ABCB

Australian Government

Department of Broadband, Communications and the Digital Economy

Digital Switchover Taskforce

Digital TV Antenna Systems

2008

Handbook

Non-Mandatory Document

Australian Government
Department of Broadband,
Communications and the Digital Economy
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Digital TV Antenna Systems

Free-to-Air digital TV in buildings with shared antenna systems

2008

2nd Edition

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This Handbook on Digital TV Antenna Systems (the Handbook) is non-mandatory and is designed to assist in making such information on this topic readily available.

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Introduction

General

Reminder

This handbook is not mandatory or regulatory in nature and compliance with it will not necessarily discharge a user's legal obligation. This Handbook should only be read and used subject to and in conjunction with the general disclaimer at page ii.

Free-To-Air (FTA) TV in Australia has been broadcast using analog signals since 1956. These analog TV signals are in the process of being replaced by more efficient digital transmissions that are already on air in most locations.

On 18 December 2007, Senator the Hon Stephen Conroy, Minister for Broadband, Communications and the Digital Economy, confirmed that the first firm steps had been taken on the road to completing switchover by the end of 2013.

"Setting a firm date of 2013 for the switchover from analog to digital television transmission in Australia has given industry the certainty it needs to drive consumer uptake of digital television".

Every Australian needs to prepare so they can access the benefits of the worldwide digital revolution. It is vital to start any necessary upgrade of receiver equipment and antenna systems now to avoid the anticipated rush in the lead up to the switchover.

While some homes may not require any modification, others may require relatively modest upgrades to their antenna systems. Buildings which have master or communal antenna (shared) TV systems may need more complex modifications. This Handbook was developed by industry to assist those who live in or are associated with multi-dwelling units (unit or apartment blocks, townhouses etc.) or other buildings with shared antenna systems such as public buildings and hotels.

If you are an architect, designer, developer, body corporate/strata manager, owners' corporation representative, facilities manager, owner or tenant, this information will help you prepare for the switchover from analog FTA to digital FTA TV. It is also a helpful tool for people involved in supplying or maintaining these TV systems.

Scope

This Handbook is written in generic terms. It has been developed to provide guidance to its users on the issues relating to digital TV antenna systems. It has been written principally for a general audience.

Consideration of the installation or modification of antenna systems should always be made in conjunction with appropriate consideration of other relevant requirements and issues, including those relating to structure, fire safety, town planning, services and other matters.

Limitations

It should be noted that this Handbook is not intended to:
- override or replace any legal rights, responsibilities or requirements;
- provide comprehensive or detailed guidance on issues relating to the installation or modification of antenna systems; and
- provide specific design solutions for a particular building or site; or replace available published information.

Switching to Digital TV

Free-to-Air digital TV

This Handbook has been developed to provide guidance on the conversion of FTA analog television to FTA digital television.

Advantages of digital TV

Digital TV features widescreen pictures and surround sound. Each broadcaster's digital TV signal offers viewers a range of services which may include:

- additional channels
- high definition channels
- widescreen pictures not available via analog
- ghost free reception
- surround sound
- electronic program guides (EPG)
- datacasting services
- closed captioning, and
- interactive services.

These services will be expanded over time.

Who should use this Handbook?

The Handbook is intended to be a helpful checklist for:

- strata/body corporate manager
- owners' corporations
- facilities managers
- tenants; and
- property owners,

to use when contracting the following service providers for work in existing multi-dwelling units:

- master or communal antenna TV consultants, installers and system integrators;
- antenna installers; and
- antenna manufacturers, suppliers, retailers and wholesalers.

The Handbook is also aimed at those involved in the design, construction and maintenance of new buildings and their in-building TV distribution systems, including:

- architects
- designers
- electrical consultants
- electrical contractors
- electrical wholesalers
- developers and
- builders

What is involved in the conversion process for reception of FTA digital signals?

The FTA digital TV transmissions are broadcast on the same frequency bands as analog TV, but on different channels and Channels 0, 1, 2, 3, 4, 5 & 5A are not used for digital TV. It is therefore a matter of determining if the current TV antenna/aerial will receive the digital TV broadcasts in your area and making sure each of the digital TV signals are distributed to each TV wall-plate outlet at the correct strength and without added interference.

