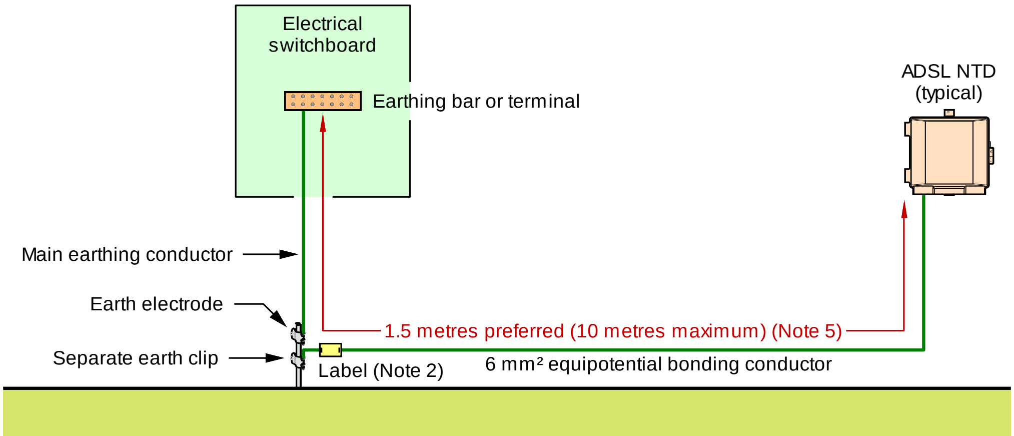
(a) Equipotential bonding to the earthing bar or terminal of the electrical switchboard (Method 1)



(b) Equipotential bonding to the main earthing conductor outside the electrical switchboard (Method 2)



(c) Equipotential bonding to the electrical earth electrode (Method 3)



Notes:

1. Only a licensed electrical worker may access the internals of an electrical switchboard.
2. The equipotential bonding conductor must be labelled "Telecommunications Bonding Conductor" or "Communications Bonding Conductor" at the switchboard end and also at the other end if the other end is not within sight of the switchboard.
3. While a 2.5 mm^2 earthing conductor is acceptable between the CET and an outdoor FTTP NTD, a 6 mm^2 conductor is recommended between the CET and the PCD in all cases to ensure compatibility with all PCDs.
4. The CET should be located in the telecommunications compartment of the CUE, if provided, as shown in Figure 53 on page 72 or, if a CUE is not provided, the CET may be located in any readily accessible location external to the electrical switchboard — preferably immediately below the switchboard per Figure F3 of AS/NZS 3000:2007.
5. The total length of bonding/earthing conductor between the earthing bar/terminal in the electrical switchboard and the PCD should preferably be less than 1.5 m but, in any case, should not exceed a length of 10 m.

11.3 Installation of earthing conductors

11.3.1 General

For a home networking system, a Communications Earth System (CES) conductor should be provided at the CCP for possible earthing of cable screens/shields.

An earth is not required at the CCP for a minimal cabling system.

A CET is required if equipotential bonding methods 1 or 2 are used (see Figure 204). The CET should be located within the telecommunications compartment of the CUE (where used) or under the electrical switchboard (see Note 4 to Figure 204). Where bonding method 3 is used, the equipotential bonding conductor may be connected to an earthing terminal located at the CCP. There is no reason why two equipotential bonding conductors cannot be installed for separate purposes, e.g. bonding method 3 for earthing of the outdoor PCD and bonding method 1 or 2 for earthing, via a CET located at the electrical switchboard, to a separate earthing terminal located at the CCP — as long as the indoor earthing terminal and the PCD earth are not interconnected to create an “earth loop” (see the next paragraph). However, it is recommended that a single equipotential bonding connection be made to the electrical earthing system to avoid confusion.

All earthing conductors should be cabled in a “tree” or “star” wiring configuration from the CET or other common earthing point. Care should be taken to avoid intentionally or accidentally earthing the same metallic component at two separate points (such as both ends of a screened cable), which may create “earth loop” currents that could generate noise in the cabling system. An example of accidental earthing (“fortuitous bonding”) would be where the outer conductor of a coaxial cable is intentionally earthed at the splitter/amplifier in accordance with 11.1.2 but a metal-bodied coaxial splitter or connector located some distance from the CCP is fastened to, or is accidentally touching, metallic building framework (which is required to be earthed by building codes).

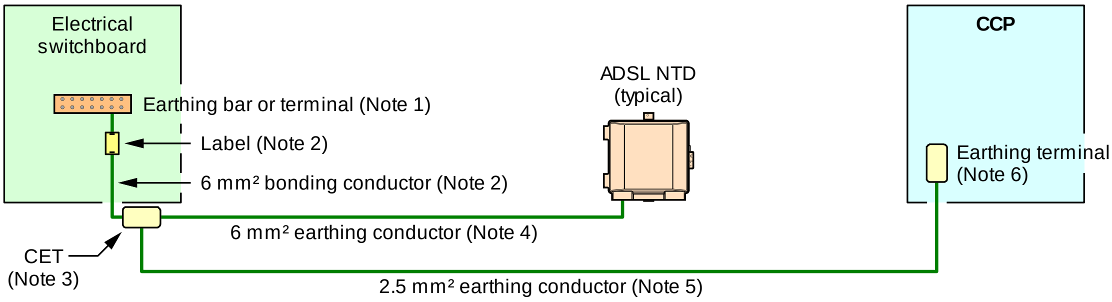
11.3.2 Earthing conductor size and colour

The equipotential bonding conductor must be at least 6 mm² in cross-sectional area (7/1.04 mm) with green/yellow insulation. Any earthing conductor required for end-user lightning protection purposes (such as to an ADSL NTD) must also be 6 mm² with green/yellow insulation. In all other cases, a minimum 2.5 mm² (7/0.67 mm) green/yellow earthing conductor is required, which must be cabled from the CET or other earthing terminal.

Earthing and bonding conductors do not need to be installed in conduit within building cavities.

The recommended earthing conductor arrangement for a generic cabling system is shown in Figure 205.

Figure 205 Recommend earthing conductor cabling for generic home cabling



Notes:

1. Only a licensed electrical worker may access the internals of an electrical switchboard.
2. The equipotential bonding conductor between the earthing bar or terminal of the electrical switchboard and the CET must be at least 6 mm² (7/1.04 mm) copper conductor with green/yellow insulation and labelled "Telecommunications Bonding Conductor" or "Communications Bonding Conductor" in accordance with the requirements of Clause 20.11 of AS/CA S009:2013 and Clause 5.6.2.7 of AS/NZS 3000:2007.
3. The CET should be located in the telecommunications compartment of the CUE, if provided, in accordance with Figure 53 on page 72 or, if a CUE is not provided, the CET should be located immediately below the electrical switchboard in accordance with Figure F3 of AS/NZS 3000:2007.
4. The earthing conductor between the CET and the PCD should be at least 6 mm² (7/1.04 mm) copper conductor with green/yellow insulation. There is no need to label this conductor. The total length of bonding/earthing conductor between the earthing bar/terminal in the electrical switchboard and the PCD should preferably be less than 1.5 m but, in any case, should not exceed a length of 10 m (see Figure 204).
5. The earthing conductor between the CET and the earthing terminal at the CCP must be at least 2.5 mm² (7/0.67 mm) copper conductor with green/yellow insulation. There is no need to label this conductor. The length of this conductor must not exceed 135 m to ensure that it does not exceed the maximum specified CES resistance of 1 ohm.
6. For a home networking system, an earthing terminal should be provided at the CCP (refer to 11.3.1). If end-users can access the earthing terminal, it is a requirement of AS/CA S009 for the terminal to have an insulated cover to prevent end-user access to the terminations. All telecommunications earthing connections (e.g. to cable screens) should be made at the CCP.

12 CONNECTION OF SERVICES TO OUTBUILDINGS

12.1 Limitations

The output ("local") ports of most domestic powered equipment (such as FTTP NTDs, modems, gateways and routers) are classified as "internal" (indoor) ports. This means they are only designed to be connected to cabling and other equipment located within the confines of the same building. Any cabling that runs to a separate building (an "outbuilding") should only be connected to local ports that are classified as "external" (outdoor) ports. External ports are designed to withstand power/earth voltage differentials that may occur between the buildings or voltages that may be induced into the outdoor cabling by lightning activity. External ports provide an extra margin of safety for the end-user and reduce the risk of damage to the equipment.

Where outdoor cabling to an outbuilding is connected to a local port of equipment and this is not supported by the manufacturer or supplier of the equipment, the cabler or consumer may be liable for any resultant personal injury or damage to the equipment or the premises. The cabler may also be in breach of Clause 5.2 of Australian Standard AS/CA S009:2013, *Installation requirements for customer cabling (Wiring rules)*, which requires the cabler to comply with the manufacturer's or equipment supplier's instructions.

If a telecommunications service is required in an outbuilding, it may be necessary to provide a separate telecommunications network service directly to that outbuilding or rely on the use of wireless/cordless technology, as described in 12.2.

12.2 Sharing of services between buildings

12.2.1 General

It is common practice for additional TOs to be cabled to outbuildings for sharing of such things as telephone services and, for copper-based telephone services (e.g. supplied via an ADSL NTD from a copper telecommunications network), this may continue subject to the requirements of section 10 of Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)* (section 10 requires the cabler to assess the need for surge suppression and install surge suppression where required). However, things are different where other telecommunications network technologies are used and for wired Ethernet connections in particular. To ensure that electrical safety standards are maintained, the local ports of powered equipment such as FTTP NTDs and modems, gateways or routers should **not** be connected to outdoor cabling unless this is supported by the manufacturer or supplier of the relevant equipment.

Further guidance is provided below.

12.2.2 Telephone services

Where access to a telephone service originating from a local port in an FTTP NTD or a VOIP gateway is required at an outbuilding, the access may be provided to the outbuilding by one of the following means:

(a) using cordless technology;

(b) using a wireless line extender; or

(c) cabling via a line isolation unit (LIU) that provides a minimum isolation of 3 kV r.m.s., which is installed at the main building.

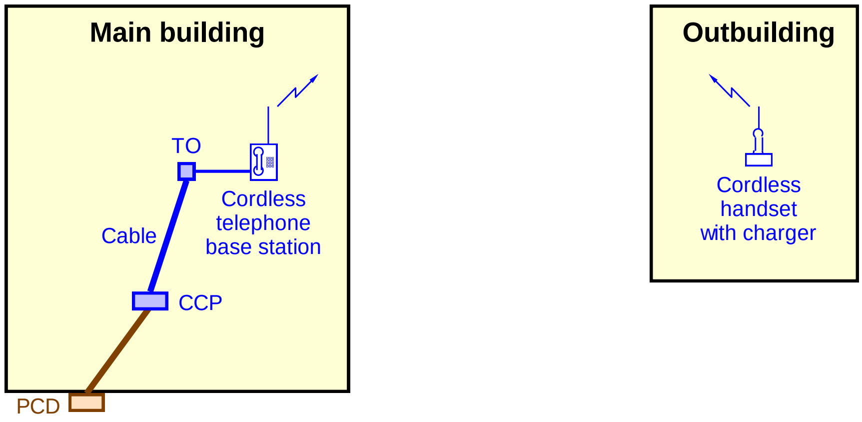
With the above methods, service will be lost at the outbuilding during power failure unless the customer equipment has its own battery backup.

In the case of method (c), it is a requirement Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*, for the cabler to assess the need for surge suppression in accordance with Australian Standard AS 4262.1, *Telecommunication overvoltages Part 1: Protection of persons*, and, where the risk of injury to the end-user is assessed as high, for surge suppression to be provided at the outbuilding. In addition, surge suppression should be installed at the main building to protect the end-user at the main building from line surges originating from the outdoor cabling.

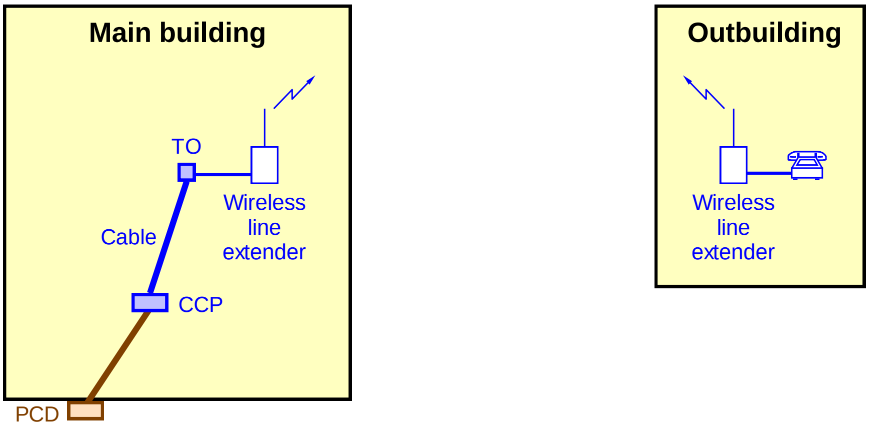
Refer to Figure 206.

Figure 206 Providing access to a telephone service at an outbuilding

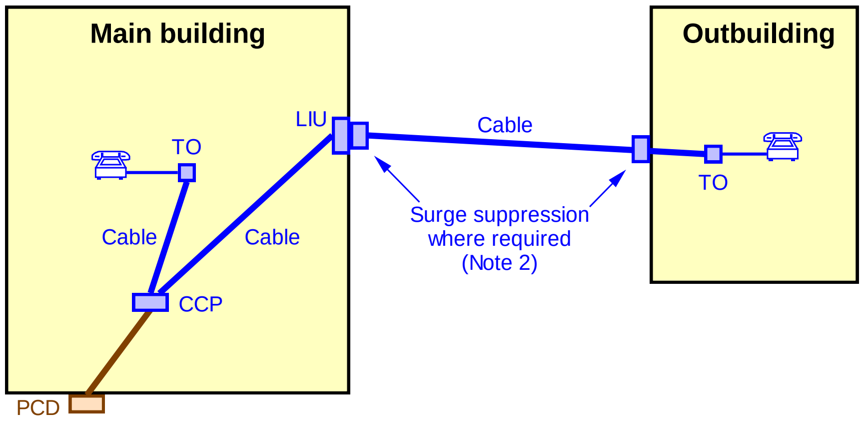
(a) Using cordless telephones



(b) Using a wireless telephone line extender



(c) Using a line isolation unit (LIU)



Notes:

1. Only methods (b) and (c) are suitable for dial-up internet access at the outbuilding.
2. Where method (c) is used, the LIU must be installed at the main building. In addition, in high lightning risk situations, it is a requirement of Australian Standard AS/CA S009, *Installation requirements for customer cabling (Wiring rules)*, for surge suppression to be provided at the outbuilding for the protection of the end-user at the outbuilding. Surge suppression should also be installed at the main building to protect the equipment and the end-user at the main building from line surges.

