Australian
Broadcasting
Authority

AUSTRALIAN BROADCASTING PLANNING HANDBOOK

FOR

DIGITAL TERRESTRIAL TELEVISION BROADCASTING

DRAFT

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CONTENTS

INTRODUCTION

The Australian Broadcasting Planning Handbook for Digital Terrestrial Television Broadcasting (The DTTB Handbook) provides a convenient single publication which includes the planning parameters, measurement methods and best practice that could be used for the detailed planning of transmission facilities for digital television.

The planning criteria for VHF/UHF digital television planning in Australia has been largely based on planning recommendations and reports published by the International Telecommunication Union (ITU). These recommendations and reports were developed and accepted at an international level in consultation with many member countries. Australia is an active member of the ITU.

The Australian Broadcasting Authority (ABA) also acknowledges the unique role of Standards Australia, in particular Standards Australia having ultimate responsibility for publishing the technical parameters to be used for transmission and reception of digital terrestrial television in Australia, as an Australian Standard.

The parameters detailed in the DTTB Handbook were developed in close consultation with the Digital Television Channel Planning Consultative Group, and will be revised to reflect current planning practices and international developments, taking account of the technical characteristics of receivers available in the market.

EXISTING AND PLANNED BROADCASTING SERVICES

To carry out the necessary channel selection and analysis process, certain information will be needed about the preferred channel groupings for an area and established and proposed broadcasting services.

Information about licensed broadcasting services is available in the *Radio and Television Broadcasting Stations Book 1998*, published by the ABA. This publication is also be available on the ABA's internet website on http://www.aba.gov.au. Alternatively, information about broadcasting stations will be available in a download format also from the ABA's internet website. The data is regularly extracted from the ABA's database, and is ideal for those wishing to obtain up-to-date information on licensed broadcasting services.

Frequency tables for the analog television bands, showing analog channels allotted to particular areas in Australia, were published in the ABA's *Frequency Allotment Plan August 1994*. That publication does not contain information about subsequently planned services.

The ABA is examining ways in which information regarding planned analog and eventually digital television services can be made readily available.

Digital television channels will not normally be assigned in advance of detailed planning and acceptance of the Digital Conversion Schemes and Implementation Plans. However, the ABA may assign some interim channels in advance for the purpose of testing, where planning policy considerations allow**.** It is acknowledged that test transmissions will be required by some broadcasters to provide useful planning information for the process.

For the purpose of analog television and radio planning refer to the ABA's *Technical Planning Guidelines* (TPGs) and the *Interim Australian Broadcasting Planning Handbook (The Analog Handbook).*

APPLICATION

For the purpose of developing the Digital Channel Plan (DCP), channel selection will only consider those 7 MHz channels occupying the Band III, Band IV and Band V television transmission bands specified below.

TV Transmission Band	*Frequency Range (MHz)*	*Channels*
III	174 - 230	VHF Channels 6 to 12
IV	526 - 582	UHF Channels 28 to 35
V	582 - 820	UHF Channels 36 to 69

Refer to Appendix 1 for more detailed information on the Australian television broadcasting services bands in particular channel numbers, frequency limits and other uses.

PROPAGATION OF RADIO WAVES

FIELD STRENGTH PREDICTION MODELS

All propagation calculations are subject to some degree of uncertainty, because of the simplifications that are made and the limited accuracy of topographic and other data. As a basis for determining the Digital Channel Plan, Recommendation ITU-R P.370-7 may be used to predict the field strength values for coverage and interference calculations.

The *Interim Australian Broadcasting Planning Handbook (The Analog Handbook)* also details propagation mechanisms and models that may be suitable for VHF/UHF digital broadcasting predictions.

Other more refined field strength prediction methods and models, in particular the ABA's modified BBC prediction software, the Canadian CRC-COV prediction software package, and the Mapinfo Decibel Planner, are currently being assessed by various broadcasting bodies for suitability in Australian conditions. The BBC prediction model, CRC-COV package and Decibel Planner may be more appropriate for detailed interference and coverage planning.

In addition to the prediction models, the existing analog channel arrangements and structures give an empirical understanding of actual propagation from existing sites.

RECEPTION

NOTIONAL RECEIVING INSTALLATION

The Handbook is based on the assumption that the receiver population, the viewers' receiving installations, will have certain characteristics. The characteristics of the receiver are described throughout the handbook as the 'notional receiving installation', specified in Appendix 2.

The field strengths of the various wanted and unwanted signals are considered to produce voltages at the receiver terminals which depend on the polarisation and directivity discrimination of the receiving antenna system. Polarisation and directivity discrimination of a typical antenna system are discussed in later sections.

COVERAGE CRITERIA (AVAILABILITY)

The coverage area of a transmitter is the area in which a specified standard of reception can be obtained with a notional receiving installation at a percentage of locations. The field strengths which are considered to provide adequate digital reception in the absence of interference from other sources, are listed in Table 1. The field strengths for urban, suburban and rural areas allow for the normal generation of electrical interference by domestic and industrial equipment, and for random variations in level with location.

For planning purposes it may be assumed that:

An **urban** area refers to a population centre exceeding 20,000 people, with buildings predominantly more than two stories high. A **suburban** area refers to a significant area occupied predominantly by single or two storey dwellings with a population exceeding 2,000 people. A **rural** area refers to towns with population clusters exceeding 200 people which, because of flat terrain, limited extent and lower level of man-made clutter, can generally be expected to have more uniform field strengths.

Planners may propose other classifications if they consider that special circumstances apply to a particular town or city. Such circumstances could include a particular development, or high levels of electrical noise.

Within the licence (coverage) area of a station, its signals will be protected from significant interference from other services provided its field strength equals or exceeds the values given in Table 1. Outside the specified licence (coverage) area no protection against interference will be provided.