For existing TV distribution systems, this would initially require a survey and then an upgrade if required. The level of upgrading required will vary greatly depending on the existing installation. This is because many installations were designed to cater for the reception of analog services only and may not meet the requirements necessary for digital FTA TV reception. For example, if a distribution system was installed for analog TV, it may have shifted some analog TV channels to other channels which could be a channel now used for digital TV transmissions.

There are likely to be costs associated with the conversion process. These may include:

- upgrading the rooftop antenna/aerial
- running new cabling
- buying new amplifiers and
- labour costs associated with the design and installation of the above.

Once the building has been upgraded, residents will also have to purchase equipment, such as a set-top box or a TV with a digital tuner, so that they can receive digital FTA transmissions.

During the remaining period while both analog and digital television transmissions are available in an area (the simulcast period), some residents may wish to continue to use the analog signals. This will only be possible until the analog signals are switched off in the area which may be well before 2013. Any upgrade of a MATV/CATV system that ensures

[1] *Older antennas may not adequately receive new digital transmission channels – e.g. in most capital cities digital transmissions on channels 6, 11, 12 & 33-36, may not be adequately received on older antennas designed for 2, 7, 9, 10 and 28.*

full availability of the FTA digital channels but may alter the analog channel distribution, should follow with comprehensive advice to those residents affected. After the analog broadcasts are switched off, only digital television channels will be available for a MATV/CATV system and all residents will have to use a digital set top box or a new TV with an integrated FTA digital tuner to view FTA television services available through the MATV/CATV system.

Residents may choose to purchase a FTA digital set-top-box or a new TV with an integrated digital tuner in advance of the change.

There may be some cases such as hotels etc, that wish to continue to distribute analog signals because of a large existing inventory of analog receivers. In such cases the headend may be equipped with digital receivers fixed tuned to particular services that feed analog TV 'modulators'. Because some FTA broadcasters may need to change their digital transmission from time-to-time, any digital receiver used in a MATV or CATV installation should be fully compliant with the Australian Digital TV Receiver Standard AS 4933 or easy access should be provided to allow for receiver manual reset.

Direct distribution of FTA reception signals from a rooftop antenna/aerial ensures access to all FTA program services.

Any new MATV/CATV system that has been installed following the Australian Standard for such installations should have the capacity to carry the entirety of these digital TV signals to the residents' wall outlets.

A system is capable of receiving and distributing FTA digital transmissions from a rooftop antenna if:

- The system for FTA reception and distribution is installed in accordance with the design specifications and meets the requirements of the Australian Standard AS/NZS 1367:2007 *Coaxial cable and optical fibre systems for the RF distribution of analog and digital TV and sound signals in single and multiple dwelling installations* (available from www.saiglobal.com).

- A confirmation of performance is done by testing every outlet for all digital FTA signals to ensure they are free from interference and within the level ranges specified in the Standard. As there may be a short term requirement for analog FTA signals this should also be checked.

[2] Australian Standard AS/NZS 1367 *Coaxial cable and optical fibre systems for the RF distribution of analog and digital TV and sound signals in single and multiple dwelling installations*

To effectively receive and distribute digital FTA signals a system should meet the following:

1. Each TV outlet provides all the FTA off-air digital signals broadcast in that area so that all services offered by each broadcaster may be accessed by a digital TV receiver (e.g. either in a set-top-box or an integrated digital tuner in a receiver with a TV screen display).

   To achieve this:

   - Each broadcaster's digital TV signal at the outlet must be complete (unaltered).
   - Each digital TV signal at the outlet must be within the required voltage levels and not be adversely affected by interference – i.e. meet a suitable signal quality level[3].

2. TV signal levels at all outlets in the system are in the range specified:-

   - in the Standard AS/NZS 1367-2007 for those installed in 2007 or later or,
   - in the case of systems installed between 2000 and 2007, in the Standard AS/NZS 1367-2000.

Note: Installations that have at the headend digital receivers which convert some of the broadcasters' programs to analog for distribution to analog receivers do not satisfy the requirement.

Particular attention needs to be paid to the following:

Cabling

- The use of RG6 and RG11 quad shielded coaxial cable is recommended; and
- The use of 'flooded' cable for all underground sections of the installation.