12.2.3 Data services

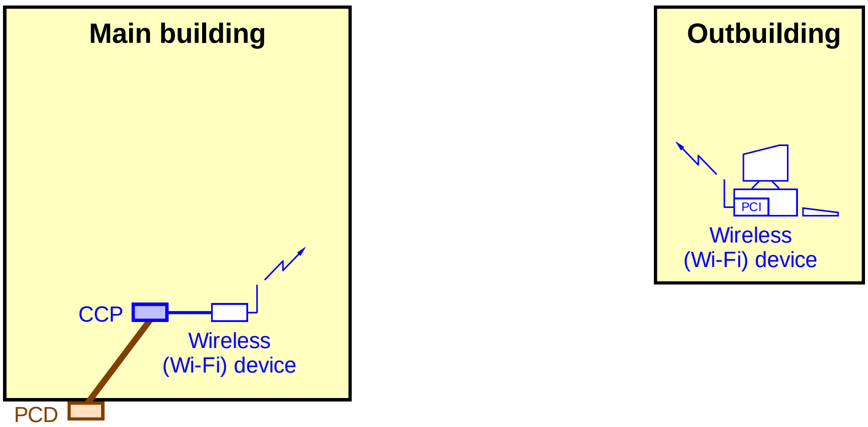
Where a broadband internet connection is required at the outbuilding, this may be provided using **wireless (Wi-Fi)** technology. Refer to Figure 207 (a).

Alternatively, optical fibre cabling may be installed between **fibre-to-Ethernet media converters** located at each building as shown in Figure 207 (b).

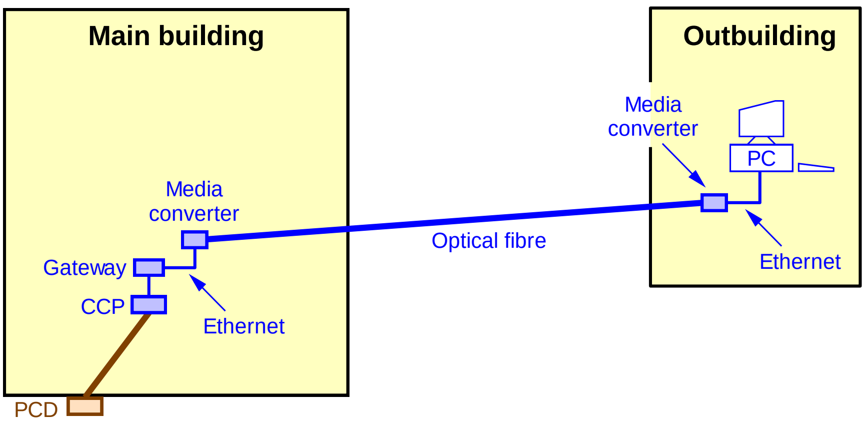
Ethernet over Power (EoP) is another possible option if the two buildings are fed from the same electrical switchboard but its suitability for safe use over power cabling between buildings is unknown.

Figure 207 Provision of a data service to an outbuilding

(a) Using Wi-Fi (limited distance, low speed)



(b) Using optical fibre and fibre-to-Ethernet media converters (longer distance, higher speed)



A typical 10/100 fibre-to-Ethernet media converter
(PHOTO COURTESY OF ANDERSON CORPORATION PTY LTD)

12.2.4 TV services

Where access to free-to-air TV is required at the outbuilding, a separate TV antenna should be installed at the outbuilding. Where access is required at the outbuilding to the TV cabling distribution system in the main building (e.g. for monitoring of CCTV channels), this may be provided using a wireless video (or wireless A/V) sender/receiver. However, such devices only transmit analogue TV signals and have a limited range.

If cabled access to the TV cabling distribution system in the main building is required, this should only be provided under the following conditions:

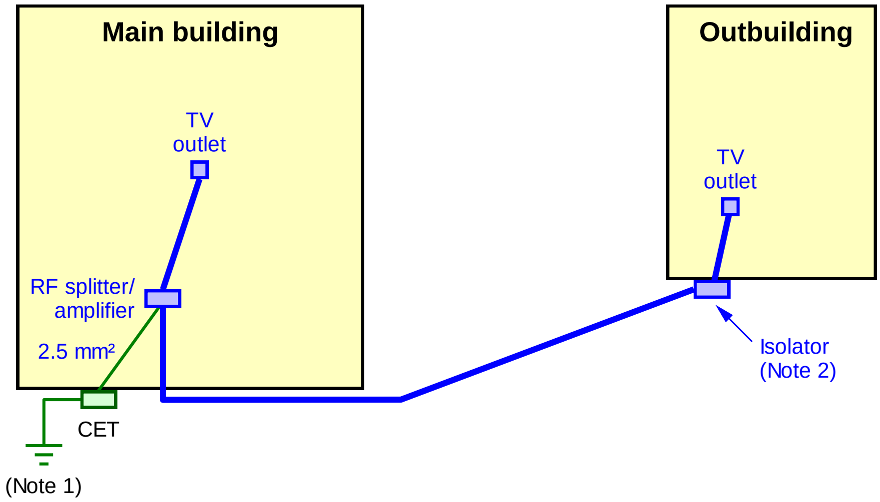
- An isolator that provides a minimum isolation of 3 kV r.m.s. and 7 kV impulse should be installed at the outbuilding, as shown in Figure 208 (a).
- Earth continuity should be maintained on the outer conductor of the coaxial cabling between the RF splitter/amplifier and the isolator at the outbuilding.

In high lightning risk situations, if coaxial cable is run to the outbuilding surge suppression should be provided at the outbuilding for the protection of the end-user. This may be achieved by earthing the outer conductor of the coaxial cable at the input (outdoor cable side) of the isolator, as shown in Figure 208 (b). In addition, to protect the equipment and the end-user at the main building from line surges originating from the outdoor outbuilding cabling:

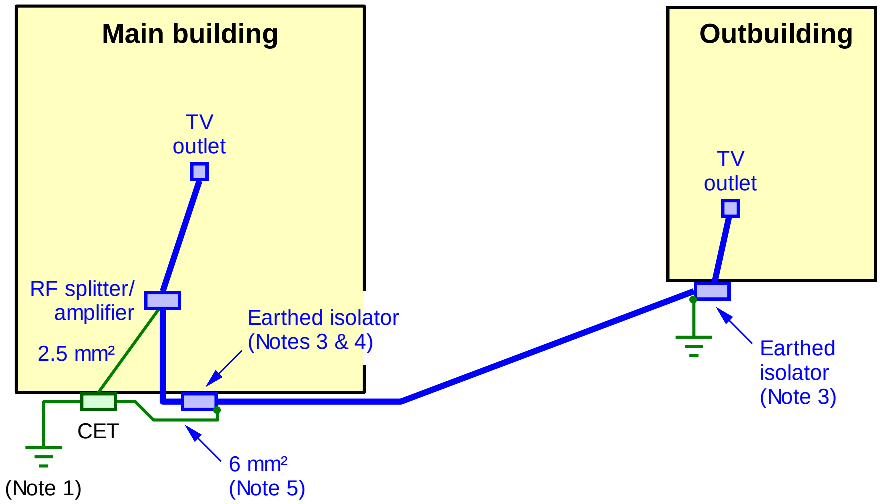
- An isolator that provides a minimum isolation of 3 kV r.m.s. and 7 kV impulse should be installed at the main building.
- The outer conductor of the coaxial cable at the output (outdoor cable side) of the isolator at the main building should be equipotentially bonded to the electrical earthing system by one of the methods described in 11.2 (page 248). The total length of earthing/bonding conductor between the earth bar/terminal of the switchboard and the isolator should be as short as possible (preferably less than 1.5 m) but in any case should not exceed 10 m.

Figure 208 Provision of a TV outlet at an outbuilding

(a) Low lightning risk situation



(b) High lightning risk situation



Notes:

1. For earthing of the RF splitter/amplifier, refer to 10.8.8 on page 219.
2. An isolator that provides a minimum isolation of 3 kV r.m.s. and 7 kV impulse should be installed at the outbuilding. The isolator at the outbuilding does not need to be earthed in this case.
3. In high lightning risk situations, surge suppression should be provided at the outbuilding for the protection of the end-user. This may be achieved by earthing the outer conductor of the coaxial cable at the input (outdoor cable side) of the isolator (see Figure 209 to Figure 212). In addition, to protect the equipment and the end-user at the main building from any line surges originating from the outdoor outbuilding cabling, an isolator should be installed at the main building and the outer conductor of the coaxial cable at the output (outdoor cable side) of the isolator at the main building should be equipotentially bonded to the electrical earthing system (see Figure 209 and Figure 213).
4. The splitter/amplifier may be located at the CCP. However, the isolator should be housed in a separate enclosure on the external wall to enable a short equipotential bonding conductor to be provided to the electrical earthing system. The isolator must be connected on the **output side** of the splitter.
5. The earthing conductor between the CET and the isolator should be at least 6 mm² in cross-sectional area.

Figure 209 Earthing of the coaxial cable outer conductor at the isolator (typical)

(a) Earthing at the isolator input (outbuilding) **(b) Earthing at the isolator output (main building)**

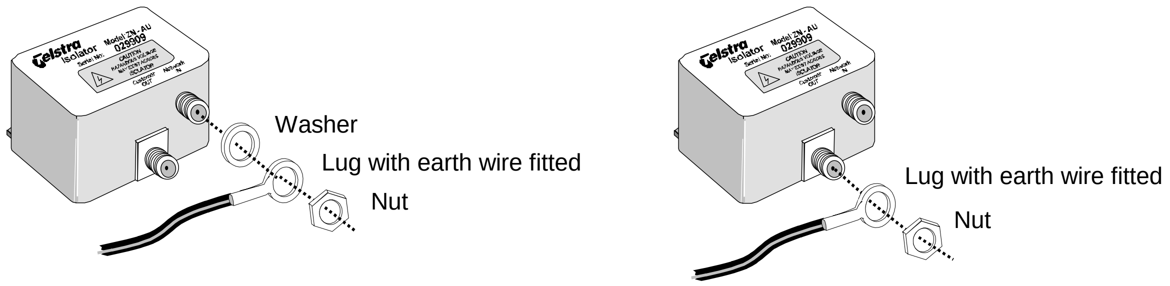
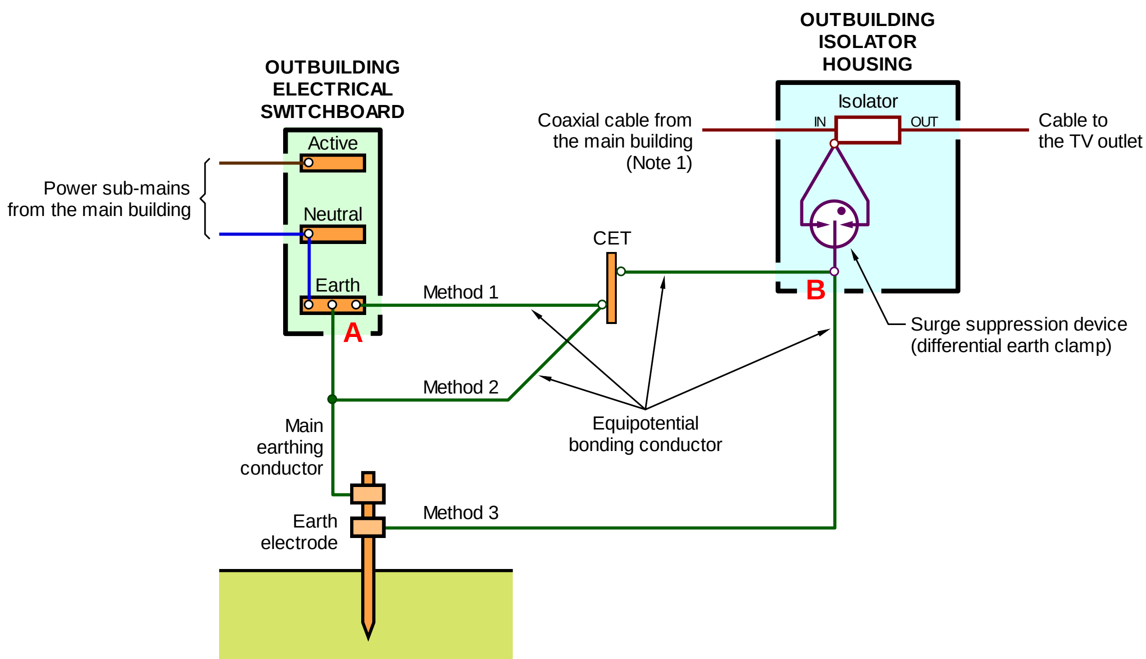


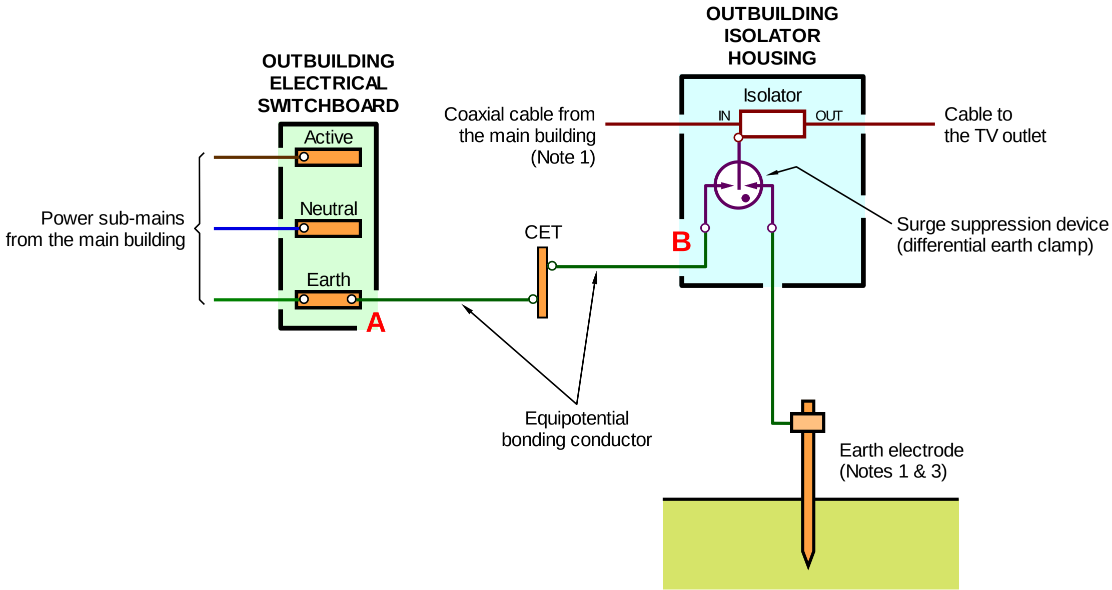
Figure 210 Earthing of the coaxial isolator at the outbuilding where the outbuilding has its own electrical switchboard with an earth electrode (high lightning risk situation)



Notes:

1. The outer conductor of the coaxial cable must be earthed on the input (main building side) of the isolator, as shown in Figure 209 (a), via a surge suppression device connected as a differential earth clamp, as shown. The differential earth clamp is necessary to prevent current flow via the outer conductor of the coaxial cable between the earth at the main building and the earth at the outbuilding under normal (non-surge) conditions.
2. The outer conductor must be equipotentially bonded (via the differential earth clamp) to the electrical earthing system using any of the bonding methods 1, 2 or 3 as shown (see 11.2 on page 248 for details). The total length of earthing/bonding conductor between points **A** and **B** should be as short as possible (preferably less than 1.5 m) but in any case should not exceed 10 m.