Table 1 Minimum Field Strength Requirements for Digital Television Reception

Parameters	***Minimum Population***	***Band III*** (dBµV/m)	***Band IV*** (dBµV/m)	***Band V*** (dBµV/m)
Urban (95% locations)	20,000	48	54	58
Suburban (80% locations)	2,000	44	50	54
Rural (70% locations)	200	42	48	52

Note: The levels given for urban, suburban and rural requirements do not take account of all environmental factors, and specific comment is requested.

For **urban** populated areas of Australia, the coverage area of a transmitter is the area in which a specified standard of **reception** can be obtained with a notional receiving system at **95%** of locations.

For **suburban** populated areas of Australia, the coverage area of a transmitter is the area in which a specified standard of **reception** can be obtained with a notional receiving system at **80%** of locations

For **rural** populated areas of Australia, the coverage area of a transmitter is the area in which a specified standard of **reception** can be obtained with a notional receiving system at **70%** of locations.

It is acknowledged that over relatively short distances, from 0 to 60 km, the variation in field strength levels for 99% time reliability compared to 50% time is negligible. For distances greater than 60 km field strength variations for 99% time reliability, compared to 50% time, increase with distance. Allowances for time variability are pending further investigation and verification. Until resolved, the coverage criteria specified in Table 1 will be considered for the purpose of developing the Digital Channel Plans.

Those residents with marginal digital reception have scope to improve their reception with a receiving system whose performance exceeds the minimum notional receiving system requirements specified in Appendix 2.

MEASUREMENT HEIGHT / FIXED ANTENNA RECEPTION

As field strength generally increases with height above ground level of the receiving antenna, it is necessary to adopt a standard height. All field strength predictions and measurements are based on a fixed external receiving antenna 10 metres above ground level. This is considered to be a standard reference height in accordance with Recommendation ITU-R P.370. This height is also assumed to be typical of a receiving installation near the edge of the licence (coverage) area.

Several measurements should be made and the median derived to minimise the effect of local disturbances.

For fixed antenna reception the Ricean propagation channel figures have been adopted.

MAXIMUM FIELD STRENGTH BEYOND THE LICENCE AREA

Unless otherwise specified the median field strength of a transmission in any rural town (consisting of 200 people or more) beyond the licence area boundary, shall not exceed the corresponding field strength figure set out in Table 1, measured at a height of 10 metres above ground.

TRANSMISSION

Planning decisions bring with them national, commercial and political viewpoints, environmental and financial considerations, together with the concerns of the general public (the viewer). Planning decisions must balance the public interest against technical factors with emphasis placed on efficient and effective allocation of channels to meet market and social needs. In general:

> *"Most homes already have a domestic receiving antenna which is both frequency selective and orientated with a particular direction and polarisation. In order to maximise the commercial attraction of digital transmissions, it is desirable that they should be easily receivable and this means that an existing antenna system should also be useable to receive the digital services."*
>
> *"In addition to using the same transmitter sites, for maximum viewer and broadcaster convenience it is desirable that, where practical, the channels used for new digital services should be close to those used for existing analog services and the same antenna and polarisation should be used"*. European Broadcasting Union Publication, July 1997

The consideration of siting, transmission or radiated power and antenna radiation pattern is an iterative process that depends on a number of factors.

RADIATED SIGNAL CHARACTERISTICS (EMISSION STANDARDS)

Radiated signal characteristics of a transmitter used for the purpose of digital terrestrial television broadcasting must comply with the *Emission Standard for the Australian Digital Terrestrial Television Services,* which are to be determined by Standards Australia. If the Australian industry adopts standards which are different from those defined in ETS 300-744 (March 1997), the protection ratios specified in Appendix 3 may need to be reviewed.

It is generally expected that digital television transmitters will be co-sited with existing analog television transmitters and, as far as possible, will use the same polarisation, no frequency offsets and similar ERP levels. On this basis, spectrum masks for digital and analog television transmitters can be derived on the basis of known interference protection ratios described in Appendix 3. Spectrum masks will also need to be considered for emissions outside the broadcasting services bands.

MAXIMUM EXPOSURE LEVELS

Licensees are advised to take note of the requirements prescribed in *Australian Standard AS 2772, Radiofrequency Radiation, Maximum Exposure Levels - 100 kHz to 300 GHz* in relation to all emissions from broadcasting transmitting facilities.

The Australian Standard presently under consideration to form the basis of a mandatory standard is AS/NZS 2772.1

MODULATION

There is a legislative requirement that commercial television broadcasters must provide a certain amount of High Definition Television (HDTV) programming format. National broadcasters have the option to provide either HDTV or Standard Definition Television (SDTV) programming formats. It is not clear which modulation formats are to be used by datacasters; however, it must be DVB-T compliant to be compatible with the commercial/national digital broadcasting transmissions.

For the purpose of planning the Digital Channel Plan, it is assumed for coverage and interference protection ratio assessments that a carrier/noise ratio of 20 dB (producing a bit rate of approximately 20 Mbit/s) is used.

For the reference modulation defined in Table 2, the DVB-T system has a theoretical carrier to noise figure of approximately 17dB in a Ricean channel. Practical implementations of this in modems have shown that a 2dB implementation factor is required. For use through a RF transmission system, an additional 1dB C/N degradation should be allowed for. Therefore, for planning purposes, the reference modulation C/N requirement is assumed to be 20dB. For the reference modulation defined in Table 2, the DVB-T system has a carrier to noise ratio of approximately 17 dB. An implementation factor of 3 dB has been added for planning purposes.