Figure 1 shows a simplified drawing of a piece of quad shielded coaxial cable.

[3] Signal quality should be measured with an appropriate digital signal strength meter which is able to measure signal level in dBμV (microVolts) and a parameter of signal quality - MER in dB.

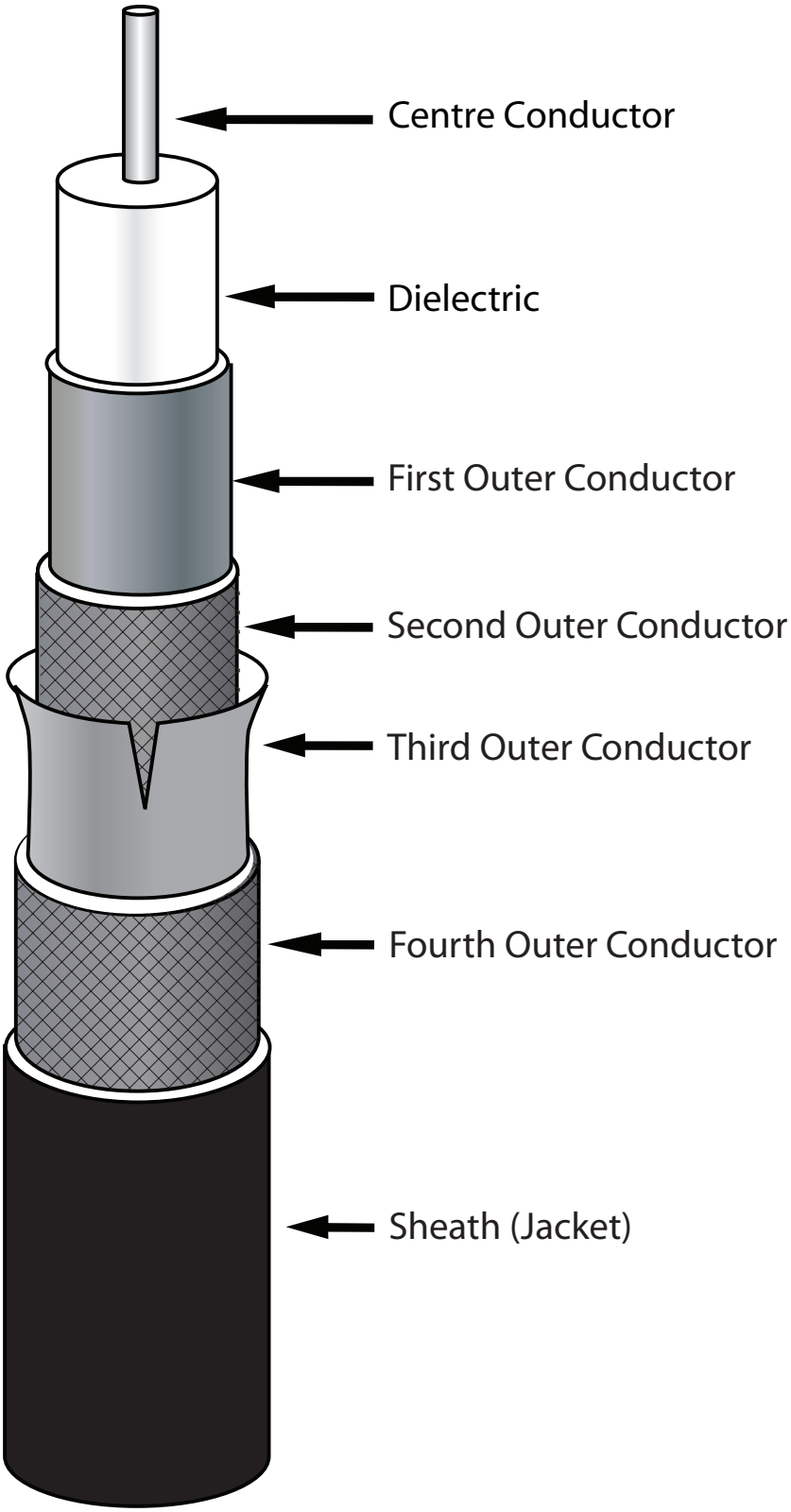

Figure 1 – Quad Shielded Coaxial Cable

Connectors

- Crimp or compression F-type connectors should be used for the interface between coaxial cables and passive or active devices. In systems used exclusively for terrestrial FTA services, PAL connectors may be used only at the front of the wallplate or on the flylead to connect to the consumer's equipment.