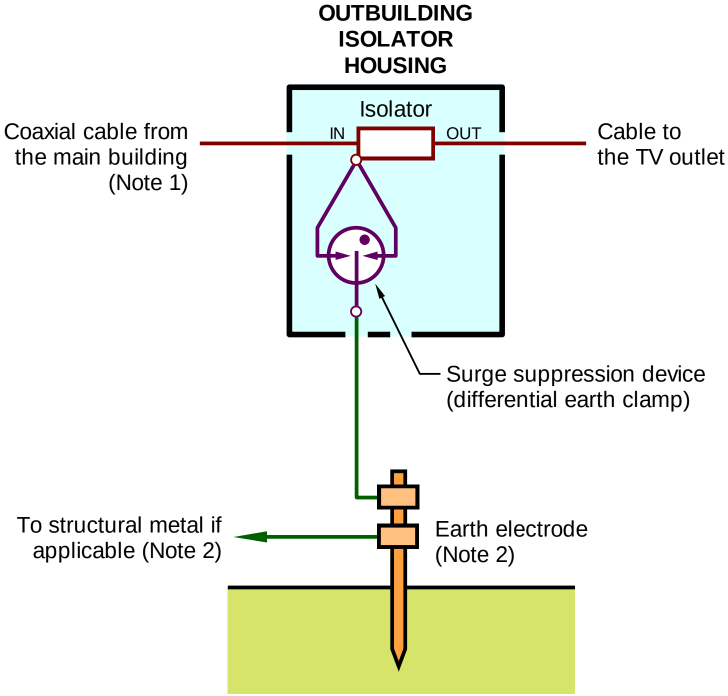
Figure 211 Earthing of the coaxial isolator at the outbuilding where the outbuilding has its own electrical switchboard but no electrical earth electrode (high lightning risk situation)



Notes:

1. The outer conductor of the coaxial cable must be earthed on the input (main building side) of the isolator, as shown in Figure 209 (a), to both the earth bar of the electrical switchboard and an additional earth electrode via a surge suppression device connected as a differential earth clamp, as shown. The differential earth clamp is necessary to prevent current flow via the outer conductor of the coaxial cable between the earth at the main building and the earth at the outbuilding under normal (non-surge) conditions.
2. The outer conductor must be equipotentially bonded to the electrical earthing system using the bonding method shown. The length of bonding conductor between points **A** and **B** should be as short as possible (preferably less than 1.5 m) but in any case should not exceed 10 m.
3. The earth electrode should have a DC resistance to the general mass of earth of no greater than 30 ohms.

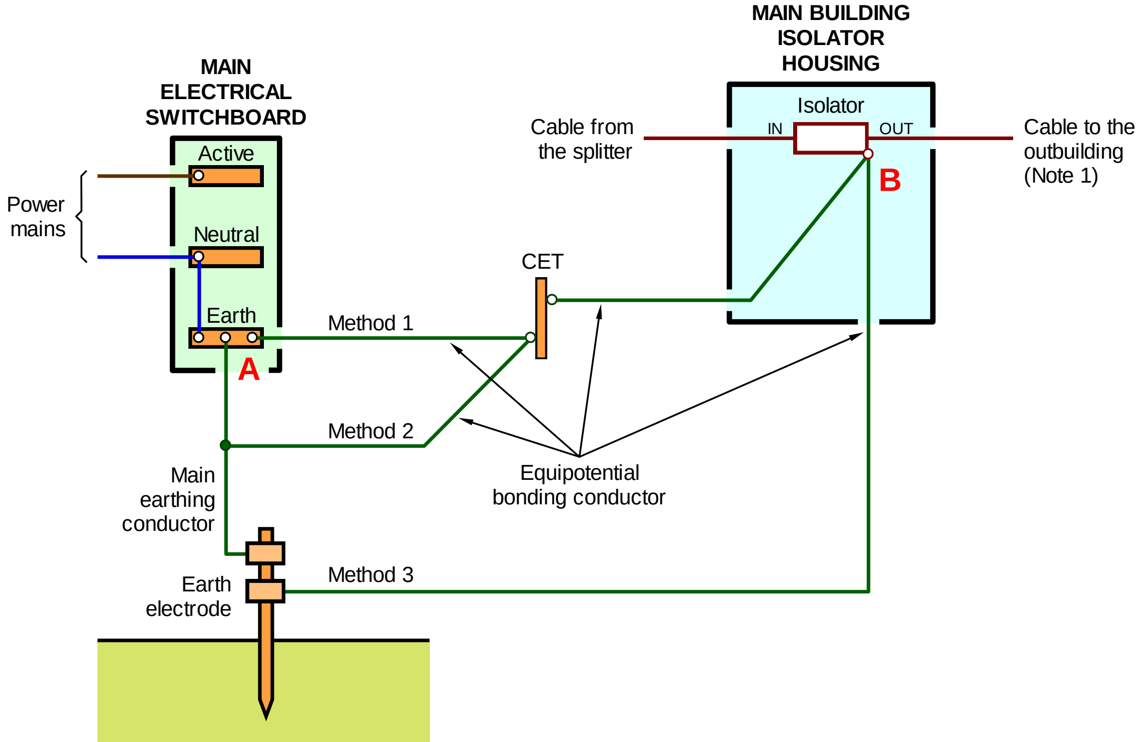
Figure 212 Earthing of the coaxial isolator at the outbuilding where there is no electrical switchboard at the outbuilding (high lightning risk situation)



Notes:

1. The outer conductor of the coaxial cable must be earthed on the input (main building side) of the isolator, as shown in Figure 209 (a), via a surge suppression device connected as a differential earth clamp, as shown. The differential earth clamp is necessary to prevent current flow via the outer conductor of the coaxial cable between the earth at the main building and the earth at the outbuilding under normal (non-surge) conditions.
2. The earth electrode should have a DC resistance to the general mass of earth of no greater than 30 ohms. In addition, where the outbuilding is of metal construction or contains structural metal, this should also be bonded to the earth electrode.

Figure 213 Earthing of the coaxial isolator at the main building (high lightning risk situation)



Notes:

1. The outer conductor of the coaxial cable must be earthed on the output (outbuilding side) of the isolator as shown in Figure 209 (b). This is additional to the earthing of the outer conductor of the coaxial cable at the RF splitter/amplifier (see 10.8.8 on page 219).
2. The outer conductor must be equipotentially bonded to the electrical earthing system using any of the bonding methods 1, 2 or 3 as shown (see 11.2 on page 248 for details). The total length of earthing/bonding conductor between points **A** and **B** should be as short as possible (preferably less than 1.5 m) but in any case should not exceed 10 m.

13 BACKUP BATTERIES FOR FTTP SERVICES

13.1 General

With conventional (copper-based) telephone services, the power required to operate the customer's telephone is fed down the copper wires of the telephone line from the telecommunications network equipment. Thus if the power fails at the customer's premises, the telephone will still work — unless, of course, the customer's telephone requires local power to operate (such as a cordless phone).

With FTTP, services are supplied to the premises via a single optical (glass) fibre, which is an efficient insulator and is incapable of conducting electrical power. Therefore, the power required to operate the telephone service (and the data service) must be provided from a Power Supply Unit (PSU) located in the customer's premises.

FTTP NTDs generally use 12 V DC power for their operation and this is derived from a carrier-supplied 230 V/12 V PSU. Some PSUs may be fitted with a 12 V backup battery to maintain service operation for a limited time during power failure (e.g. a blackout).

Telstra FTTP NTDs may use either of two types of PSU, shown in Figure 214, which may house an optional 12 V backup battery. These are briefly described below. General technical information is also provided for the benefit of consumers and any cabler or service provider who may be required to install, test or replace a backup battery in a Telstra PSU.

For guidance on replacing the backup battery in an NBN Co PSU, refer to the NBN Co user guide (www.nbnco.com.au).

WARNING: Mode 3 or Mode 5 connections on VOIP ports.

Critical Mode 3 or Mode 5 equipment (such as security alarms and personal response systems) normally have battery backup so that they will operate during power failure (e.g. a blackout). However, VOIP gateways do not usually have battery backup and they will not work on power failure unless they are powered from a UPS (Uninterruptible Power Supply). While the PSU from an FTTP NTD may have a backup battery, this will only maintain operation of the FTTP NTD during power failure (and usually only the first telephone service on that NTD), not any gateway connected to it.

Figure 214 Typical Telstra FTTP PSUs

Wall mounted with optional 12 V 7.2 Ah battery

Shelf/Wall mounted with optional 12 V 4.5 Ah battery

Note: The PSU at left is used for all outdoor Telstra FTTP NTDs and some indoor NTDs. The smaller PSU at right is used for later model indoor Telstra NTDs that have lower power consumption and therefore require a smaller backup battery. Typical technical specifications for these PSUs are provided in Table 14 and Table 15.

13.2 PSU and battery specifications

13.2.1 General description

Some FTTP PSUs are designed to house a sealed, maintenance-free, 12 V VRLA (Valve-Regulated Lead-Acid) AGM (Absorbed Glass Mat) battery. VRLA batteries are also available in a gelled electrolyte design ("gel cell") but the AGM design is more suitable for the PSU application.

To test a battery prior to installation or to test the PSU/battery while in service, all that is required is a digital voltmeter or multimeter. Voltage readings at the battery terminals and at the PSU charging lead terminals will provide a reasonably good indication of the state of the PSU and the battery. However, a "dead" battery (i.e. a battery that is no longer serviceable) may produce erroneous voltage readings, so it is advisable to have a fresh battery on hand to confirm the correct operation of the PSU.

If a battery has failed prematurely, it is possible that the PSU is faulty and is either undercharging or overcharging the battery. If a faulty PSU is suspected based on the guidance below, refer the matter to the relevant carrier whose responsibility it is to replace a faulty PSU.

13.2.2 PSU status indicators

The PSU and battery status are indicated by LEDs (Light Emitting Diodes) on the PSU. These should be checked periodically by the end-user.

Some PSUs can also be set to provide audible indication of mains power failure and low battery (e.g. for an end-user who is visually impaired). Generally this feature needs to be set by the relevant carrier or service provider at initial installation.

The indicator functions of Telstra PSUs are described in Table 14 and Table 15. Refer to the PSU User Guide for other types of PSU.

13.2.3 Technical specifications

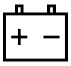
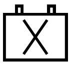
The technical specifications for the Telstra PSUs and the corresponding batteries are provided in Table 14 and Table 15 to assist consumers, cablers and service providers in selecting a suitable battery. Other types of PSU for FTTP NTDs will have similar specifications as they tend to be generic in nature.

Table 14 PSU and battery for outdoor Telstra NTDs and earlier model indoor NTDs

 CyberPower CS24U12V		 APC PowerShield CP24U12	 Optional backup battery
PSU			
Status indicators (the CyberPower CS24U12V also has an optional audible alarm — see 13.2.2)			
AC		Green	The PSU is operating from mains power
		Yellow	The PSU is operating from battery power (power failure)
		Off	Mains power is off and the battery is flat or not fitted
OUTPUT		Green	DC is being supplied from mains power or the battery
		Off	No DC power is being supplied from the PSU
BATTERY		Off	A battery is fitted and is operating satisfactorily
		Red	A battery is not fitted or the battery needs to be replaced
Maximum power consumption			32 W (with no battery or battery fully charged)
Battery			
Battery voltage / capacity			12 V: 35 W/Cell 15 min (7.0 Ah) or 36 W/Cell 15 min (7.2 Ah)
Battery type			Sealed, maintenance-free VRLA (Valve-Regulated Lead-Acid) AGM (Absorbed Glass Mat) designed for: • UPS (Uninterruptible Power Supply) standby applications; or • UPS standby and cyclic applications
Battery terminals			'Quick-connect' tab terminals, FASTON 250 (F2) or equivalent (6.35 mm wide x 0.8 mm thick) (see Note)
Maximum battery dimensions (mm)			153L x 66W x 95H (104H to the tip of the terminals)
Typical battery weight			2.4 kg
Battery design life in standby service			3–5 years
Typical battery recharge time (from flat)			18 hours
Maximum backup time on battery power: Outdoor ONT Indoor ONT			 3.5 hours (all services active) to 8 hours (all services idle) 5 hours (all services active) to 10 hours (all services idle)
PSU output/float charging voltage			13.3 V – 13.8 V

Note: **DO NOT** use a battery with **smaller terminals** (these are commonly used in security alarm panels) as these may be too loose and fail in service or **overheat and burn**. Only use a battery with the correct terminal size.

Table 15 PSU and battery for later model indoor Telstra NTDs

 Delta DUPS-1215		 Optional backup battery	
PSU			
Status indicators (visual only – no audible alarm available)			
System status		Green	Mains power is on
		Off	Mains power is off
Battery power		Off	Battery charging
		Green	Battery discharging
		Green flashing	< 45% battery capacity remaining
Replace battery		Off	A battery is fitted and is operating satisfactorily
		Red	Battery failed self-test and needs to be replaced
Maximum power consumption:			
Minimum			6.5 W (services idle, no battery or battery fully charged)
Typical maximum			10.5 W (services in use, no battery or battery fully charged)
Absolute maximum			20 W (services in use, battery charging)
Battery			
Battery voltage / capacity			12 V: 23 W/Cell 15 min (4.5 Ah) to 25 W/Cell 15 min (5.0 Ah)
Battery type			Sealed, maintenance-free VRLA (Valve-Regulated Lead-Acid) AGM (Absorbed Glass Mat) designed for: • UPS (Uninterruptible Power Supply) standby applications; or • UPS standby and cyclic applications
Battery terminals			'Quick-connect' tab terminals, FASTON 250 (F2) or equivalent (6.35 mm wide x 0.8 mm thick) (see Note)
Maximum battery dimensions (mm)			93L x 70W x 102H (108H to tip of terminals)
Typical battery weight			1.7 kg
Battery design life in standby service			3–5 years
Typical battery recharge time (from flat)			18 hours
Maximum backup time (new indoor ONT)			4 hours (all services in use) to 8 hours (all services idle)
PSU output/float charging voltage			13.3 V – 13.8 V

Note: **DO NOT** use a battery with **smaller terminals** (these are commonly used in security alarm panels) as these may be too loose and fail in service or **overheat and burn**. Only use a battery with the correct terminal size.