Table 2 DVB-T Reference Modulation

ITU-Mode	*Modulation*	*Code Rate*	*C/N*	*Bit Rate*	*Guard Interval*
M3	***64-QAM***	2/3	20 dB	≈20 Mbit/s	1/8

DVB offers flexibility in the use of various non-hierarchical transmissions, by allowing changes in the modulation, code rate and guard interval to accommodate different broadcasting requirements. To accommodate HDTV it has been assumed the reference modulation listed above in Table 2 will be employed, however the broadcaster has the option of using other modulation schemes to improve coverage or data capacity as outlined in Appendix 4.

CARRIERS / GUARD INTERVAL

The DVB transmission allows for the use of either 1705 carriers (known as '2k'), or 6817 carriers ('8k'). The '8k' system is compatible with the '2k' system. Standards Australia is in the process of recommending a 2k/8k compliant standard for television receivers.

Based on current evidence, it is assumed that the number of carriers does not have any effect on the protection ratios and therefore is not considered in developing the Digital Channel Plan. However, it is recognised that the number of carriers and guard interval will determine the transmission capacity, the ruggedness of the system, and the ability to implement single frequency networks.

The choice between a 2k and 8k modulation scheme does not affect the protection ratios outlined in Appendix 3.

CHANNEL OFFSETS

The use of frequency offsets as a means of reducing protection ratios is well known in analog television planning and implementation. A similar requirement may exist for digital television interference in order to improve compatibility with an analog television service on an adjacent channel. In addition, implementation issues such as combiner constraints may also limit the broadcaster's ability to use the same transmission antenna for an adjacent channel digital service, which may be overcome with a frequency offset.

For the purpose of developing the Digital Channel Plan, channel offsets will not normally be considered. However, on a case-by-case basis, the ABA is willing to consider frequency offsets to encourage sharing of broadcasting facilities and reduce the likelihood of interference to analog services, providing the use of frequency offsets would not be detrimental to channel allocations in the same or adjacent market.

EFFECTIVE RADIATED POWER (ERP)

Effective radiated power, in a given direction, is the product of the power supplied to the antenna system and its gain relative to a half-wave dipole in that given direction.

TRANSMIT ANTENNA RADIATION PATTERNS

The design of an antenna may provide for either omnidirectional or directional horizontal radiation patterns.

Directional antennas may be useful in providing a required ERP in given directions for coverage purposes, while at the same time avoiding interference to other services by restricting the ERP in the direction of those services. In other cases, directional antennas may conserve transmitter power with a consequent cost saving and provide a better engineering planning solution.

In addition to the selection of the horizontal pattern in azimuth, the amount of beam tilt and null fill may also be controlled to improve coverage within the licence (coverage) area.

BEAM TILT

The addition of a beam tilt shall be specified for an antenna having a relatively narrow vertical radiation pattern to aim the axis of the main vertical beam for optimum coverage of the designated licence (coverage) area. The beam tilt angle specified may be varied somewhat to suit the width of the vertical radiation pattern and the expected tower stability.

For the purpose of determining the Digital Channel Plan, beam tilt is not a consideration. Beam tilt can be considered by broadcasters during detailed implementation planning.

NULL FILL

Null fill is necessary if reception is required at depression angles where a null or minimum exists in the vertical radiation pattern of the transmission antenna, generally for areas close to the transmitter. Alternatively it may be necessary to limit the radiation at high depression angles to avoid high field strengths very close to the transmitter.

For the purpose of determining the Digital Channel Plan, null fill is not a consideration. Null fill can be considered by broadcasters during detailed implementation planning.

LOCATION OF TRANSMIT SITE

In determining the location of a transmit site, a licensee should refer to the *Standards Australia* draft document AS/NZS3516.2-1998, *Siting of radiocommunication facilities, Part 2: Guidelines for fixed, mobile and broadcasting services operating at frequencies above 30 MHz*. In addition the following advice should be noted:

Transmitter sites shall be chosen so that field strengths consistent with Table 1 are provided in the licence (coverage) area.

The sites and the effective radiated power proposed shall be such that the maximum field strength provisions prevent receiver overload and also comply with maximum exposure levels. (Refer to pages 8 and 14 of this document).

Sites shall be selected which are not a hazard to air navigation and which have a minimum intrusion on the environment. The broadcaster is responsible for obtaining all necessary approvals from federal, state and local government planning authorities.

Within a licence (coverage) area, as far as possible, a new television transmitter should co-site with existing television services. Sharing of facilities (tower, antenna etc) is preferred where the services are intended to serve the same region. Where stations are co-sited, but do not share antennas and/or support structures, the spacing, orientation and height of the support structures and the mounting of the transmitting antenna shall be such as to prevent reflections, or re-radiation.

A transmitter shall be located so that, for a particular broadcasting band, viewers within population centres of the licence area of the service shall receive all television services licensed to serve that area from a single direction.

POLARISATION

Television services may have either horizontal or vertical polarisation. In the absence of other planning considerations, it is preferred that main stations have horizontal polarisation.

The use of mixed (orthogonal) polarisation is not being considered in Australia for digital television.

INTERFERENCE

INTERFERENCE CRITERIA

Based on interference criteria recommendations cited by the European Broadcasting Union (EBU), in the case of a wanted digital service, the interfering field strength prediction at 50% of locations for 1% of the time (50/1) of the unwanted services is to be chosen.

In the case of a wanted analog service, the interfering field strength prediction at 50% of locations for 10% of the time (50/10) of the unwanted services is to be chosen. (This is consistent with the current analog arrangements in Australia.)

Allowances for time variability is pending further investigation and verification. Until resolved, those interference criteria specified above will be considered for the purposes of developing the Digital Channel Plan.

TROPOSPHERIC/CONTINUOUS INTERFERENCE (FADING RANGE)

Differing protection ratios for continuous and tropospheric interference are specified. Where a source of potential interference does not vary markedly with time it is said to be continuous. In circumstances where the potential interfering signal is not continuous in nature, whether brought about as result of long distance or some other intermittent source of interference, it is said to be tropospheric. This is an attempt to take into account the subjective annoyance of interference which, on one hand is present the whole time and, on the other hand, only becomes apparent occasionally. For small percentages of the time a higher level of interference can be tolerated than would be acceptable on a continuous basis.