- Although PAL type connectors are still in widespread use for FTA TV equipment, the move to F-type connectors using crimp or compression connection is recommended because of its greater consistency of performance.

Amplifiers

- When broadband or channelised headend and/or distribution amplifiers are used within the system each device should meet the performance requirements described in the standard AS/NZS 1367:2007.

Other considerations

- When designing a building or new installation attention should be given to the amount of space available in risers for the routing of cabling and for the installation of outlets.

- Other requirements such as the Building Code of Australia and its referenced documents (which includes Australian Standards) may have additional provisions that impact on the installation of MATV/CATV systems. This Handbook does not describe or list all requirements relevant to the installation of MATV/CATV systems.

- Once a MATV/CATV system has been installed which meets the specifications outlined previously, residents in individual dwellings will need to purchase a digital set-top box or a TV with an in-built digital tuner in order to receive digital FTA signals. In some systems the reticulated signal may be derived from a converted digital FTA service to analog to facilitate the continued use of analog receiver sets. In this circumstance, residents should be advised of the limitations of the system when analog TV sets continue to be used. These limitations include aspect ratio and the inability to receive the additional services.

- A copy of installation documentation should be left on site for future reference.

Subscription TV services

In some buildings there may be a cable or satellite delivered subscription TV service available to residents.

Any systems currently providing subscription TV services should only be modified in accordance with service level agreements in place between the facility owners and subscription TV providers. Where these systems are intended to be used or modified, consultation with the relevant subscription TV providers should be sought to ensure minimal interruption to services is incurred.

If digital subscription TV services are being considered at the time of upgrading or installing a new system to cater for digital FTA TV, cabling provisions for both could be taken into account to ensure efficiency in costs and ease of access, to undertake all required works. Advice, standards and specifications for systems capable of receiving and distributing digital subscription TV services can be obtained by contacting your local subscription TV service provider.