13.2.4 Battery pre-conditioning and storage

13.2.4.1 Pre-conditioning

On initial purchase, a new battery should have a terminal voltage no less than 12.66 V. If the battery has a terminal voltage of less than 12.66 V when purchased, it may not have been maintained properly in storage or it may be faulty. The battery does not have to be fully charged before fitting it in the PSU. The PSU should bring it to full charge within 18 hours.

13.2.4.2 Battery storage

The terminal voltage of a fully charged battery with the charging voltage and load removed for at least four hours should be no less than 13.0 V. For a battery in good condition, the terminal voltage should remain above 13.0 V for several days. Thereafter, the terminal voltage may drop below 13.0 V but should remain above 12.7 V for several months if stored at around 25°C. For longevity, the terminal voltage of a stored battery should not be allowed to drop below 12.66 V. A stored battery must be periodically refreshed by a “topping charge” (at least every six months) to prevent sulfation. The PSU may not be able to revive a battery that has been left in a discharged state for a prolonged period.

13.2.4.3 Vacant premises

For a new home where power is not yet connected, the battery may be fitted to the PSU (preferably in a fully charged state) as long as 230 V mains power is not applied to the PSU before the customer moves in. No current will be drawn from the battery until mains power is applied to the PSU. Therefore, for any new home that may remain vacant for some time, it is advisable to fit the battery after all testing has been completed and after the PSU has been switched off. The PSU should remain plugged into the power point (to ensure that the NTD is earthed via the 230 V plug) but the power point should remain switched off until the home is occupied.

For an established home, switching off the PSU for a long duration (e.g. while on holidays or if vacating the premises) will result in the battery being fully discharged through the fixed load (i.e. the NTD) in a matter of hours. If it remains in that state for a prolonged period, at best the battery life will be reduced and at worst the battery will fail completely. Where it is necessary to switch off the power for a long time, the battery should be disconnected before the power is switched off (such that the battery is stored in a fully charged condition) and then either left disconnected or reconnected while the PSU is switched off in accordance with the preceding paragraph. Alternatively, in the case of an indoor NTD, the power cord may be unplugged from the rear of the NTD — although there may be some leakage via the internal circuit of the PSU, limiting this option to shorter duration power-downs (e.g. days rather than weeks). The battery may be stored without load in a fully charged condition for up to six months, as described in 13.2.4.2, without significant detriment to the battery.

13.2.4.4 Cycling the battery

While a lead-acid battery may benefit from an occasional partial or full discharge followed by a full recharge, in general “cycling” (discharging and recharging) of a lead-acid battery reduces its service life. The battery should be maintained on float charge continuously until needed (i.e. during a power failure event) and does not need to be regularly cycled like some other types of rechargeable batteries.

Note: A float charge is the application of a charging voltage to a fully charged battery that is just below the maximum terminal voltage of the battery. Current will not be drawn from the charger under float-charge conditions to avoid sulfation of the plates but the charging voltage will automatically rise to provide a “topping charge” if the terminal voltage of the battery falls below the float voltage. In the case of batteries used in the FTTP PSUs described in this document, the float voltage is approximately 13.6 V.

13.3 Installing or replacing the battery

13.3.1 Safety precautions

The battery should be installed, removed or replaced by an experienced person.

- A tool may be required to remove the battery cover. Refer to the PSU User Guide for details.
- Ensure that the PSU is plugged into the power outlet, even if it is switched off. The earth pin of the power plug may be providing a safety earth to the NTD.
- Use the correct battery for the particular PSU (see Table 14 and Table 15) and connect it correctly (see 13.3.3). There is a danger of explosion if the wrong battery is used or the battery is incorrectly connected.
- The battery is quite heavy and contains acid. Personal injury or acid spillage may occur if the battery is dropped.
- If the PSU is wall mounted, you may have to hold the battery in one hand while connecting or disconnecting the terminals with the other hand. A second person may be required to hold the battery for you.
- Disconnecting the terminals may require considerable effort. Force should only be exerted on the terminal itself using your fingers — tugging the wire connected to the terminal may pull the wire out of the terminal. Tools (e.g. pliers) should **not** be used due to the danger of short-circuiting the battery terminals with the tool.
- The battery may be connected or disconnected with the PSU switched on or off but, in either case, sparking may occur at the terminals. This may startle you and cause you to drop the battery, so be prepared for a spark.
- Avoid using any metal tools or wearing metal jewellery while fitting or removing the battery. If the battery terminals are bridged by a metal object, severe sparking or heating may occur resulting in personal injury.
- If the battery shows any sign of physical damage or leakage, wear rubber gloves and goggles to remove the battery. Neutralise any leaked fluid with a mixture of baking soda and water.
- Check any label inside the PSU for any further warnings.

13.3.2 Removing the battery

13.3.2.1 General

The battery may usually be removed with the power to the PSU switched on. However, whether the PSU is switched on or off during battery removal, **the power plug should remain plugged into the power point to ensure that the equipment remains earthed** (i.e. via the power plug and socket).

13.3.2.2 Battery disposal

Dispose of the battery properly. The battery contains toxic materials and must not be put in the rubbish bin but should be taken to a battery recycle facility. Most battery vendors accept old batteries for recycling.

13.3.3 Fitting the battery

The battery may usually be fitted with the power to the PSU switched on. However, whether the PSU is switched on or off during battery removal, **the power plug should remain plugged into the power point to ensure that the equipment remains earthed** (i.e. via the power plug and socket).

Use the correct battery for the particular PSU (refer to Table 14, Table 15 or the PSU User Guide). Connect the red wire to the positive (**+**) terminal and the black wire to the negative (**–**) terminal. Ensure that the battery tab is properly inserted into the battery lead terminal and is not jammed between the terminal and its plastic shroud. There is a danger of explosion if the incorrect battery is used or the battery is incorrectly connected.

Note that connecting the battery without the mains power switched on may not start the PSU. It will be necessary to apply mains power to the PSU to start it after the battery is installed. This is a safeguard to prevent discharge of the battery if the PSU and battery are installed before power is available (e.g. a new home — see 13.2.4.3). Once mains power has been applied to the PSU, the power can then be switched off to test operation of the battery in the standby mode.

Note: Some PSUs have a "Cold Start" button that will start the PSU from the battery with no mains power connected. Refer to the PSU User Guide for more information.

13.3.4 Testing the battery and PSU

13.3.4.1 Charged battery voltage

A freshly charged battery should have a terminal no-load (open-circuit) voltage of 13.2 V to 13.7 V immediately after being removed from charge. This should deplete after several hours to around 13.0 V to 13.2 V and should remain above 13.0 V for several days. Thereafter, the terminal voltage may drop below 13.0 V but should remain above 12.7 V for several months (see 13.2.4.2).

13.3.4.2 Charging voltage

When the battery is installed in the PSU, charging will commence. The terminal voltage of the battery while charging should gradually increase from the initial battery voltage up to a maximum of 15.0 V (preferably no more than 14.7 V) and eventually drop back to a float-charge voltage of 13.3 V to 13.8 V. The voltage measured at the DC output terminals of the PSU should be the same as the battery terminal voltage during charging.

13.3.4.3 No-battery PSU voltage

When the PSU is switched on without a battery fitted, there should be no voltage on the battery charge terminals but the voltage measured at the DC output terminals of the PSU should be 13.3 V to 13.8 V.

13.3.4.4 Standby battery voltage

When the PSU goes into standby (backup) mode (i.e. when 230 V mains power to the PSU is removed), the terminal voltage of the battery should fall quite rapidly below 13 V but should stay above 12 V for at least 2 hours. The battery is considered to be fully discharged at 10.5 V under load and the PSU should automatically disconnect the load at this point to preserve battery life.

When power is restored, the battery should be fully charged by the PSU within 18 hours.

13.3.5 Where to buy the battery

The backup battery should meet the specifications set out in Table 14, Table 15 or the PSU User Guide, as applicable. The battery is not the same as those used for security alarm panels which, while they may have the same characteristics as FTTP PSU batteries, usually have smaller terminals. A suitable battery may be hard to find initially (i.e. until FTTP/NBN has significant market penetration) but it may be ordered in by the vendor or it may be purchased online from a number of online vendors.

Some prospective battery suppliers, in alphabetical order, are:

- APCRBC (http://www.apcrbc.com.au/)
- Battery Guru (http://www.batteryguru.com.au/)
- Battery World (http://batteryworld.com.au/)
- KT Battery (http://www.ktbattery.com/)
- Master Instruments (http://www.master-instruments.com.au/)
- Solar Guru (http://www.solarguru.com.au/)

14 TESTING OF THE COMPLETED INSTALLATION

14.1 General

The generic cabling system should be inspected and tested after completion to ensure that:

- there are no open circuits
- there are no short circuits
- all sockets are correctly terminated
- the CCP is correctly labelled
- TO sockets are correctly colour-coded or labelled in relation to the CCP colour-coding or labelling
- end-user information is clear, concise and corresponds to the actual installation
- the "as-built" cabling plan is neat and accurate.

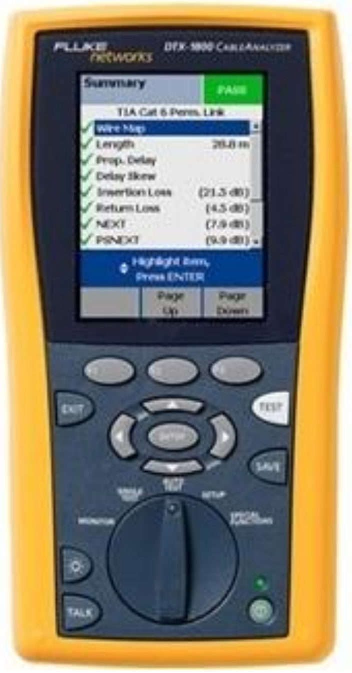
Further guidance for testing of the cabling is provided below.

14.2 Data cabling

Three levels of testing may be performed on the data cabling:

- Certification testing — this testing is usually conducted by the installer at completion to prove ("certify") to the customer that the installation has been done correctly and meets the required standards. It requires the use of an expensive test instrument that tests the technical parameters set out in the cabling standards. The results are generally provided to the customer in a printout. The tests that are conducted will include:
  - Wiremap
  - Cable Length
  - DC Loop Resistance
  - Propagation Delay
  - Skew (Delay Skew)
  - Return Loss (RL)
  - Insertion Loss (IL)
  - Near-End Crosstalk (NEXT)
  - Power Sum NEXT (PS NEXT)
  - Equal-Level Far-End Crosstalk (ELFEXT)
  - Power Sum ELFEXT (PS ELFEXT)
  - Attenuation-to-Crosstalk Ratio (ACR)
  - Power Sum ACR (PS ACR)

Figure 215 A typical certification tester



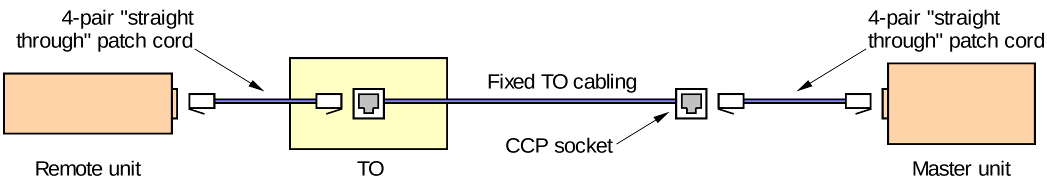
- Qualification testing — this testing is normally conducted on an existing installation to determine whether it "qualifies" to support a certain application (e.g. Gigabit Ethernet) or to identify defects that may affect bandwidth. A special "qualification" test instrument is generally used for this purpose.
- Verification testing — this type of testing is only used to "verify" that the cables have been correctly connected to the sockets. It may also be referred to as "wiremap" testing.

In homes where cable runs are relatively short, as long as cables have been installed with due care in accordance with 10.5.8.2 on page 181, it may only be necessary to perform verification testing on the TO cabling. This may be done using a basic 4-pair cable continuity tester that checks for open circuits, short circuits and miswiring. All data cables should be tested between the CCP and the TOs and, where applicable, between the CCP and the outdoor NTD. A typical continuity tester and the test arrangements are shown in Figure 216. It is not normally necessary to perform "certification" testing in homes unless the customer specifically requires and is prepared to pay for it. For more information, refer to 4.14.4.7 on page 38.

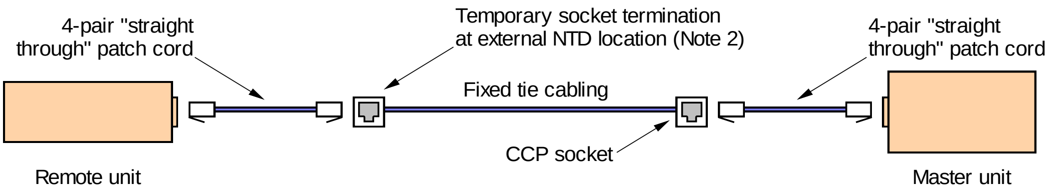
Figure 216 Basic continuity testing of the data cables

(a) Typical 4-pair cable continuity tester

(b) Test arrangement for cables between the CCP and the TOs



(c) Test arrangement for a data cable between an outdoor NTD and the CCP



Notes:

1. The tester should test for correct wire mapping (pair allocation), split pairs, short circuits, open circuits and reversals. Some testers, such as the one shown above, can also be used for simple testing of the TV (coaxial) cabling (suitable F-connector to BNC adaptors may be required for such testing).
2. The data cable may connect to the data port of an outdoor FTTP NTD via an 8P8C (RJ45) plug terminated directly onto the tie cable, which is plugged into a socket in the NTD, or via a small “punch-down” block inside the NTD. In either case, this connection should be made by the carrier or service provider when the NTD is installed or when the data service is supplied by the service provider. However, the cable should be tested by the installer of the customer cabling beforehand to ensure that it has been terminated correctly (to T568**A** wiring) at the CCP — refer to 10.5.11 on page 184.

14.3 Coaxial cabling

DC continuity and insulation resistance should be tested between each cable connector at the completion of the installation to ensure that there is no open circuit or short circuit in any cable run and, where possible, the RF power level should be measured at each wall plate in accordance with 10.8.9 on page 220.