An acceptable method of deciding whether the interference is continuous or tropospheric is based on the ‘fading range’ of the interfering signal. The fading range may be taken to be the difference in field strength levels between the estimated field strength levels expected to occur at 50% of locations for 50% of the time compared to 50% of locations for 1% of the time.

When the fading range of the unwanted signal is less than 10 dB over a given path, protection ratios for continuous interference should be used. When the fading range of the unwanted signal is greater than or equal to 10 dB over a given path, protection ratios for tropospheric interference should be used.

PROTECTION RATIOS (PR)

When considering the potential to cause interference to reception of an existing broadcasting service (or conversely, when considering the potential for an existing broadcasting service to cause interference to reception of a proposed new service) specific ratios of wanted to unwanted signal levels are nominated as suitable 'protection ratios' to be applied under various circumstances.

Refer to Appendix 3 for a list of Protection Ratios that need to be considered in determining the Digital Channel Plans.

The Communications Laboratory of the then Department of Communications and the Arts conducted preliminary protection ratio measurements relevant to digital television, the results of which have been incorporated in the ITU draft recommendation referred to in Appendix 3. These measurements were conducted using a limited sample of prototype transmission and receiving equipment. The required protection ratio varies with the digital modulation scheme employed. The measurement of protection ratios is also an empirical process dependant on the sample of equipment tested. Consequently, the protection ratios defined in the ITU recommendation, and in Appendix 3 of this document, will be refined as the appropriate modulation scheme for Australia is defined and domestic DVB-T receivers are introduced.

Additional measurements are proposed to determine protection ratios for interference to DVB-T from second harmonics of FM broadcast services; local oscillator and image channel interference from DVB-T receivers; consideration of adjacent channel PAL services with typical frequency offsets and DAB-T as introduced in Australia.

INTERMEDIATE FREQUENCY (IF)

The recommended intermediate frequency (as defined by the vision carrier) for the domestic PAL analog television receiver in Australia is nominally 36.875 MHz**,** whereas professional receiving equipment is nominally 38.9 MHz.

The local oscillator signal generated in a domestic television receiver is therefore 36.875 MHz higher in frequency than the vision carrier frequency of the wanted television service. The local oscillator signal may be radiated from the antenna installation causing interference to other receivers.

When planning for analog television, adjacent channels were unusable and the local oscillator and image channels were avoided where possible. For instance, in UHF analog television planning, a three channel (n+3) plan was used to avoid adjacent channel ($n \pm 1$), local oscillator channel ($n \pm 5$) and image channel ($n \pm 10$) interference.

It is expected that Standards Australia will determine the nominal intermediate frequency for the domestic and professional DVB television receivers for Australia. However, for the purpose of developing the Digital Channel Plan, the ABA assumes that the intermediate frequency (as defined by the centre of the channel) for the domestic and professional digital television receiver in Australia will be 36.65 MHz.

The protection ratios for a wanted analog television signal (PAL B) interfered with by an unwanted DVB-T 7 MHz system, suggests that image channel interference is a consideration. This would also suggest that local oscillator interference should also be considered. (refer to Table 10 at Appendix 3).

For the purpose of developing the Digital Channel Plan, the ABA assumes that the allocation of local oscillator and image channels should be avoided where possible. However, given the congestion of television channels within and surrounding metropolitan areas of Australia, the assignment of local oscillator channels will be difficult to avoid.

ANTENNA DISCRIMINATION

For the purposes of determining predicted interference, the antenna discrimination, both in terms of directional discrimination and orthogonal wave discrimination, shall be as defined in *the Interim ABA Broadcasting Planning Handbook.*

INTERFERENCE SUMMATION

The calculation of effective interference level (Eu) in the presence of a number of sources of interference (due to co-channel, adjacent channel or receiver characteristics) is to be performed as follows.

Considering the interference contributions in order of decreasing magnitude, add the squares of the voltages of the individual values of useable field strength (Ea) and extract the sum, excluding those components whose voltages are more than 6 dB below the root sum squared value (expressed in decibels) of the higher components already included.

Note: The root sum squared process may be calculated in decibels using the relationship:

$$Eu = 10 \log \sum 10^{(0.1Ea)}$$

MAXIMUM FIELD STRENGTH TO PREVENT RECEIVER OVERLOAD

The maximum field strength figures discussed below have been extracted from the *ABA's Technical Planning Guidelines* and are only relevant to an average PAL signal level in an area. Until Australia can assess a range of digital receivers, it will be difficult to determine an overload level for a digital television receiving system. Given that the RF input stage is expected to be similar to current analog receivers, for planning purposes the levels listed below may be assumed to be appropriate pending investigation and verification.

> *Within the licence (coverage) area, a transmitter shall be located so that not more than 1 per cent of the total population of the licence area resides in an area which has a field strength greater than 110 dBµV/m. The height of the transmission antenna above ground level may be altered to assist in complying with this guideline.*
>
> *A transmitter must not be sited so that a significant part of the population to be served receives a field strength of more than 120 dBµV/m (1 V/m). One tenth of one per cent (0.1 per cent) of the population, or 100 persons, whichever is less, constitutes a 'significant part'.*

Those residents experiencing receiver overload would need to incorporate an attenuator at the receiver input to limit the signal level at the RF input stage of the digital and/or analog receivers.

INTERFERENCE MANAGEMENT

In accordance with section 110 of the *Radiocommunications Act 1992*, a licensee must ensure that no harmful interference shall be caused to the operation of any licensed radiocommunication station or service. If the operation of the transmitter is causing interference to other licensed services, the licensee is required, at the licensee's own expense, to adjust, or fit devices to, receivers in order to minimise that interference.