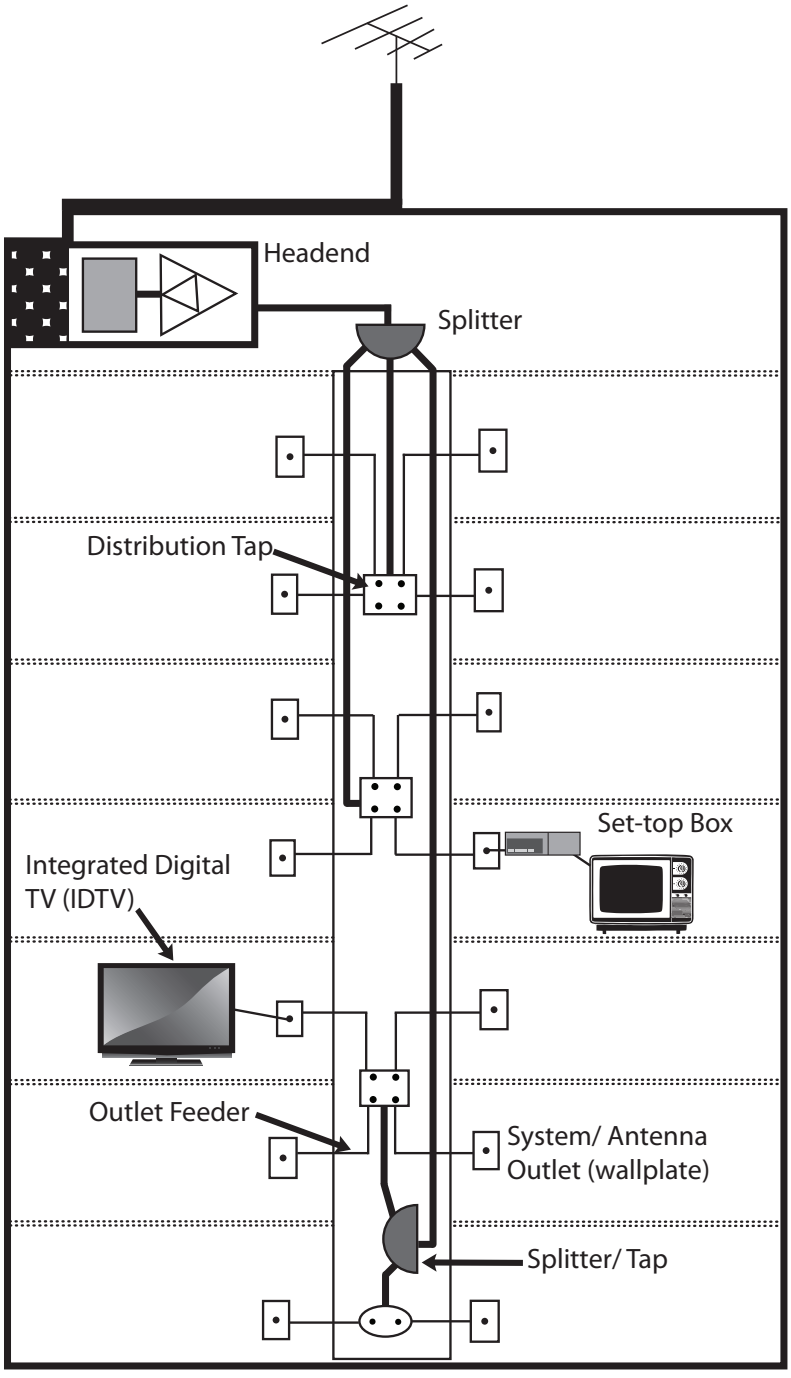

Figure 2 - Example of a Multi-Dwelling Unit MATV System

Note: some buildings may also have a satellite dish on the roof or underground cabling for carrying subscription TV services.

Understanding the building's current installation

It should be thoroughly understood whether the signals being received are FTA via a rooftop (outdoor) aerial/antenna or whether they come via a subscription TV service, as this may affect the quality of the transmission and limit the FTA services available.

There are various ways of distributing (reticulating) TV signals throughout a building, as outlined below. The best outcome will depend on the location of the building, its particular circumstances and the availability of FTA TV services.

Type of system	**Distribution system delivers**	**Issues**
Analog only	Analog channels only	Residents will lose all TV reception when analog transmissions are stopped.
Analog and digital	Analog and digital channels	Residents can access FTA digital TV now via a TV with a digital tuner or set-top box. Analog FTA signals will be available until switch off however in some systems problems can occur if the headend equipment channel shifts analog channels to prevent ghosting and these channels appear on a digital channel and block the digital signal.
Digital only	Digital channels only	Residents need a TV with a digital tuner or set-top box to receive FTA TV. This allows every unit owner/tenant full access to all FTA digital services. This is expected to be the most common scenario.
Digital and digital to analog	Digital channels and digital channels remodulated to analog (e.g. output of a set-top box)	Digital TV is now available to residents with a TV with a digital tuner or set-top box. This allows for the continued use of analog TV sets in hotels, hospitals etc. and may reduce the cost of transition to digital. Conversion of digital channels to analog for distribution is mainly for commercial premises and advantages of FTA digital TV are lost on channels that are converted to analog. The headend equipment may need to be reconfigured whenever digital transmissions change.
Analog and digital to analog	Analog channels and digital channels remodulated to analog	Residents can access analog versions of digital channels. Many of the advantages of digital TV, such as widescreen and surround sound, are not available. Residents with a TV with a digital tuner or set-top box do not have access to digital TV.

Digital to analog only	Digital channels remodulated to analog	Residents can access analog versions of digital channels. Many advantages of digital TV, such as widescreen and surround sound, are not available. Residents with a TV with a digital tuner or set-top box do not have access to digital TV.
Subscription TV and analog	Analog channels rebroadcast by subscription TV broadcasters	Some analog FTA signals will be available until switch off. FTA channels are only available to residents who pay for a service. The only way to ensure access to all the FTA digital services for all residents is via distribution of the signals received from a rooftop antenna/aerial.
Subscription TV, analog and digital	Analog and digital channels and channels rebroadcast by subscription TV broadcasters	Analog FTA signals will be available until switch off. FTA digital TV is now available to residents with a TV with a digital tuner or set-top box. Some FTA channels are available to residents who subscribe to the service.