15 REFERENCES

Document number	Title
AS/CA S008	Requirements for customer cabling products
AS/CA S009	Installation requirements for customer cabling (Wiring rules) (formerly AS/ACIF S009)
AS/NZS 1367	Coaxial cable and optical fibre systems for the RF distribution of analogue and digital television and sound signals in single and multiple dwelling installations
AS 1417.1	Receiving Antennas for Radio and Television in the Frequency Range 30 MHz to 1 GHz Part 1 — Construction and Installation
AS 1684.2	Residential timber-framed construction — Non-cyclonic areas
AS 1684.3	Residential timber-framed construction — Cyclonic areas
AS/NZS 1768	Lightning protection
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3080	Telecommunications installations — Generic cabling for commercial premises
AS 4262.1	Telecommunication overvoltages Part 1: Protection of persons
AS/NZS ISO/IEC 15018	Information technology — Generic cabling for homes
HB 29	Communications Cabling Manual Module 2: Communications cabling handbook
HB 252	Communications Cabling Manual Module 3: Residential communications cabling handbook

16 ASSOCIATED DOCUMENTS

Document number	Title
017153a01	Cabling of premises for telecommunications — Essential information for home cabling
017153a02	Cabling of premises for telecommunications — Lead-in cabling and building entry facilities for homes

17 DEFINITIONS

Term	Definition
10Base-T	Standard Ethernet — see “Ethernet”
10GBase-T	10 Gigabit Ethernet — see “Ethernet”
10G Ethernet (10 Gigabit Ethernet)	See “Ethernet”
10 GE (10 Gigabit Ethernet)	See “Ethernet”
100Base-TX	Fast Ethernet — see “Ethernet”
1000Base-T	Gigabit Ethernet — see “Ethernet”
3G	Third Generation (cellular mobile technology)
4G	Fourth Generation (cellular mobile technology), otherwise referred to as “LTE” (Long Term Evolution)
6P	Six-Position — the physical contact capacity of modular sockets and plugs commonly used for analogue telecommunications connections
802.11 b/g/n	An abbreviated reference to a set of standards issued under IEEE 802.11 for the implementation of wireless local area networks (“Wi-Fi” networks) in the 2.4 GHz and 5 GHz radio frequency bands. 802.11b supports a maximum raw data rate of 11 Mbps; 802.11g supports a maximum raw data rate of 54 Mbps; while 802.11n supports a maximum raw data rate of 150 Mbps. In all cases, the actual data throughput is usually far less than the theoretical maximum stated in product specifications.
8P	Eight-Position — the physical contact capacity of modular sockets and plugs commonly used for digital telecommunications connections
8P4C	Eight-Position Four-Contact — a modular socket format used by Telstra for telephone connections that is compatible with all types of 8P and 6P plugs
8P8C	Eight-Position Eight-Contact — the modular socket and plug format used for digital (especially Ethernet) connections, commonly (but incorrectly) described as “RJ45”
AC (or a.c.)	Alternating current — an electric current that changes direction or reverses (“alternates”) polarity at a certain rate or “frequency”. Mains electrical power is alternating current that changes polarity at a rate of fifty times per second (i.e. at a frequency of 50 Hz).
ACIF	Australian Communications Industry Forum (now CA)
ACMA	Australian Communications and Media Authority (formerly AUSTEL, then ACA) — the telecommunications industry regulator responsible for technical regulation (e.g. governance of compliance labelling, cabling provider registration, mandatory technical standards for customer equipment, and wiring rules)

Term	Definition
ADSL	Asymmetric Digital Subscriber Line — a telecommunications network service that provides high speed access to the internet using the same copper pairs used to supply telephone services
aerial cable/cabling	Cabling that is suspended between poles, buildings or other supporting structures external to a building (also see “catenary”)
AGM	Absorbed Glass Mat — a type of lead-acid battery in which the electrolyte is absorbed in a fibreglass mat separator
Ah	Ampere hour — a method of rating battery capacity. For example, a battery rated at 7 Ah will theoretically supply 1 ampere continuously for 7 hours or 2 amperes for 3.5 hours. However, in reality the capacity of the battery to supply current depends on the discharge rate and temperature. See also “W/Cell 15 mins” which is often used for UPS batteries.
ALIC	Aerial Lead-In Cable — a Telstra term for 2-pair cable with an integral bearer wire that is specifically designed for use as aerial lead-in cable
analogue	An analogue signal is a continuous signal that varies in magnitude and frequency in accordance with the source information. An analogue service is one that transmits or receives analogue signals. Compare with “digital”.
ANSI	American National Standards Institute — one of many organisations that set standards for interchange of information (communications)
AS	Australian Standard
as-built	Describes a drawing or plan that shows what was actually done in the end, as distinct from a design drawing or plan that proposes what is to be done
AS/CA (Australian Standard/ Communications Alliance)	An Australian standard developed and produced by Communications Alliance (formerly ACIF)
AS/NZS (Australian/New Zealand Standard)	A joint Australian/New Zealand Standard prepared by representatives from each country and which includes requirements common to each country
attenuation	The gradual decay (“loss”) of a signal along a transmission medium (e.g. in free air or a length of cable). It may also be used to describe an instantaneous loss of signal through a device (e.g. a splitter) but use of the expression “insertion loss” is generally favoured in such cases.
A/V	Audio-Visual — the general expression used to describe exchange of information comprising sound and/or visual signalling components, usually between entertainment equipment
AWG	American Wire Gauge — a method of identifying conductor size (the conductor diameter is usually used for conductor size in Australia)
balanced cable	A cable whose transmission elements are identical, e.g. twisted pair/quad copper cable. Compare with “unbalanced cable”.

Term	Definition
balun	Short for "**bal**anced to **un**balanced", a transformer used to match the impedance of a balanced medium (e.g. a TV antenna or a twisted pair cable) to the impedance of an unbalanced medium (e.g. coaxial cable)
band-pass filter	A device that only allows a certain range (band) of signal frequencies to pass through it without significant loss
bandwidth	A range (band) of signal frequencies usually expressed using the lower limit and the upper limit of the frequency range (e.g. 300 Hz to 3400 Hz is the usual "voice" bandwidth in a telecommunications transmission system)
bargeboard	A sloping board fixed to the gable of a building immediately below the roof line to conceal the roof construction
baseband	A range of signal frequencies whose lower and upper limits are close to 0 Hz. In telecommunications systems, the upper frequency limit of a baseband signal is usually less than 4 kHz.
Belling-Lee connector	A type of coaxial connector named after the company that invented it (Belling & Lee Ltd). See "PAL connector" for more information.
BER	Bit Error Ratio or Bit Error Rate — the number of erroneous bits at the output of a digital transmission system divided by the total number of received bits
BigPond	Telstra's internet service provider
BNC (Bayonet Neill-Councelman)	A type of connector commonly used for connection of coaxial cable to electronic RF equipment such as test instruments and CCTV cameras
bonding	See "equipotential bonding"
bps	bits per second — the number of binary digits (bits) transmitted or received by a device in one second. A bit is represented by either 1 or 0. Bits can be combined in a string to form a "Byte" (B) that represents a character (e.g. a letter or a numeral). Usually 8 bits = 1 Byte. Thus 100 Bps (Bytes per second) = 100 x 8 = 800 bps (bits per second).
broadband	A signal or service that has a wide frequency bandwidth, usually in the radio frequency spectrum
brownfield	In the context of the installation of telecommunications infrastructure, the term commonly used to describe established residential or commercial areas that are to be supplied with new infrastructure or innovative services. Compare with "greenfield".
builder	A person charged with the construction or renovation of any building
building	A substantial construction intended to protect persons, animals, vehicles, machinery, tools or equipment from the weather
building entry point	The point on a building where the Telstra lead-in cable enters the building

Term	Definition
C clip	See “wallboard clip”
CA	Communications Alliance (formerly ACIF)
cable	An assembly of one of more cable units (e.g. pairs, quads, coaxial tubes, fibres) in an overall sheath. Compare with “cabling”.
Cable internet, Cable pay TV or “Cable”	See “HFC”
cabler	See “cabling provider”
cabling	Cable or cables and any associated works or parts such as trenching, pits, poles, conduits, trays, connecting devices, jumpers, etc.
cabling pathway	A conduit, duct, trunking or clear corridor within a building cavity that may be used for pulling in cable
cabling provider	A person who installs, repairs or alters, or supervises the installation, repair or alteration of, customer cabling
cabling space	A cupboard, closet, enclosure or suitable space in which to install equipment or to provide safe and convenient access to cabling pathways for pulling in cables
carriage service	A telecommunications network service provided by a carrier or a service provider. Telephone and internet (e.g. ADSL) services are carriage services.
carriage service provider	A company that supplies carriage services to the general public
carrier	In this document, “carrier” has two meanings depending on the context in which it is used: • When used in relation to the supply of a telecommunications service, it means the owner of the telecommunications infrastructure over which that service is supplied. • When used in relation to transmitting communications data, it means a signal frequency (usually RF) that is modulated in a certain way to convey the data.
Category 3 / 4 / 5 / 5e / 6 / 6_A / 7 / 7_A	Cable or connecting hardware designed for use in local area network (LAN) installations and which is rated (categorised) according to the speed of the data it is designed to carry. Such LAN cabling may also be used for other purposes such as connection/distribution of telephone or ADSL services.
catenary	A suspension system, typically a wire rope, between two points to provide support for one or more cables or conduits. A catenary may be used for indoor or outdoor cabling. See also “aerial cable/cabling”.
CCP	See “Central Connection Point”

Term	Definition
CCTV	Closed Circuit Television — a fixed camera system used for video surveillance of selected areas such as the main entrance
Central Connection Point (CCP)	A device provided as a central cable connection point for generic home cabling, which may be a single, multi-socket wall plate or a patch panel
central filter (ADSL)	A high pass filter used for connection of ADSL services, which is designed to be wired in series with one or more telephones or other telephone equipment. Also referred to as a “central splitter” or “remote splitter”. Compare with “distributed filter”.
centre conductor	The conductor that runs along the axis of a coaxial cable between the insulating core (dielectric) and the shield. The centre conductor may also be referred to as the “inner conductor”.
CES	Communications Earth System — a system of telecommunications earthing that originates from the earthing system of the nearest electrical switchboard
CET	Communications Earth Terminal — a terminal used for equipotential bonding of a communications earthing system to the electrical earthing system and used as a demarcation point between the two systems. It may also be referred to as a “bonding terminal”.
channel	For local area network (LAN) or “generic” cabling, this describes an end-to-end transmission path between any two pieces of equipment and includes the fixed cabling, sockets, plugs, patch cords and equipment connecting cords but does not include the connecting socket in the equipment itself
characteristic impedance	The impedance that an infinite length of a transmission line would exhibit at a particular frequency when measured at the near end of the line
Class A / B / C / D / E / E_A / F / F_A	A defined level of Local Area Network (LAN) or “generic” cabling system performance based on the speed of the data to be carried by the system
CMUX (Customer Multiplexer)	Equipment that is typically housed in a roadside cabinet and that supports the supply of ADSL, PSTN, ISDN and other special services to customers
C/N (CNR)	Carrier-to-Noise Ratio — the difference (in dB) between the level of the actual signal to be conveyed (carrier level) and the noise level
coaxial cable	A dual conductor cable in which a centre conductor is surrounded by, but does not contact, a concentric, cylindrical outer conductor. The outer conductor may be solid tubing (“hardline” cable) or may comprise braided conductors and/or a thin aluminium foil that may be flexed (“flexible” cable). Coaxial cable is referred to as “unbalanced cable” in cabling standards because the inner and outer conductors are of different composition and have a different DC resistance.
coaxial outlet	See “TV outlet”

Term	Definition
COFDM (Coded Orthogonal Frequency Division Multiplexing)	A modulation technique that can overcome multipath effects (i.e. signal reflections off hills, buildings, etc.) including simultaneous transmission of the same signal from multiple broadcasting antennas.
Combined Utilities Enclosure (CUE)	An electrical meter panel or switchboard enclosure that has a separate compartment for telecommunications equipment and, optionally, additional compartments for other utilities such as gas and water
combiner	A device that combines RF signals connected to separate input ports into a single output port. Some combiners may be used in the reverse direction as splitters.
computer equipment	For the purposes of this document, this includes personal computers, laptop/notebook computers, printers, scanners, Ethernet routers/switches, hand-held tablet devices, etc.
conduit	A tube or pipe that physically accommodates cables. Larger conduits are sometimes referred to as “ducts”. See also “flexible conduit” and “rigid conduit”
conduit half-saddle	A clip used for securing conduit that is fastened by a single nail or screw on one side of the clip only
conduit saddle	A clip used for securing conduit that is fastened by a nail or screw on each side of the clip
consumer	A potential customer or end-user. See also “customer” and “end-user”.
copper network	A telecommunications network that uses cables with copper or copper-alloy conductors to supply services to customer premises. This includes twisted pair and coaxial cables.
cordless	A description generally used for telephones that use radio technology to link a portable handset to a fixed “base station” that is physically connected to the telephone line. Conventional handsets are normally “corded” (i.e. connected to the base instrument via a cord), so the expression “cordless” describes the opposite of “corded”. Compare with “wireless”.
crossover patch cord	A patch cord in which the transmit (send) and receive pairs for each signalling channel are transposed so that the “send” port of data terminating equipment is connected to the “receive” port of similar data terminating equipment. Most Ethernet devices now have “auto-sensing” ports and crossover patch cords are not required. Compare with “straight-through patch cord”.
CUE	See “Combined Utilities Enclosure”
customer	A person who subscribes to (pays for) the supply of a telecommunications network service. Compare with “consumer” and “end-user”.