Under section 132 of the *Radiocommunications Act 1992* the Australian Communications Authority (formerly the Spectrum Management Agency) may issue class licences. One particular kind of class licence that operates with the broadcasting services broadcasting bands are low interference potential devices (LIPD).

Two particular types of LIPDs currently operating in the television bands are wireless audio transmitters often used with wireless microphones and biomedical telemetry transmitters often used as patient monitors in hospitals.

A LIPD is not afforded protection from interference caused by other services, nor can a LIPD transmit on the same channel as a television channel originating within that licence area.

ELECTROMAGNETIC COMPATIBILITY

Electromagnetic compatibility (EMC) refers to the ability of a transmitter to operate without causing interference to another broadcasting or radiocommunication service. EMC calculations must take into account possible interference occurrences due to intermodulation, harmonic products, local oscillator radiation, co-channel and adjacent channel services.

In general, a digital service that complies with *Emission Standards for the Australian Digital Terrestrial Television Services* (which is expected to be determined by Standards Australia), would be compatible with other broadcasting and radiocommunication services. However, in particular circumstances, a broadcaster may be required to install filters or a more stringent spectrum mask to ensure electromagnetic compatibility.

It is generally expected that digital television transmitters will be co-sited with existing analog television transmitters and, as far as possible, will use the same polarisation, no frequency offsets and similar ERP levels. On this basis spectrum masks for digital and analog television transmitters can be derived on the basis of known interference protection ratios described in Appendix 3. Spectrum masks will also need to be considered for emissions outside the broadcasting services bands. Refer to the ETS Standard 300-744.

To deal with the problem of Electromagnetic Interference (EMI) the Australian Communications Authority (ACA) has introduced the Electromagnetic Compatibility (EMC) Framework. The purpose of this regulation is to minimise electromagnetic interference between electronic products which may diminish performance or disrupt essential communications.

MISCELLANEOUS

ANCILLARY DEVICES

For the purpose of developing the Digital Channel Plan, the RF signals generated by ancillary devices (such as VCR's, video cameras, Subscription TV set-top units and electronic games) have not been taken into account.

Existing manufacturers have generally adopted the use of the Australian television broadcasting service bands RF output, with at least a two channel selection options to avoid interference to/from existing analog broadcasting services in the area. With the introduction of digital television, on the adjacent analog television channels, ancillary devices will need a larger channel selection range than previously required.

Standards Australia are presently considering a standard to form the basis of mandatory requirements for consumer television interference (DR97566). The standard addresses the parameters and requirements for interfacing of ancillary equipment with television receivers, to ensure compatibility and acceptable operational performance. The preferred frequencies for locally generated signals (RF output) being considered extends from 470 to 862 MHz (UHF Channel 25 to 75) which extends beyond the broadcasting services bands.

It is also worth noting that VHF television channels 0 and 1, that are presently being used by many ancillary devices, are not being considered for digital television broadcasting.

TELEVISION BROADCASTING SERVICE BANDS

Table 3 Australian Television Broadcasting Bands - Television Channel Numbers and Frequency Limits (in MHz)

VHF		*UHF*			
BAND I		**BAND IV**		47	659-666 MHz
0	45- 52 MHz	28	526-533 MHz	48	666-673 MHz
1	56-63 MHz	29	533-540 MHz	49	673-680 MHz
2	63-70 MHz	30	540-547 MHz	50	680-687 MHz
		31	547-554 MHz	51	687-694 MHz
		32	554-561 MHz	52	694-701 MHz
BAND II [2]		33	561-568 MHz	53	701-708 MHz
3	85-92 MHz	34	568-575 MHz	54	708-715 MHz
4	94-101 MHz	35	575-582 MHz	55	715-722 MHz
5	101-108 MHz			56	722-729 MHz
				57	729-736 MHz
		BAND V		58	736-743 MHz
BAND III		36	582-589 MHz	59	743-750 MHz
5A[3]	137-144 MHz	37	589-596 MHz	60	750-757 MHz
6	174-181 MHz	38	596-603 MHz	61	757-764 MHz
7	181-188 MHz	39	603-610 MHz	62	764-771 MHz
8	188-195 MHz	40	610-617 MHz	63	771-778 MHz
9	195-202 MHz	41	617-624 MHz	64	778-785 MHz
9A	202-209 MHz	42	624-631 MHz	65	785-792 MHz
10 [4]	209-216 MHz	43	631-638 MHz	66	792-799 MHz
11 [4]	216-223 MHz	44	638-645 MHz	67	799-806 MHz
12	223-230 MHz	45	645-652 MHz	68	806-813 MHz
		46	652-659 MHz	69	813-820 MHz

Note 1. The dial markings on some older UHF tuners show only approximate channel numbers

Note 2. No new assignments will be made to television services in Band II

Note 3. No new assignments will be made to television services on channel 5A

Note 4. Existing services on channels 10 and 11 are currently assigned a 1 MHz negative off-set. The current channel 10 occupies 208-215 MHz and channel 11 currently occupies 215-222 MHz. New services on channels 10 and 11 will be assigned to channel 10 (209-216 MHz) and channel 11 (216-223 MHz)

TELEVISION BROADCASTING SERVICES BANDS

This part of the handbook applies to all licensees or any person so authorised who intends to undertake any planning work relating to digital television broadcasting services occupying any of the broadcasting services bands currently used by analog television services.

TV Transmission Band	*Frequency Range (MHz)*	*Channels*	*Note*
I	45 - 70	VHF Channels 0, 1 & 2	1
II	85 - 108	VHF Channels 3, 4 & 5	1
III	137 - 144	VHF Channel 5A	2
	174 - 230	VHF Channels 6 to 12	3
	230 - 240		3
IV	520 - 526	UHF Channel 27	4
	526 - 582	UHF Channels 28 to 35	
V	582 - 820	UHF Channels 36 to 69	

Note 1. Television Band I (Channels 0, 1 & 2) and Band II (Channels 3, 4 & 5) are not being considered for the introduction or ongoing transmission of digital television services.