Digital reception may be achieved when broadband amplifiers are used in distribution systems, but old antennas may not adequately receive new digital transmission channels – e.g. in most capital cities digital transmissions on channels 6, 11, 12, and 28 to 36 may not be well received on older antennas designed for channels 2, 7, 9 and 10.

A Master/Communal Antenna TV System Installation Assessment Form has been included at Appendix A. This was originally developed by the now disbanded Digital Broadcasting Australia and has been revised by industry for this publication. The installer should complete this form and include it with their quote for works on the system.

Want to know more?

For general information visit **www.digitalswitchover.gov.au**

For information about digital TV products, go to the Australian Industry Group website **www.aigroup.asn.au**

To find MATV/CATV system installers in your area, search for 'MATV TV antenna services' in your local phone directory.

For reference to issues dealing with Australian Standard NZS 1367: 2007 or 2000, enquiries should be directed to Standards Australia sub committee CT-002-06 Cabled Distribution Systems **www.standards.org.au**

For information about subscription TV services, visit the Australian Subscription Television and Radio Association (ASTRA) website – **www.astra.org.au**

Frequently asked questions

Analog TV

What is analog TV? The television system we are all familiar with that commenced as black and white in 1956 and changed to colour in 1975. In Australian capital cities the common stations are ABC, SBS and channels 7, 9 and 10. In regional areas throughout Australia the affiliated TV networks are Prime, Southern Cross, WIN, GWN, NBN and Imparja. Analog TV is subject to ghosted pictures due to co-channel and multi-path interference, geographic location and climatic conditions. Australian analog broadcasters use the PAL system of analog encoding and modulate this signal onto a VHF or UHF radio carrier. In an analog system the signal is continuous (linear) and varies in magnitude and frequency in sympathy with the source signal.

Amplifier

What is an amplifier? A device used to boost the strength of TV signals received by the TV antenna. The most common form of amplifier used for TV reception is the Masthead amplifier, which should only be used to boost signals in weak signal reception areas. Distribution Amplifiers are also used in master antenna TV systems to compensate for loss in the cabled distribution system and ensure the strength of the signal being received by each dwelling is correct.

Communal antenna TV (CATV) system

What is a CATV system? A system designed to receive and distribute sound and TV signals to communities. This can now also encompass cabled TV signal distribution such as found in mining communities.

Connectors

What is a connector? Connectors are used as a method of connecting coaxial cable. Hex Crimp or compression connections are recommended, because of the greater consistency of performance of the finished connection. A Hex Crimp connection has a six-sided indentation from the crimping tool. The Compression Connector uses a conical compression that encircles the entire circumference of the RG cable maintaining the integrity of the cable structure. This method provides excellent pullout strength and reduces signal ingress/egress providing superior connection and impedance matching.

Datacasting Services

What are datacasting services? Enhanced options offered with some digital programming to provide additional program material or non-program related resources, allowing viewers the ability to download data (video, audio, text, graphics, maps, services) to specially equipped computers, cache boxes, or set-top boxes.

Digital TV

What is digital TV and how is it different to analog? Digital TV is the sending and receiving of moving images, sound and other data by means of digital processes on radio of discrete (digital) signals, in contrast to the analog processed signals used by analog TV. Digital TV allows for greater consumer choice through more services – i.e. extra channels, wide-screen pictures, some in high definition, surround sound etc. In the future digital FTA services may include interactive services, significantly increasing the user experience. It is important however to have a good quality signal for a digital receiver as unlike analog TV, the picture and sound will suddenly breakup if the quality falls below a threshold (digital 'cliff' effect). Also picture breakup can be experienced from interference generated by electrical equipment especially with arcing contacts e.g. Motors in hair driers. This is known as electrical impulse noise.

Electronic Program Guide

What is an electronic program guide? An application available on some digital receivers that provides an on-screen listing of programming and content that digital TV viewers have available to them.