Term	Definition
customer cabling	Any cabling connected on the customer's side of the network boundary, whether supplied or owned by a carrier, service provider, customer or any other person
customer equipment	Any equipment connected on the customer's side of the network boundary, whether supplied or owned by a carrier, service provider, customer or any other person
cycle/cycling (batteries)	A cycle describes the action of charging and discharging a battery once (or vice versa). Cycling generally refers to multiple or regular cycles.
D	Deep or Depth
DAB+	Digital Audio Broadcasting (digital radio) — a form of terrestrial radio broadcasting that is used in Australia. The "+" indicates an Australian enhancement to the original DAB standard. Also described as "T-DAB" (Terrestrial Digital Audio Broadcasting).
daisy-chain wiring	Wiring telephone sockets sequentially, one after the other, in a "bus", "series" or "looped" configuration — an alternative cabling method to "star" wiring. Star wiring is recommended for new installations.
data	In the context of this document, an alternative description for "digital"
data cable	A cable designed to carry digital information ("data"), usually at very high bit rates ("speed"), but which may also be used to carry analogue (voice) signals
data service	A service that transmits or receives digital signals
data speed	See "speed"
dB	decibel or decibels — the logarithmic value of the ratio of two signal power levels used to quantify the gain or loss incurred by a device
dBmV	dB millivolt/s — a measure of signal level expressed in dB and referred to a signal of 1 mV when terminated into 75 ohms. To convert dBmV to dBµV, add 60 to the value expressed in dBmV.
dBµV	dB microvolt/s — a measure of signal level expressed in dB and referred to a signal of 1 µV when terminated into 75 ohms. To convert dBµV to dBmV, subtract 60 from the value expressed in dBµV.
DC (or d.c.)	direct current — an electric current that flows in one direction only such as that derived from a battery or a solar cell
DC resistance	The opposition to the flow of direct current (DC) incurred by any electrically conductive element such as a wire, a cable, the windings of a transformer or a resistor
decibel	See "dB"

Term	Definition
developer	A person or company involved in the development or redevelopment of any real property (real estate)
dielectric	A non-conductive insulator material between the centre conductor and the outer conductor (shield) of a coaxial cable
differential earth clamp	Sometimes abbreviated to “DEC”, this is a device that electrically connects two earthing systems under overvoltage (e.g. surge) conditions but maintains electrical isolation between the two systems under normal operating conditions
digital	A digital signal is a signal that conveys information in binary form, i.e. as a mixture of two states (on/off or 1/0). A digital (or “data”) service is one that transmits or receives digital signals. Compare with “analogue”.
diplexer	A passive filter that combines or separates RF bands or groups of signals such as VHF and UHF, satellite IF and terrestrial TV, or forward and reverse paths. Some diplexers may be used in the reverse direction, i.e. as a combiner or a multiplexer (splitter).
distributed filter/splitter (ADSL)	A low pass filter that is inserted between the wall socket and the telephone equipment to pass voice frequencies and block ADSL frequencies. A separate filter is required for each telephone equipment connection. Also referred to as a “distributed splitter” or an “in-line filter”. Compare with “central filter”.
distributor	See “Home Distributor (HD)”
DOCSIS	Data Over Cable Service Interface Specification — an international telecommunications standard that enables high-speed internet to be supplied over an existing HFC pay TV network. The latest iteration is version 3.0 which Telstra uses to offer data download speeds of up to 100 Mbps on its HFC (“Cable”) network.
duct	See “trunking” and “conduit”
ducting	See “trunking”
earth	An electrical connection to the mass of earth. This can be made by driving or burying a metal electrode in the ground but, within customer premises, is usually – and should be – made via a connection to the earthing bar or terminal of the electrical switchboard. Earth is referred to in some documents as “ground”.
earth electrode	A metal rod, wire or mat driven or buried in the ground to make an electrical connection to the mass of earth
earthing	The act of connecting equipment or cabling to an earth reference such as to the electrical earthing system of the electrical installation or an earth electrode. Earthing is also called “grounding” in some documents.
eaves	The underside of a roof projecting beyond the external wall face that is usually lined with sheeting (also called a “soffit”)

Term	Definition
electrician	A licensed electrical worker
electromagnetic interference	See "EMI"
ELV	Extra-Low Voltage — a voltage not exceeding 42.4 V peak (about 30 V AC r.m.s. for a sine wave) or 60 V DC
emergency call	See "personal response system"
EMI	**E**lectro**M**agnetic **I**nterference — a broad reference to any phenomenon that may cause disturbance to an electric circuit due to electromagnetic induction, capacitive coupling or electromagnetic radiation. When the source of the interference is in the radio frequency spectrum, it may also be referred to as "RFI" (Radio Frequency Interference).
end-user	A person who may use a telecommunications network service and may be the customer who pays for the service or a casual user (e.g. a relative or employee of the customer). Compare with "consumer" and "customer".
EoP (Ethernet over Power)	A technology that enables the existing power wiring within a premises to be used to transmit telecommunications data between two or more points using a "powerline adaptor" at each end. The adaptor plugs into a standard power point and has a standard Ethernet socket for connection of the Ethernet device. It may also be referred to as "powerline Ethernet", "powerline networking", "HomePlug" or, incorrectly, "PLC" (Powerline Communications). EoP should not be confused with PoE (Power over Ethernet).
equalisation	A means of modifying the frequency response of an amplifier or network to achieve a relatively flat overall response across the range of wanted signals. Compare with "slope".
equipotential bonding	Bonding (connecting) two or more earthing systems or earthed parts together to ensure that they are at approximately "equal potential"
Ethernet	A standard for interconnecting computers via a local area network (LAN). The current standards used are • "standard" Ethernet (10Base-T), which supports a maximum data speed of 10 Mbps • Fast Ethernet (100Base-TX), which supports a maximum data speed of 100 Mbps • Gigabit Ethernet (1000Base-T), which supports a maximum data speed of 1,000 Mbps (1 Gbps) • 10 Gigabit (or 10G) Ethernet, which supports a maximum data speed of 10,000 Mbps (10 Gbps)
Ethernet over Power	See "EoP"
extra-low voltage (ELV)	See "ELV"
F-connector	A threaded connector used for connection of coaxial cables and fly leads that provides high immunity to the ingress or egress of RF signals

Term	Definition
fascia (board)	A vertical board immediately below the roof line that is fixed to the ends of the roof rafters and which provides support for the roof gutter
Fast Ethernet	See “Ethernet”
FGL	Finished Ground Level — the final level of the ground after all earthworks have been completed and lawns, gardens and paths have been established
Fibre To The Node (FTTN)	See “FTTN”
Fibre To The Premises (FTTP)	See “FTTP”
field strength meter	A meter used by coaxial cabling installers to measure RF power levels and signal quality at various points in a coaxial cabling system
finished ground level	See “FGL”
fixed cabling	Cabling that is concealed in building cavities, enclosed in conduits or ducts, or fastened to building surfaces and is regarded as permanent
flexible conduit	In the context of this document, this means conduit that has corrugated walls to provide limited flexibility. Compare with “rigid conduit”.
float charge	The application of a charging voltage to a fully charged secondary cell or battery that is just below the maximum terminal voltage of the cell/battery. Current will not be drawn from the charger under float-charge conditions to avoid sulfation of the plates but the charging voltage will automatically rise to provide a “topping charge” if the terminal voltage of the cell/battery falls below the float voltage.
fly lead	A flexible cord used to connect equipment to other equipment or to a telecommunications outlet
FM	Frequency Modulation — a method of embedding an information signal (e.g. audio, video or data) into a carrier signal where the information is expressed as fluctuations in the frequency of the carrier signal
FOXTEL	The major provider of pay TV services in Australia (partly owned by Telstra)
free-to-air TV (FTA TV)	Television channels that are broadcast to the general public free of encryption or subscription fees
FRL	Fire Resistance Level — the fire-resistance grading period (in minutes) for a building element (e.g. a dividing wall between living units) determined in accordance with building codes
FRL-rated	Any building element that is required by building codes to comply with an FRL level (e.g. a dividing wall between living units)
FTA	See “Free-to-air TV (FTA TV)”

Term	Definition
FTP	Foil-screened Twisted Pair — a general term sometimes used to describe any twisted pair cable that employs an aluminium foil screen around either the cable core or the individual pairs or both. For a description of the various forms of screened cable, refer to Annex E of Australian Standard AS/NZS 3080:2003, *Telecommunications installations — Generic cabling for commercial premises*.
FTTN	Fibre To The Node — a technology in which a carrier's optical fibre is terminated in a street cabinet no more than several hundred metres away from a customer's premises, with the final connection being made using copper twisted pair cabling. Services are then supplied via VDSL2 from the cabinet to the premises. Also called "FTTC" (Fibre to the Curb).
FTTP	Fibre To The Premises — a telecommunications network technology in which services are supplied to the customers' premises via optical fibre
F-type connector	See "F-connector"
gain	See "RF gain"
gateway	A general term used in this document for a device that performs one or more of the functions of a modem, router or switch
Gbps	Gigabits per second — one gigabit equals one thousand million bits
generic	Non-proprietary or general purpose
generic cabling	A structured telecommunications cabling system that is capable of supporting a wide range of applications including voice (e.g. telephone) and data (e.g. Ethernet) services. Generic cabling can be installed without prior knowledge of the required applications.
GHz	Gigahertz — a frequency of a thousand million hertz (1,000,000,000 a.c. cycles per second)
Gigabit Ethernet	See "Ethernet"
greenfield	In the context of the installation of telecommunications infrastructure, the term commonly used to describe new residential or commercial real estate developments that are to be supplied with telecommunications services. Compare with "brownfield".
H	High / Height
half-saddle	See "conduit half-saddle"
HDAV	High-Definition Audio/Video — a proprietary method of distributing high-definition audio and video content over Ethernet cabling
HDBaseT	A standardised technology for distribution of high-definition audio/video content of entertainment devices over Ethernet cabling. For more details, refer to the website http://www.hdbaset.org/.

Term	Definition
HDMI	High-Definition Multimedia Interface — an interface for transferring uncompressed, digital, high-definition audio/video content between devices using a single connector and cord
hertz (Hz)	See “Hz”
HFC	Hybrid Fibre-Coax — a broadband network that uses optical fibre distribution to neighbourhood “nodes” which convert the optical signals to electrical signals for distribution to customers’ premises using coaxial cabling
high-pass filter	A device that allows frequencies above a certain threshold to pass through it without significant loss but which significantly attenuates frequencies below that threshold
high-speed broadband / data	A description often used to describe download bit rates higher than the maximum achievable via a dial-up connection (i.e. higher than 56 kbps). See also “speed”.
high voltage (HV)	See “HV”
home automation	A term used to broadly describe the automatic operation of facilities in the home that are traditionally operated manually by the occupant, e.g. lights, HVAC (heating, ventilation and air conditioning), garage doors and other electrical appliances. These are invariably associated with the electrical power installation but may be integrated with the telecommunications cabling to provide remote activation or monitoring via public networks.
Home Distributor (HD)	A collection of components used to terminate cables and which provides for cross-connection of lines, using patch cords, to more than six telecommunications outlet sockets. In this document, the expression Central Connection Point (CCP) is used to describe such a collection of components, which may or may not constitute a distributor.
home network	A Local Area Network (LAN) provided in a home. A home network is less sophisticated than a corporate LAN and is characterised by a small “hub” (typically a modem/gateway and an Ethernet router/switch), a limited number of telecommunications outlets and relatively short cable runs.
home networking	The interconnection of services and equipment over a home network
HV	High Voltage — a voltage exceeding 1000 V AC or 1500 V DC
Hz	Hertz — the base unit of measurement for frequency. One hertz equals one cycle of AC voltage or current or a compression and subsequent rarefaction of air in a sound wave
ICT	Information and Communications Technologies — a description used in Australian standards to describe computer and telecommunications equipment that are connected via “balanced” (twisted pair) cabling (called “data cabling” in this document) or optical fibre cabling. Examples of services that fall into this category are telephone, ADSL and Ethernet.

Term	Definition
ID	Inside Diameter — the diameter of a conduit or pipe that is circular in cross-section measured between the internal surfaces of the conduit/pipe
IDC	Insulation Displacement Connector — a conductor termination method in which pressure is applied to the conductor insulation to displace it and make electrical contact between the conductor and the terminal
IF	Intermediate Frequency — used in RF receivers or equipment to translate (shift) signals in the receiver's tuning range to a different but fixed frequency. With satellite transmission, the satellite signals are transmitted at between 12.250 GHz and 12.750 GHz and are converted to an intermediate frequency of 950 MHz to 2150 MHz by the receiving antenna (LNB) at the satellite dish. These lower frequencies are more manageable for distribution within the premises using flexible coaxial cabling.
impedance	A measure of the opposition to AC current flow determined by the combined effect of DC resistance, inductive reactance and capacitive reactance. The symbol for impedance is "Z" and is expressed in ohms (symbol "Ω").
in-line filter	See "distributed filter"
in span/in-span	Any point between two consecutive fixing points for an aerial cable, e.g. between two consecutive poles or cable supports
indoor	Installed inside a building but not underground (e.g. installed beneath a concrete slab) or exposed to the weather
inner bend radius	The radius of a bend in a cable or conduit measured from the centre point of the arc to the closest surface of the cable or conduit
insertion loss	The reduction in signal strength incurred by a transmission medium (e.g. a cable) or a device (e.g. a splitter). See also "attenuation".
inside diameter	See "ID"
interconnect/interconnection	The connection of two or more devices together by means of cable(s) or cord(s)
intermediate frequency	See "IF"
internet	A global system of interconnected computer networks that provides consumers and businesses access to the World Wide Web (WWW) and which provides the infrastructure to support electronic mail (email)
IPTV (Internet Protocol Television)	Real-time delivery ("streaming") of TV services or programs using IP signalling, e.g. via the internet or a local area network. Compare with "Video on Demand (VoD)".
ISAM (Intelligent Services Access Manager)	A multiplexer that is typically housed in a roadside cabinet and that supports Fibre To The Node (FTTN) and the supply of ADSL2 and PSTN services to customers

Term	Definition
ISDN	Integrated Services Digital Network — a digital telecommunications network service that allows connectivity to various public or private networks for either voice or data transmission
ISO/IEC	International Standardisation Organisation/International Electrotechnical Commission — used to prefix a standard or other document developed jointly by both organisations
isolation box	An outdoor enclosure that houses a coaxial cable isolator which is used to isolate any HFC network voltage and earthing system from any voltage and earthing system used in the customer's premises (see also "isolator")
isolator	A device used for coaxial cabling connections to buildings that insulates the indoor metallic cable elements from the outdoor metallic cable elements while still allowing the transfer of radio frequency signals between the cables by means of capacitive or inductive coupling. An isolator is necessary to prevent the interconnection of power voltages and earthing systems between buildings that may create a safety hazard, cause damage to cable or equipment, or ignite a fire.
kbps	kilobits per second — one kilobit equals one thousand bits
keystone socket	A mounting arrangement for modular telephone or data sockets commonly used in patch panels and also used by Telstra for mounting sockets on wall plates
kg	kilogram/s
kgf	kilogram-force — a gravitational metric unit of force equal to the magnitude of the force exerted by one kilogram of mass in standard gravity. One kilogram-force is by definition equal to 9.80665 Newtons.
kHz	kilohertz — a frequency of one thousand hertz (1,000 a.c. cycles per second)
kV	kilovolt/s — 1 kV = 1000 V
LAN	Local Area Network — a computer network for interconnecting computers and other digital devices within a building or premises using wired (Ethernet) and/or wireless (Wi-Fi) technologies
lead-in cabling	A carrier's (e.g. Telstra's) cabling from the last distribution point (typically in the street) and the network boundary in the customer's premises
LED	Light Emitting Diode
legacy cabling	Cabling that was installed under a different regulatory environment and that is considered to be obsolete or obsolescent by current standards
legacy network	A telecommunications network designed primarily for supply of telephone services and not originally intended to support high-speed data services