Note 2. VHF Channel 5A is currently within the Broadcasting Services Bands (BSB) and has been recommended for clearance by the ABA and ACA to allow for the introduction of Low Earth Orbiting Satellites (LEOS).

In accordance with the *Australian Radiofrequency Spectrum Plan January 1997*, the allocation to the broadcasting service in the band 137 to 144 MHz will remain until existing stations of that service are transferred to other broadcasting bands. No new assignments will be made to broadcasting services in this band.

Note 3. The Digital Radio Technical Working Group is considering the use of VHF Band III spectrum for the introduction of digital terrestrial radio. DRB receivers have a tuneable range from 174 MHz to 240 MHz. Developments within Europe are considering the use of the Band III frequency range to 240 MHz.

In accordance with the *Australian Radiofrequency Spectrum Plan January 1997*, the allocation to the band 174 to 230 MHz is reserved for Broadcasting Services. The primary use of this band in Australia has been for analog television broadcasting, planning both digital television and radio within this band would require co-ordination with the DRB Technical Working Group.

In accordance with the *Australian Radiofrequency Spectrum Plan January 1997*, the allocation of the band 230 to 240 MHz is reserved for Defence purposes.

Note 4. UHF Television Channel 27 has a bandwidth of 6 MHz and therefore is not currently being considered for broadcasting services.

Note 5. The ABA and ACA area considering spectrum that may be handed back for other uses resulting from increased spectral efficiency with Digital Television.

On the 12 October 1998, the ACA released a draft new Australian Radiofrequency Spectrum Plan and invited public comment on it, in accordance with the requirements of Section 33 of the Radiocommunications Act 1992. The draft Plan is intended to replace the January 1997 Plan.

NOTIONAL RECEIVER

The parameters shown in the table below were calculated from formula extracted from the *European Broadcasting Union (EBU) Report July 1997.*

Table 4 DVB-T 7 MHz reference receiver (notional receiver)

Parameters	*Band III*	*Band IV*	*Band V*	*Note*
Frequency	230 MHz	582 MHz	820 MHz	1
Equivalent noise band width	$6.7*10^6$ Hz	$6.7*10^6$ Hz	$6.7*10^6$ Hz	
Receiver noise figure	6 dB	7 dB	8 dB	2
Receiver noise input power	-129.7dBW	-128.7dBW	-127.7dBW	
Minimum required C/N	20 dB	20 dB	20 dB	3
Minimum receiver signal input power	-109.7 dBW	-108.7 dBW	-107.7 dBW	
Minimum equivalent receiver input voltage, 75*W *nominal	29 dBµV	30 dBµV	31 dBµV	
Feeder loss RG59 @ 15 metres	3 dB	4 dB	5 dB	4
Antenna gain relative to half wave dipole	8 dB	11 dB	12 dB	5
Effective antenna aperture	1.5 dB	-3.6 dB	-5.6 dB	
Antenna Height	10 m	10 m	10 m	
Minimum power flux density	-108.2 dBW/m^2	-101.1 dBW/m^2	-97.1 dBW/m^2	
Minimum field strength	37.6 dBµV/m	44.6 dBµV/m	48.6 dBµV/m	
Allowance for man made noise	1 dB	0 dB	0 dB	

Note 1. The frequency (and subsequent figures) have been changed to reflect Australian upper frequency band limits.

Note 2. As a guide, for planning purposes the values listed may be assumed for receiver noise figure pending investigation and verification. Noise figures for UHF bands derived from BBC Seminar on DVB-T reception and receiver performance.

Note 3. The DVB-T system has a carrier to noise figure of approximately 17 dB, an implementation factor of 3 dB has been added for planning purposes.

Note 4. Figures derived from the *Interim Australian Broadcasting Planning Handbook*

Note 5. Figures derived from the *Interim Australian Broadcasting Planning Handbook*

Reception characteristics of a notional digital television receiver must comply with those to be determined by Standards Australia. If Australia adopts a standard less stringent than defined above, the coverage criteria and service reliability will need to be readdressed.

Table 5 DVB-T 7 MHz reference receiver (notional receiver) with location probability

Location Probability: 70%	***Band III***	***Band IV***	***Band V***	***Note***
Location correction factor	3 dB	3 dB	3 dB	
Time correction factor	0	0	0	1
Minimum median power flux density @ 10 metres 50% time and 50% of locations	-104.2 dBW/m^2	-98.1 dBW/m^2	-94.1 dBW/m^2	
Minimum equivalent field strength @ 10 metres 50% time and 50% of locations	42 dBµV/m	48 dBµV/m	52 dBµV/m	

Location Probability: 80%	***Band III***	***Band IV***	***Band V***	***Note***
Location correction factor	5 dB	5 dB	5 dB	
Time correction factor	0	0	0	1
Minimum median power flux density @ 10 metres 50% time and 50% of locations	-102.2 dBW/m^2	-96.1 dBW/m^2	-92.1 dBW/m^2	
Minimum equivalent field strength @ 10 metres 50% time and 50% of locations	44 dBµV/m	50 dBµV/m	54 dBµV/m	

Location Probability: 95%	***Band III***	***Band IV***	***Band V***	***Note***
Location correction factor	9 dB	9 dB	9 dB	
Time correction factor	0	0	0	1
Minimum median power flux density @ 10 metres 50% time and 50% of locations	-98.2 dBW/m^2	-92.1 dBW/m^2	-88.1 dBW/m^2	
Minimum equivalent field strength @ 10 metres 50% time and 50% of locations	48 dBµV/m	54 dBµV/m	58 dBµV/m	

Note 1. It is acknowledged that over relatively short distances, from 0 to 60 km, the variation in field strength levels for 99% time reliability compared to 50% time is negligible. For distances greater than 60 km field strength variations for 99% time reliability, compared to 50% time, increase with distance. Allowances for time variability are pending further investigation and verification. Until resolved, the coverage criteria specified in Table 1 will be considered for the purpose of developing the Digital Channel Plans.