Flooded Cable

What is flooded cable used for? This type of coaxial cable is usually intended to be installed through a moist environment where there is usually a viscous sealing fluid present under the outer protective plastic sheath which in the case of a minor puncture will reduce the ingress of water and subsequent corrosion of the metallic components of the cable.

Free-to-Air (FTA) TV

What is FTA TV? Broadcasts delivered using transmitted radio signals in the air. These signals can be received within a given broadcast transmission area (e.g. Perth, Canberra, etc.) without charge by anyone with a TV and appropriate indoor or outdoor antenna.

Headend

What is a headend? A piece of equipment connected between receiving antennas, or other signal sources, and the remainder of the cabled distribution system, to process the signals to be distributed. The headend might include amplifiers, frequency converters, combiners, diplexers, PAL modulators and transmodulators. An MATV headend is normally the initial distribution fan-out point in multi-dwelling buildings or other locations where many TVs need access to the digital TV channels and possibly other required services (e.g. FM radio or the new digital radio services).

High Definition TV

What is high definition TV? This is currently the most superior video picture available in digital TV. The 1080i and 720p formats in a 16:9 wide-screen aspect ratio are the two commonly accepted high definition formats. Not all digital TV is high definition.

Master Antenna TV (MATV) System

What is a MATV system? This system can combine a variety of video media sources at a "head-end" facility and distribute that video information from one source throughout a multi-dwelling unit environment (i.e. via cabling carrying the FTA TV signals from the roof to each dwelling). Other video media sources can be from a satellite dish, VCR, broadband connection, personal computers, or any other audio/video device.

Quad Shielded Cable

Why use quad shielded cable? This antenna cabling that has four layers of shielding to prevent leakage or interference of TV signals.

Satellite Master Antenna TV (SMATV) system

How is a SMATV system different from a MATV system? It extends the MATV system above the previous 862 MHz limit to encompass the satellite intermediate frequency of 950 – 2150 MHz. This allows for access to satellite and FTA at the user's wall plate.

Subscription TV Services

What are subscription TV services? Fee-based digital TV services provided by cable and satellite. A regular monthly fee is usually paid to maintain access to subscription TV services. In Australia these services are provided mainly by FOXTEL, AUSTAR, TransACT, Neighbourhood Cable, SelectTV and a range of other providers.

Acknowledgements

This Handbook was developed by industry, coordinated by the Digital Switchover Taskforce in the Department of Broadband, Communications and the Digital Economy (DBCDE) with support from the Australian Communications and Media Authority (ACMA) and issued as a Handbook by the ABCB to assist in disseminating information to building and construction practitioners.

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This Handbook could not have been developed without the assistance and technical expertise of MATV/CATV consultants, installers and system integrators; and antenna installers, manufacturers, suppliers, retailers and wholesalers; and the following national, commercial (metropolitan, regional and remote) and community broadcasters:

APPENDIX A

MASTER/COMMUNAL ANTENNA TV SYSTEM INSTALLATION ASSESSMENT FORM

DATE OF INSPECTION:	
BUILDING ADDRESS:	
BUILDING MANAGEMENT CONTACT DETAILS:	
DESCRIPTION OF BUILDING	
Number of dwelling units, apartments, townhouses	
Number of floors	
Approximate date of construction	
Does the building have any heritage restrictions?	
Public (housing development), private, investment, owner/ occupiers	

TYPE OF DISTRIBUTION SYSTEM	
Does the existing CATV/MATV system, if installed since 2000, appear to generally comply with AS/NZS 1367-2000?	
If yes, is Section 2 Safety adhered to as to safety earthing and AC isolation of outlets?	
Does the building have a lightning protection system installed?	
Are any FTA analog channels translated and, if so, to which channels?	
Does the building have a subscription TV service? If so, how is the service received (cable, satellite) and who is the provider?	
If via satellite, does the SMATV system combine terrestrial FTA services?	