Term	Definition
LIU	Line Isolation Unit — a device that provides a high level of electrical isolation between two items of equipment that are to be interconnected
LNB	Low Noise Block downconverter — a device mounted on a satellite dish to amplify and convert the entire block of received frequencies to a lower block of “intermediate frequencies” that can be distributed in the premises using conventional coaxial cables. The process works in reverse for signals transmitted from the premises to the satellite.
loss	See “RF loss”
low-pass filter	A device that allows frequencies below a certain threshold to pass through it without significant loss but which significantly attenuates frequencies above that threshold
low voltage (LV)	See “LV”
LV	Low Voltage — a voltage exceeding 42.4 V peak (about 30 V AC r.m.s. for a sine wave) or 60 V DC but not exceeding 1000 V AC or 1500 V DC. The mains supply voltage used in homes is LV and is dangerous to touch. Equate to “Lethal Voltage”.
m	metre or metres
Main Distribution Frame (MDF)	See “MDF”
masthead amplifier	An RF amplifier that is mounted on the antenna mast and which is normally only used where the signal is weak and the antenna will be connected via a long run of coaxial cable to an access point in the building
MATV	Master Antenna Television — an RF distribution system where an antenna signal is connected to multiple users in a building or premises
Mbps	megabits per second — one megabit equals one million bits
MC	Multi-Core (HV cable) — a high voltage power cable in which the phase and neutral conductors are contained under the same sheath
MDF	Main Distribution Frame — a collection of components used to terminate cables and which provides for cross-connection of lines by means of “jumper” wires (“jumpers”) and which provides, or is intended to provide, a termination point for a carrier’s twisted pair lead-in cabling. An MDF is a defined network boundary point.
MDU	Multiple Dwelling Unit — a living unit within a building complex that contains multiple addresses, e.g. a flat, apartment, villa, town house
media converter	An Ethernet device that converts electrical signals to optical signals and vice versa — used for cabling between separate buildings
MER	Modulation Error Ratio — the measure of noise within digital modulation

Term	Definition
MHz	megahertz — a frequency of one million hertz (1,000,000 a.c. cycles per second)
media equipment	Equipment used for entertainment purposes such as television sets, audio/video players/recorders, media players, hi-fi equipment and multi-media personal computers
media networking	The interconnection of equipment used for entertainment purposes such as television sets, audio/video players/recorders, media players, hi-fi equipment and multi-media personal computers
media player	A device that plays media files stored on a memory stick or a hard disk or streamed from the internet or another device connected to the LAN
metallic	Made from metal, e.g. copper, aluminium, steel
min	minimum
min	minute/s
mm	millimetre/s — one millimetre is one thousandth of a metre
Mode 3	A wiring arrangement ("connection mode") for a telephone line that allows a certain device to take control of the line to make an important call so that interruption of the call from another telephone access point is prevented
Mode 5	A connection arrangement similar to Mode 3 but which only switches one leg of the line instead of both legs as with Mode 3
modem	Short for "**mod**ulator/**dem**odulator", provides an interface between a public telecommunications network line (e.g. a telephone line) and a computer, usually to convert analogue signals to digital signals and vice versa
mounting bracket	Otherwise known as a "stud bracket", a metal plate used in cavity walls to position and fasten wall plates on the finished wall lining
Multiple Dwelling Unit (MDU)	See "MDU"
multiswitch	A type of RF splitter/amplifier used for distribution of satellite and terrestrial TV signals to TV access points over the same coaxial cables
mutual isolation	The attenuation between two output ports of an RF device (e.g. a splitter) to prevent mutual interference between the output ports. Also called "RF isolation".
mutual interference	See "mutual isolation"
mV	millivolt/s — one millivolt equals one thousandth of a volt
naked DSL	An ADSL service supplied over the same copper twisted pair that is normally used to supply a telephone service but without the telephone service

Term	Definition
NAS	See “Network-Attached Storage”
National Broadband Network (NBN)	A national telecommunications network – or, more correctly, various telecommunications networks – being established by a government-owned company, NBN Co, to provide all Australians with access to high-speed broadband services using FTTP, wireless and satellite technologies
NBN	See “National Broadband Network”
NBN Co	A company established by the Commonwealth Government in 2009 to build the National Broadband Network (NBN)
network	A system or series of systems provided to facilitate interconnection of services and equipment. A network operated by a carrier to supply public telecommunications services to customers’ premises is referred to in this document as a “telecommunications network” whereas a network used within premises to distribute services or interconnect services and equipment is called a “Local Area Network” (LAN) or a “home network”.
networking	The interconnection of services and equipment via a local area network
Network-Attached Storage (NAS)	A file storage device connected to a Local Area Network (home network) that may be used as a central repository for sharing of files between multiple users of the network and/or for file/system backup.
network boundary	The point on a telecommunications network that is deemed to be the physical boundary of that network beyond which a carrier or service provider will not usually accept responsibility for the installation, repair or replacement of cabling or equipment
Network Media Player (NMP)	A media player designed to be connected to a Local Area Network (LAN), usually via Ethernet. See also “media player”.
Network Termination Device (NTD)	A device that delineates between a carrier’s network and customer cabling or customer equipment. An NTD is a defined network boundary point.
Newton	The metric unit for force equal to the amount of net force required to accelerate a mass of one kilogram at a rate of one meter per second squared
Next G	A third generation (3G) mobile network operated by Telstra that uses the 850 MHz radio frequency spectrum
NGWL	Next G Wireless Loop — a technology used by Telstra to supply fixed telephone and data services to customers’ premises using the Next G mobile network
NMP	See “Network Media Player”
nominal impedance	The nominal design impedance of a transmission system or component based on the characteristic impedance of that system or component over a given range of frequencies. See also “characteristic impedance”.

Term	Definition
NTD	See "Network Termination Device"
OD	Outside Diameter — the diameter of a conduit or pipe that is circular in cross-section, measured between the external surfaces of the conduit/pipe
ohm/s	The value of DC resistance or AC impedance of a component, circuit or system, indicated by the symbol "Ω"
on-line gaming	Real-time playing of games via the internet
ONT	Optical Network Terminal — the powered equipment used to convert optical signals to electrical signals on an FTTP network for the connection of conventional telephone and data equipment. The ONT is referred to as a "Network Termination Device" (NTD) in this document.
open circuit	Often abbreviated to "o/c", a condition where a normal electric circuit path is broken and current ceases to flow. This may happen intentionally (e.g. via a switch) or unintentionally (e.g. due to a faulty connection).
Open registration	A class of cabling provider ("cabler") registration under which the type of customer cabling work that a cabler can legally do is not limited by the nature of the work to be performed. Compare with Restricted registration.
optical fibre	A fine, flexible, transparent fibre made of pure glass (silica) designed to convey light between two points. The American spelling, "fiber", is often encountered but there is no actual difference between "fibre" and "fiber".
outbuilding	A structure associated with, but not physically attached to, the main building in a premises, e.g. a shed, garage, cottage or "granny flat"
outdoor	Installed outside a building, including on the external surface of a building or other structure as well as underground or aerial
outer conductor	The outer "shield" of a coaxial cable, located directly under the sheath
outlet	A wall plate or a small, surface-mounted box containing a socket or sockets for connection of equipment. In the case of a power outlet, a switch is usually provided for each socket.
outlet box	Called a "wall box" in the electrical trade, a small metal or plastic box used in solid masonry or brick walls to position and fasten wall plates on the wall
outside diameter	See "OD"
P20	Plastic 20 mm (conduit) — a Telstra designation for conduit made to its specification for use in residential lead-in cabling and based on pressure pipe standard AS/NZS 1477, *PVC pipes and fittings for pressure applications*. 20 mm is the nominal inside diameter — the actual inside diameter is approximately 23 mm and the outside diameter is approximately 27 mm.

Term	Definition
PAL connector	The common style of push-in coaxial connector used on TV/video appliances and wall plates for connection of coaxial fly leads. PAL is the abbreviation for “Phase Alternating Line”, an analogue TV colour-encoding system used in broadcast television systems in Australia and many other countries. Also called a “Belling-Lee” or an “IEC 169-2” connector. The preferred connector for digital RF services is the “F-connector”.
passive	A device or equipment that does not require power to function
patch cord	A flexible cord terminated with plugs to make a cross-connection between sockets or between a socket and equipment within a patch panel
patch panel	An array of sockets that may be cross-connected by means of patch cords
pathways and spaces	See “cabling pathway” and “cabling space”
pay TV	A TV service requiring payment by subscription to the service to access it
PC	Personal Computer — includes a desktop computer, laptop computer, notebook computer and a tablet computer
PCD	Premises Connection Device — an outdoor device normally used as an intermediate connection point between the underground or aerial lead-in cabling and the indoor cabling but may also be used as an intermediate connection point for lead-in cabling running between two buildings
permanent link	In this document, this means a cable between a telecommunications outlet and the CCP. A permanent link includes the socket connected to the cable at each end but does not include any equipment connecting cords (“fly leads”) or patch cords.
personal response system	Often referred to as a “medical alert” or “emergency call” system, this is a communications system that enables a person with a disability or medical condition to call for assistance by initiating a call to a predetermined number via the telephone network. The call may be initiated by pressing the button on a portable device or on a fixed device located in a room.
plug	A connecting device designed to be inserted into a mating socket
plug pack	A small, double-insulated and plastic-encased transformer that plugs directly into a power outlet
PoE	Power over Ethernet — a technology that supports the supply of DC power over wired Ethernet cabling from a hub to terminal devices such as IP cameras and wireless access points. This should not be confused with EoP (Ethernet over Power).
polarisation	The orientation of the oscillations of a transmitted radio frequency wave, i.e. horizontal or vertical. TV transmission is either horizontally or vertically polarised whereas satellite transmission uses both horizontal and vertical polarisation.
power mains	The cabling that connects the premises to the power grid in the street

Term	Definition
power outlet/power point	A 230 V (or “240 V”) AC domestic power outlet (often described as a “socket-outlet”, “General Purpose Outlet” or “GPO”)
Power Supply Unit (PSU)	See “PSU”
power utility	A supplier of electricity (“power”) to businesses and consumers
powered equipment	Equipment that is powered from a power outlet and which is necessary to supply, connect or distribute a telecommunications service. It may also be referred to as “active equipment”.
premises	An area of land that contains one or more buildings. In this document, “premises” refers to the land and any building or structure located on that land. The description “building” is used in reference to any building within the premises.
Premises Connection Device	See “PCD”
pre-wiring	Also described as “roughing in” or “pre-provisioning”, this is the practice of cabling a building during construction to minimise installation costs and maximise concealment of cables
property entry point	The point in a premises where Telstra lead-in cable enters the premises
PSTN	Public Switched Telephone Network — the telephone network used to supply standard telephone services to businesses and consumers, also sometimes referred as “POTS” (Plain Old Telephone Service)
PSU	Power Supply Unit — equipment used to convert 230 V AC power to a lower DC voltage to operate telecommunications equipment such as an FTTP NTD. If a PSU contains a battery to maintain the supply of the DC voltage during a blackout, it may be referred to as a “UPS” (Uninterruptible Power Supply).
pull-cord	A cord or rope threaded through conduit during its installation for use to pull cable through it from end to end at a later time. Also referred to as “draw-cord” or “draw-wire”.
quadshield	A coaxial cable with an outer conductor comprising four layers of shielding — an inner foil, an inner braid, an outer foil and an outer braid
QAM	Quadrature Amplitude Modulation — a method of modulating digital signals by changing (modulating) the amplitude of two carrier waves that are 90° out of phase, used for pay TV supplied via HFC (“Cable”)
QPSK	Quadrature Phase Shift Keying — a form of carrier frequency modulation that is based on using four changes in carrier phase to quantify the data being conveyed
Radio Frequency (RF)	See “RF”

Term	Definition
RCD	Residual Current Device — a safety device that automatically disconnects voltage from a power circuit if it detects current leakage between the active wire of the circuit and earth. It is sometimes called an "ELCB" (Earth Leakage Circuit Breaker) but is commonly known as a "safety switch".
readily accessible	Capable of being reached quickly and without climbing over or removing obstructions, mounting upon a chair, using a moveable ladder, and in any case not more than 2 m above the ground, floor or platform
registered cabler / cabling provider	A person who is registered in accordance with regulatory requirements to install or repair customer cabling. See also "Open registration" and "Restricted registration"
REN	Ringer Equivalence Number — a numerical value that indicates the approximate load that a ringing device (e.g. a bell or tone ringer) places on the telephone line. A standard telephone usually has a REN of 1.
Restricted registration	A class of cabling provider ("cabler") registration under which the type of cabling work that a cabler can legally do is limited according to the nature of the work to be performed. Compare with Open registration.
return loss	The loss of signal power resulting from reflection of the signal caused by a discontinuity or impedance mismatch ("imbalance") in a transmission path
return path	In an RF (coaxial cable) distribution system, this refers to the frequency spectrum used for transmission of information from the consumer end to the service provider's system. Also referred to as "reverse path" and synonymous with "upstream" or "upload".
RF	Radio Frequency — for the purposes of this document, this means any frequency between 5 MHz and 2150 MHz
RF amplifier	A powered device used to increase the RF signal level to ensure that the correct signal levels are present at all outlets
RF gain	An increase in signal level due to amplification via an RF amplifier
RF isolation	See "mutual isolation"
RF loss	A reduction in signal level due to the dissipation of energy along a cable or through a connector or splitter — also referred to as "RF attenuation"
RF modulator/modulation	A device or technique that converts audio and video (A/V) signals from an appliance to radio frequencies to which a TV receiver can be tuned
RF power level	The RF signal level measured at any given point with a field strength meter, usually measured in dBµV or, for HFC networks, in dBmV
RF splitter	A device that divides the incoming RF signal between two or more outputs while maintaining impedance matching of the various cabling legs and minimising transfer of signals between the output legs

Term	Definition
RG	Radio Guide — at least this seems to be the most popular opinion as to what “RG” means. It is based on a US military specification that no longer exists, so the designation itself has no formal definition or status.
RG6	High performance coaxial cable typically used for TV, satellite and cable broadband cabling in dwellings (also referred to as “series 6”)
RG11	High performance coaxial cable typically used for cable and satellite TV (also referred to as “series 11”). It has lower attenuation than RG6 cable and may be used instead of RG6 cable for long cable runs to avoid the need for an RF amplifier.
RG59 or RG59/U	A relatively low grade coaxial cable that only incorporates one or two layers of shielding (e.g. a braid and/or a foil). Sometimes suffixed with a “U” (for “Utility”, meaning general purpose), it is commonly used for single-channel RF (e.g. closed circuit TV camera) or A/V applications.
rigid conduit	Conduit that is stiff and cannot be bent without deformation. UPVC (Unplasticised PolyVinyl Chloride) is one form of rigid conduit, as is polyethylene (PE). Compare with “flexible conduit”.
RIM	Remote Integrated Multiplexer — a large Pair Gain System (PGS) typically housed in a roadside cabinet that uses digital multiplexing technology to supply PSTN services.
Ringer Equivalence Number (REN)	See “REN”
RJ	Registered Jack — a designation introduced by regulators in the USA in the 1970s to specify both a type of socket (jack) and wiring pattern for connection of customer wiring at the carrier’s network interface. This is comparable to “Connection Modes” introduced in Australia around the same time. It has become popular to use certain RJ designations to (incorrectly) describe a physical socket and plug only, e.g. “RJ45” is the popular designation for an 8P8C modular socket/plug.
RJ11	Registered Jack No. 11 — a term commonly (but incorrectly) used to describe a 6P (6-position) modular plug or socket. “RJ12” is another popular misnomer for this plug/socket. The correct designation is 6P2C (8-position 2-contact), 6P4C (6-position 4-contact) or 6P6C.
RJ45	Registered Jack No. 45 — a term commonly (but incorrectly) used to describe an 8P (8-position) modular plug or socket. The correct designation for the 8P sockets commonly used in Australia are 8P8C (8-position 8-contact, mostly used for Ethernet) and 8P4C (8-position 4-contact, used by Telstra for telephone and ADSL connections).
rms (or r.m.s.)	root mean square — the value of AC current that produces the same heat energy in a purely resistive load as the same value of DC current. For an AC sine wave, this is equal to 70.7% of the peak AC value.
router	A device that provides connectivity between two or more computers and which provides them with shared access to a broadband internet service