PROTECTION RATIOS

The protection ratios shown in the following tables have been extracted from the ITU Document 11/22 E (14 April 1998), Draft revision of recommendation ITU-R BT.1368 *entitled Planning Criteria for Digital Terrestrial Television Services in the VHF/UHF Bands*. This ITU document represents the most recent information available.

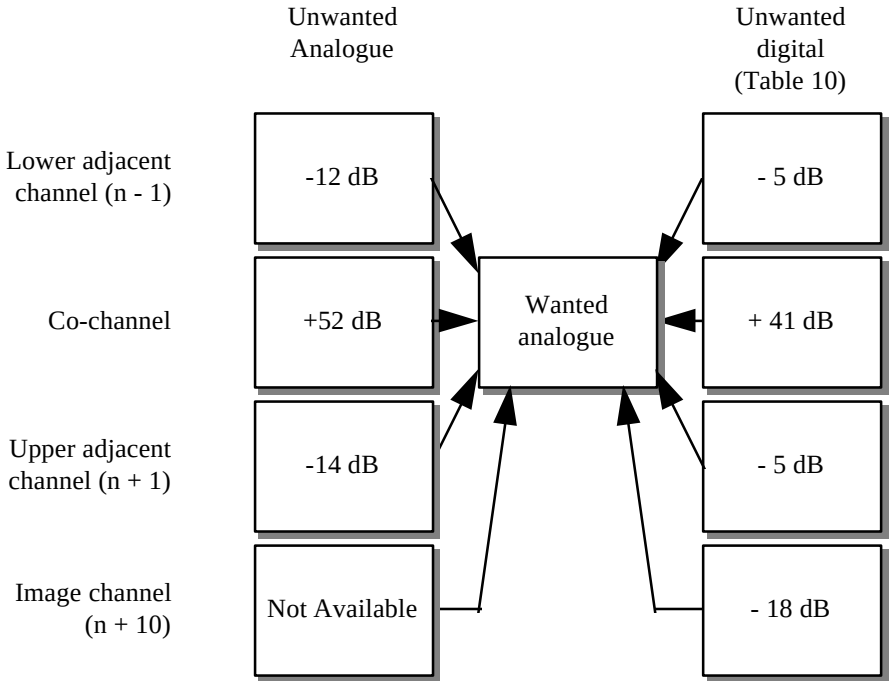


Figure 1 Analog Protection Ratio

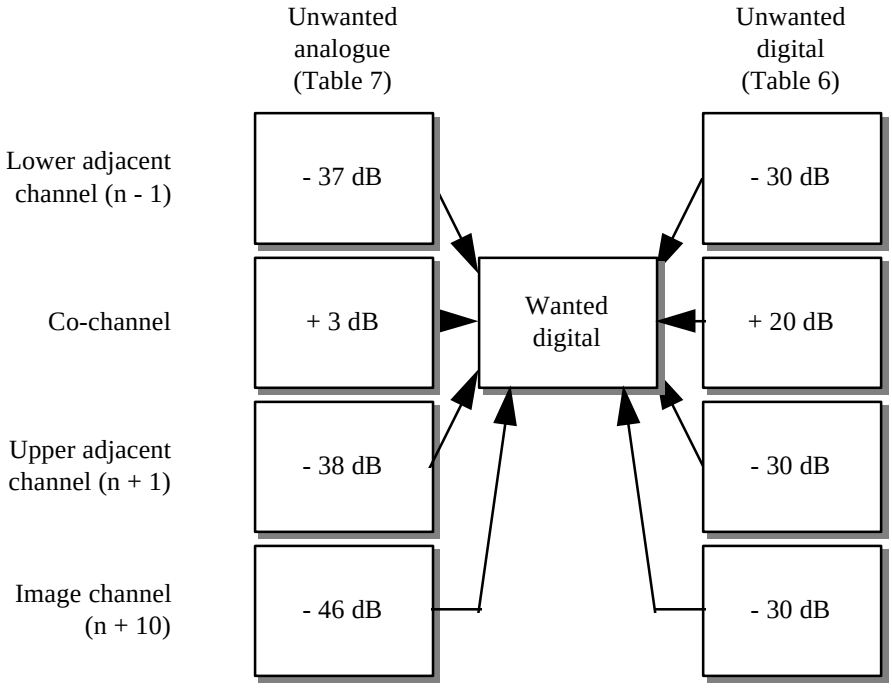


Figure 2 Digital Protection Ratio

Table 6 Protection ratios (dB) for 7 MHz DVB-T interfered with by 7 MHz DVB-T

Parameter	D*f*	*Tropospheric*	*Continuous*	*ITU Table*
Lower Image (n -Y)			-30	Note 1 & 4
Lower LO (n-X)			-30	Note 2 & 3
Lower Adjacent (n-1)	***-7***		-30	Note 1
Co-channel (n)	***0***		+20	Table 6
Upper Adjacent (n + 1)	***+7***		-30	Note 1
Upper LO (n-X)			-30	Note 2 & 3
Upper Image (n -Y)			-30	Note 1 & 4

The frequency difference (D*f*) is the centre frequency of the wanted DVB-T signal minus the centre frequency of the unwanted DVB-T signal in MHz

The Australian situation is typically a dominant incoming signal with lower level delay signals and thermal noise. This will normally be the case with directional receiving antennas at roof level. In the case of a Single Frequency Network (SFN), the delay signals may also come from other transmitter sites. Of the three types of propagation channels used Gaussian, Ricean and Rayleigh, for fixed antenna reception the Ricean channel figures have been adopted.