TYPE OF ANTENNA **Provide the details for each existing antenna:**			
Antenna	1	2 (if applicable)	3 (if applicable)
Description of type (UHF, VHF, Wideband, Single band)			
Polarity			
Channel coverage			
Likely age of antenna			

TYPE OF HEADEND	
Mast Head amplifier (if used) or Preamplifier (if used)	
Passive equalizers (if used)	
Fixed channelised amplifiers with equalizers	
Frequency agile channelised amplifier	
Fixed channel converters	
Frequency agile channelised converters	
Launch amplifier (multiband or wideband)	
Final active device specified maximum output level, if available	

FREE-TO-AIR DISTRIBUTION SYSTEM COMPONENTS	
Type of cable used for trunk, branch, spur (RG59, RG6, RG11, air spaced)	
Shielding employed in cable above (single, dual, tri, quad) if determinable	
Style of splitters and taps (screw and saddle, F)	
Type of cable used to outlet (RG59, RG6, RG11, air spaced)	
Shielding employed in cable above (single, dual, tri, quad) if determinable	
Type of connection on rear of outlets (screw and saddle, PAL, F, etc)	
Type of outlet (PAL, F, etc)	
Type of equalisers (if any)	
Type of inter-stage amplifiers without equalizers (if any)	
Type of inter-stage amplifiers with equalizers (if any)	
Specified maximum output level of inter-stage amplifiers, if available	

DISTRIBUTION TOPOGRAPHY	
Type – loop through, tree and branch or star system; mixture, unknown, etc.	
Location and accessibility of distribution components (in riser, external housing, ceiling, false ceiling cavity, unknown, etc.)	
Distribution cabling – internal or external to building	
Distribution cabling: if internal (in conduit/duct, cable tray), if external (conduit/duct, etc.)	
Cable to outlet – internal or external to building (completely or partly)	
Cable to outlet totally in conduit/duct, in conduit and ceiling cavities, wall cavity and ceiling cavities, rendered into walls and/or slab, unknown, etc.	

SIGNAL LEVELS OF RECEIVED ANALOG CHANNELS	
Input to headend or preamplifier (if used)	
Output from headend	
At outlet/s (at most distant extents of system, if possible). Required absolute minimum 60dBμV, preferred 63dBμV or greater; maximum 80dBμV.	
Other areas as may be applicable for the system installed (i/p and o/p of inter-stage amplifiers, etc.)	

SIGNAL LEVELS OF RECEIVED DIGITAL CHANNELS	
Input to headend or preamplifier (if used)	
Output from headend	
At outlet/s (at most distant extents of system, if possible). Required absolute minimum 50dBμV, preferred 53dBμV or greater; maximum 74dBμV.	
Other areas as may be applicable for the system installed (i/p and o/p of inter-stage amplifiers, etc.)	

AT OUTLETS, PICTURE QUALITY FOR ANALOG CHANNELS	
What level of picture quality across all terrestrial analog channels is present at outlets checked (Kyoto scale 1-5, with 5 excellent)	

AT OUTLETS, MODULATION ERROR RATIO (MER) AND MARGIN FOR DIGITAL CHANNELS	
If any terrestrial digital channels are available at outlets, what is their margin above Quasi Error Free point (minimum required greater than 9dB, typically equal or greater than 15dB) Depending on the digital meter available, provide at least one of the following measurements: • Across all terrestrial digital channels, what value of MER is achieved? Required MER ≥ 25dB. • Across all terrestrial digital channels, what value of margin to failure is achieved? Margin to failure measured at outlets on all digital channels shall be greater than 9dB (typically ≥15dB with preferred >20dB) relative to Quasi Error Free. **Note re method to use to determine margin to failure:** Add attenuation in 3dB or larger steps until Quasi Error Free is reached or almost exceeded. If exceeded by next 3dB attenuation added, previous total is margin	

LEVEL OF UPGRADE OR REPLACEMENT REQUIRED FOR THE RETICULATION OF FTA DIGITAL TV RF CHANNELS TO OUTLETS AT THE REQUIRED LEVELS OF SIGNAL QUALITY	
Minor upgrade (replace antenna/minor headend adjustments)	
Major upgrade (extend or replace most or all of headend)	
Total upgrade of the headend and distribution system (complete replacement)	
In your opinion, would it be appropriate for people in this building to use an indoor antenna to receive DTT services?	

OTHER COMMENTS, INCLUDING FIRST STEPS TO IMPROVE RECEPTION DIFFICULTIES

SIGNATURE OF TECHNICIAN UNDERTAKING SURVEY …….

NAME ……..……

DATE …….