Term	Definition
rural	In this document, this refers to an area in which the properties have frontages greater than an average of 60 m, lot sizes generally larger than 1000 m², and there is usually no curb and channel and no street lighting. The telecommunications network construction is usually characterised by long cable routes with direct-buried cables.
Rx	Receive
saddle	See “conduit saddle”
SC	Single Core (HV cable) — a high voltage power cable in which the phase and neutral conductors are contained under separate sheaths. SC is also an abbreviation for “Snap Connector”, which is a type of optical fibre connector (not referred to in this document).
screen (cable/connector)	An electrically conductive layer or shroud surrounding cable conductors or connections within a connector, which provides a “Faraday cage” around the conductors/connections to reduce electrical interference (noise) from other electric circuits and also to reduce electromagnetic radiation from the cable/connector to other circuits. The screen may provide a signal return path for some types of cable (e.g. coaxial cable). Also referred to as a “shield”, especially for coaxial cable.
screening effectiveness	The ability of a device, equipment or system to attenuate the influence of electromagnetic fields from outside the device, equipment or system, or to suppress the radiation of electromagnetic fields from inside the device, equipment or system
service provider	A person or company that may provide carriage services (e.g. an internet or pay TV connection using a carrier’s network) or content services (e.g. pay TV programs or an internet web site) — see also “carriage service provider”
Set Top Unit (STU)	A device that decodes encrypted pay TV signals allowing the customer to view the pay TV channels to which the customer has subscribed — also sometimes referred to as a “Set Top Box” (STB)
shield (cable/connector)	An electrically conductive layer or shroud surrounding cable conductors or connections within a connector, which provides a “Faraday cage” around the conductors/connections to reduce electrical interference (noise) from other electric circuits and also to reduce electromagnetic radiation from the cable/connector to other circuits. The shield may provide a signal return path for some types of cable (e.g. coaxial cable). Also commonly referred to as a “screen”.
short circuit	Often abbreviated to “s/c”, an electric circuit of low (or no) impedance that provides an unintended path for electric current, e.g. due to a mishap or fault

Term	Definition
skin effect	A phenomenon that occurs in a conductor at signal frequencies above about 1 MHz whereby the high-frequency currents only flow in the outer layer ("skin") of the conductor. Skin effect occurs due to the presence of "eddy currents" that are induced in the centre of the conductor by the changing magnetic field produced by the AC current flowing through it.
slope	In an RF distribution system, this is the difference in gain or attenuation at two specified frequencies between any two points in a device or in the system. A positive slope of level with increasing frequency may be deliberately established to compensate for increased loss at higher frequencies. Compare with "equalisation".
smart wiring	An expression commonly used to describe cabling used to interconnect "smart" devices such as personal computers or home automation systems. The wiring itself is passive and can't include any "intelligence" or "smarts".
socket	Often also described as a "jack", a socket is a connecting device designed to accept a mating plug
span	The distance between two consecutive fixing points for an aerial cable or catenary, e.g. between two consecutive poles or cable supports
S/PDIF	Sony/Philips Digital Interconnect Format — a digital audio connection specification for interconnecting adjacent consumer audio equipment using either a coaxial cord with RCA connectors or and optical fibre cord with TOSLINK connectors
speed	A term used to describe data throughput, i.e. the amount of data transferred from one point to another over a finite period of time — usually expressed in bits per second (bps) or Bytes per second (Bps)
splice box	A box that provides facilities for joining ("splicing") optical fibre cables together
splitter	A device in which RF signals connected to a single input port are divided equally or unequally between two or more output ports. Some splitters may be used in the reverse direction as combiners. The term "splitter" may also be used in reference to an ADSL filter (see "central filter").
standby (batteries)	The state of a battery that is fully charged ready for use
star wiring	A method of cabling sockets/outlets radially from a common point — an alternative cabling method to "daisy-chain" or "bus" wiring
STP	Screened Twisted Pair (or Shielded Twisted Pair) — a twisted pair cable that includes at least one metal foil and, optionally, a metal braid wrapped around the bundle of cable pairs ("overall screen") and may also include a separate metal foil wrapped around each individual cable pair. The overall screen usually includes a longitudinal conductor, called a "drain wire", for connection to an earth reference at the cable termination point.

Term	Definition
straight-through patch cord	A patch cord in which the conductors are connected to the same plug contact number at each end of the cord. Compare with “crossover patch cord”.
structured cabling system	A term used to describe a cabling system having a structure that enables it to be used for various purposes including a local area network (LAN) and telephony. Also called “generic cabling” or, in a home, “smart wiring”.
STU	See “Set Top Unit”
stud bracket	See “mounting bracket”
surface cabling/conduit	Cable or conduit that is fastened to the visible surface of a building or structure such as a wall or ceiling
surge suppression	A device or technique used to limit the rise in voltage between two or more parts of a cabling system or within equipment, which may be caused by a lightning discharge or a surge in the power supply system
suspended ceiling	A ceiling that consists of lightweight tiles held within a metal frame suspended via wires or rods from the underside of the floor above or from the roof structure. Also referred to as a “false ceiling”.
SWER	Single Wire Earth Return — a method of electricity distribution in which the return path of the HV supply is via the general mass of earth (usually used for the supply of electricity to rural premises)
switch (data/network/Ethernet switch)	A computer networking device that enables multiple Ethernet devices to be interconnected in a local area network (LAN)
switching socket	A type of telephone socket in which certain contacts “make” when the plug is removed, commonly used for “Mode 3” and “Mode 5” connections
T568A	An 8P8C modular socket pin/pair assignment for termination of 4-pair data cable that was originally specified in USA telecommunications standard TIA/EIA-568-B but which has now been universally adopted
T568B	An 8P8C modular socket pin/pair assignment for termination of 4-pair data cable that was originally specified in USA telecommunications standard TIA/EIA-568-A but was superseded by the T568A pin/pair assignments introduced in standard TIA/EIA-568-B that replaced TIA/EIA-568-A
T-DAB	See “DAB+”
technical regulation	The regulation, by the ACMA, of technical telecommunications matters such as setting technical standards for the design, manufacture and connection of customer equipment and customer cabling products, and making cabling provider rules including a system for registration of cablers and setting of cabling standards (“wiring rules”)
telecommunications network	A system, or series of systems, that is operated by a carrier or carriage service provider for carrying communications to, from or between customers by means of guided and/or unguided electromagnetic energy

Term	Definition
telecommunications network technology	A technique or medium used to provide consumer access to core services such as the public switched telephone network or the internet
Telecommunications Outlet (TO)	A fixed connecting device to which an end-user may connect customer equipment to telecommunications cabling. A telecommunications outlet includes the socket(s) and associated mounting hardware (e.g. wall plate)
telephone cable	A type of cable that is only designed to carry voice-frequency signals and is not designed to carry signals above the voice bandwidth
telephone service	A service that provides for spoken communications between customers who use the service. In the context of this document, this includes a VOIP service.
telephony	The use of equipment or cabling for voice-frequency transmission between two or more points by translating sound into electrical signals and vice versa
Telstra	Telstra, its employees or contractors
TIA/EIA	Telecommunications Industry Association/Electronics Industry Alliance — the TIA is a standards-setting body that is an offshoot of the EIA and which develops telecommunications standards primarily for use in the USA
tie cabling	An expression used in this document to describe the physical link between the outdoor PCD and the CCP
TO/TOs	See “Telecommunications Outlet”
TOSLINK	TOShiba LINK — a digital audio connector specification for interconnect-ing adjacent consumer audio equipment using an optical fibre cord. See also “S/PDIF”.
transmodulation	The conversion of RF signals from one form of modulation to another, e.g. from QPSK DVB-S satellite IF signals to QAM DVB-C format
trishield	A coaxial cable with an outer conductor comprising three layers of shielding — an inner foil, an inner braid and an outer foil
trunking	A tray or trough system with removable covers along its length that is used for housing and protecting cables. Sometimes referred to as “ducting”.
TV	Television
TV outlet	An outlet containing at least one RF socket (e.g. an F-connector) for connection of TV equipment. It may also be referred to as a “coaxial outlet” but is called a “Broadcast Outlet” (BO) in some standards, handbooks and other documents.
TV service	A service that provides access to TV programs either as a free service (“free-to-air” or “FTA”) or a subscription service (“pay TV”)

Term	Definition
twisted pair cable	A type of cable in which two conductors (a “pair”) are twisted together to cancel out electromagnetic induction (“crosstalk”) from an adjacent pair within the same cable or from an external source such as another cable. Twisted pair cable is referred to as “balanced cable” in cabling standards because the pair conductors are identical (except for insulation colour).
Tx	Transmit
U clip	See “wallboard clip”
UHF	Ultra-High Frequency — the radio frequency spectrum between 300 MHz an 3 GHz
unbalanced cable	A cable whose transmission elements are not identical, such as coaxial cable in which the centre conductor and the outer conductor (shield) are composed of different materials. Compare with “balanced cable”.
underground	Installed below ground level external to a building but not including anything installed within an underground structure such as a service tunnel or mine
UPS	Uninterruptible Power Supply — a power supply that continues to supply power to equipment for a limited duration if the primary source of power (e.g. 230 V AC mains power) fails. A UPS contains a battery to maintain the supply of DC power to the equipment (as in the case of FTTP) or to regenerate AC power using a circuit called an “inverter”.
UPVC	Unplasticised Polyvinyl Chloride — a material commonly used for the manufacture of rigid plastic conduit
urban	In this document, this refers to an area in which the properties have frontages less than an average of 60 m, lot sizes generally smaller than 1000 m^2, and the roads usually have curb and channel and street lighting. The telecommunications network cables are usually installed in conduit.
USA	United States of America
USB	Universal Serial Bus — an industry standard for the interconnection of digital devices and for the supply of DC power to a connected device
UTP	Unscreened Twisted Pair (or Unshielded Twisted Pair) — twisted pair cable that does not contain a screen/shield. Compare with “STP”.
UV	Ultraviolet — the damaging component of sunlight that is invisible to the human eye
µV	microvolt/s
V	Volt/s
V AC	Volt/s Alternating Current

Term	Definition
V DC	Volt/s Direct Current
VDSL	Very high rate Digital Subscriber Line — a more advanced DSL technology than ADSL and ADSL+ that uses a higher bandwidth to provided greater data throughput, albeit over shorter distances. Second-generation VDSL, VDSL2, provides theoretical data rates of 100 Mbps simultaneously in both directions but in practice these rates are unrealistic.
VHF	Very High Frequency — the radio frequency spectrum between 30 MHz an 300 MHz
Video on Demand (VoD)	Services that allow a consumer to browse a catalogue of movies or TV programs online and select one or more movies/programs for download to a computer or other compatible device for playing immediately or later. IPTV technology may be used to play the downloaded content or it may be stored in a certain file format for playing using, for example, a digital video recorder (DVR) or media player.
VoD	See “Video on Demand”
voice	A general term sometimes used to describe applications that operate in the voice frequency spectrum, e.g. up to 4 kHz in an analogue system or 64 kbps in a digital system
VOIP	Voice Over Internet Protocol — a technology that enables voice frequency (e.g. telephone) calls to be made over the internet, usually at a lower cost than conventional long distance telephone calls
VRLA	Valve-Regulated Lead-Acid — a construction method for batteries that enables the battery to be sealed and mounted in virtually any orientation. However, the battery contains a safety pressure-relief valve so that the battery can vent gas if it is charged at too high a rate. A VRLA battery is more commonly known as a “sealed battery”.
W (power)	Watt/s
W (dimensions)	Wide/Width
W/Cell 15 mins	Watts per cell for 15 minutes — an alternative method to Ah (ampere hour) for rating battery capacity. W/Cell 15 mins is often used for UPS batteries. To convert W/cell to Ah, divide by 5, e.g. 35 W/Cell ≈ 7.0 Ah.
wall plate	A face plate normally used on a cavity wall or on a mounting block to which one or more telecommunications sockets may be fitted for connection of cords by end-users
wallboard clip	Sometimes called a “C clip” or a “U clip”, a metal clip used on a sheeted cavity wall to mount a wall plate by insertion of the clip into a rectangular hole cut into the wall for the purpose
WAN	Wide Area Network — a network that covers a broad area or which is used to interconnect two separate local area networks (LANs)

Term	Definition
WAP	See “Wireless Access Point”
Wavelength (λ)	Wavelength is the distance between the peaks of two consecutive cycles of an AC signal wave. It is related to the speed of propagation of the signal through the medium by which it is carried. In a vacuum, electro-magnetic waves travel at the speed of light which is approximately 300 million metres per second. The theoretical wavelength of a signal at a particular frequency is calculated using the formula: Wavelength (in metres) = 300,000,000 ÷ frequency (in Hz).
Wi-Fi	See “wireless”
wireless	A description generally used for services and equipment that are connected using radio technology. Some forms of this technology (e.g. wireless LAN) are also referred to as “Wi-Fi”. Where the radio signal is transmitted via a satellite, it is described as “satellite” rather than “wireless”. Compare with “cordless”.
Wireless Access Point (WAP)	A device that enables wireless devices to connected to a wired network. A WAP may be a standalone device or may form part of a router.
wireline	Opposite to wireless — means interconnection by means of a physical line (cable) whether copper twisted pair, coaxial or optical fibre
wiremap (testing)	An electrical continuity test performed on twisted pair Ethernet cabling to verify correct pin/pair assignments at connectors
wiring rules	For telecommunications cabling, this means Australian Standard AS/CA S009 or its replacement. For electrical cabling, this means Australian/New Zealand Standard AS/NZS 3000 (see “REFERENCES”)
Z	See “impedance”

18 DOCUMENT CONTROL SHEET

Issue number	Issue date	Details on the change
1	26/08/2013	Approved version for publication