Note 1. For adjacent and image channel interference a protection ratio of -30 dB is assumed to be appropriate. This assumption is based on only one measurement, further studies are required

Note 2. For overlapping channel, in absence of measurement information the protection ratio should be extrapolated from the co-channel ratio figure as follows.

$PR = 20 + 10*\text{Log}_{10}(\text{Overlap (MHz)} / 7 \text{ (MHz)})$

PR= -30 dB should be used when the above formula gives PR < -30 dB.

Note 3. Where X is the number of channels between the wanted channel and the channel affected by Local Oscillator (LO) interference. In the case of current Australian analog planning X=5.

Note 4. Where Y is the number of channels between the wanted channel and the channel affected by image interference. In the case of current Australian analog planning Y=10.

Table 7 Co-channel protection ratios (dB) for 7 MHz DVB-T interfered with by overlapping PAL B signal including sound

Parameter	D*f*	*Tropospheric*	*Continuous*	*ITU Table*
Lower Adjacent (n-1)	***-9.25***		-35/-37	Table 10/16
	-8.75		-14	Table 16
	-8.25		-8	Table 16
	-7.75		-4	Table 16
	-6.25		-2	Table 16
	-3.45		+1	Table 16
	-3.25		+3	Table 16
Co-channel (n)	***-2.25***		+3	Table 8/16
	-1.25		+3	Table 16
	1.75		+2	Table 16
	2.75		-1	Table 16
	4.25		-29	Table 16
Upper Adjacent (n + 1)	***4.75***		-38/-36	Table 12/16
LO Channel (n + 5)				
Image Channel (n+10)			-46 dB	Table 14

The frequency difference (D*f*) is the vision carrier of the analog television signal minus the centre frequency of the DVB-T signal in MHz

Table 8 Co-channel protection ratios (dB) for 7 MHz DVB-T interfered with by CW or a FM carrier

Parameter	D*f*	*Tropospheric*	*Continuous*	*ITU Table*
Frequency Difference	***-10.5***		-38	Table 18
	-4		-33	Table 18
	-3.4		-3	Table 18
	0		-3	Table 18
	3.4		-3	Table 18
	4		-33	Table 18
	10.5		-38	Table 18

The frequency difference (D*f*) is the FM carrier frequency minus the centre frequency of the DVB-T signal in MHz

Table 9 Protection ratios (dB) for 7 MHz DVB-T interfered with by T-DAB

Parameter	D*f*	*Tropospheric*	*Continuous*	*ITU Table*
Frequency Difference	-4.5		-30	Table 21
	-3.7		-6	Table 21
	-3.5		-5	Table 21
	-2.5		+28	Table 21
	0		+29	Table 21
	2.5		+28	Table 21
	3.5		-5	Table 21
	3.7		-6	Table 21
	4.5		-30	Table 21
The frequency difference (D*f*) is the centre frequency of T-DAB minus the centre frequency of the DVB-T signal in MHz				

Table 10 Protection ratio (dB) for analog television (PAL B) interfered with by an unwanted 7 MHz DVB-T system

Parameter	D*f*	*Tropospheric*	*Continuous*	*ITU Table*
	-7.75	-16	-11	Table 32
Lower Adjacent (n-1)	***-4.75***	-9	-5	Table 26/32
	-4.25	-4	+3	Table 32
	-3.75	13	+20	Table 32
	-3.15	23	+30	Table 32
	-2.75	30	+37	Table 32
	-1.75	34	+41	Table 32
	-0.75	35	+41	Table 32
Co-channel (n)	***2.25***	35	+41	Table 24/32
	4.25	35	+41	Table 32
	5.25	31	+38	Table 32
	6.25	26	+33	Table 32
	7.25	21	+30	Table 32
	8.25	4	+9	Table 32
Upper Adjacent (n + 1)	***9.25***	-9	-5	Table 28/32
	12.25	-9	-5	Table 32
Image Channel (n+10)		-22	-18	Table 31
The frequency difference (D*f*) is the centre of the unwanted DVB-T minus the vision carrier frequency of the wanted analog television in MHz				

Table 11 Protection ratios (dB) for wanted FM sound interfered with by an overlapping 7 MHz DVB-T

Parameter	D*f*	*Tropospheric*	*Continuous*	*Chester Report*	*ITU Table*
FM Sound	***-5***	0	+9	Table A1.35	
	-3.7	0	+9	Table A1.35	
	-3.5	5	+14	Table A1.35	
	-3	6	+16	Table A1.35	
	0	6	+16	Table A1.35	Table 34
	3	5	+15	Table A1.35	
	3.5	3	+12	Table A1.35	
	3.7	-17	-11	Table A1.35	
	> 4.0	< -32	< -27	Table A1.35	
The frequency difference (D*f*) is the centre of the digital radio carrier frequency minus the centre frequency of the DVB-T signal in MHz					

Table 12 Protection ratios (dB) for T-DAB interfered with by 7 MHz DVB-T

Parameter	D*f*	*Tropospheric*	*Continuous*	*Chester Report*	*ITU Table*
Terrestrial DAB	-4.5		-49	Table A1.39	
	-3.7		0	Table A1.39	
	-3.5		+1	Table A1.39	
	-2.5		+2	Table A1.39	
	0		+2	Table A1.39	
	2.5		+2	Table A1.39	
	3.5		+1	Table A1.39	
	3.7		+0	Table A1.39	
	4.5		-49	Table A1.39	
The frequency difference (D*f*) is the centre of DVB-T minus the centre frequency of T-DAB in MHz					

MODULATION SCHEMES

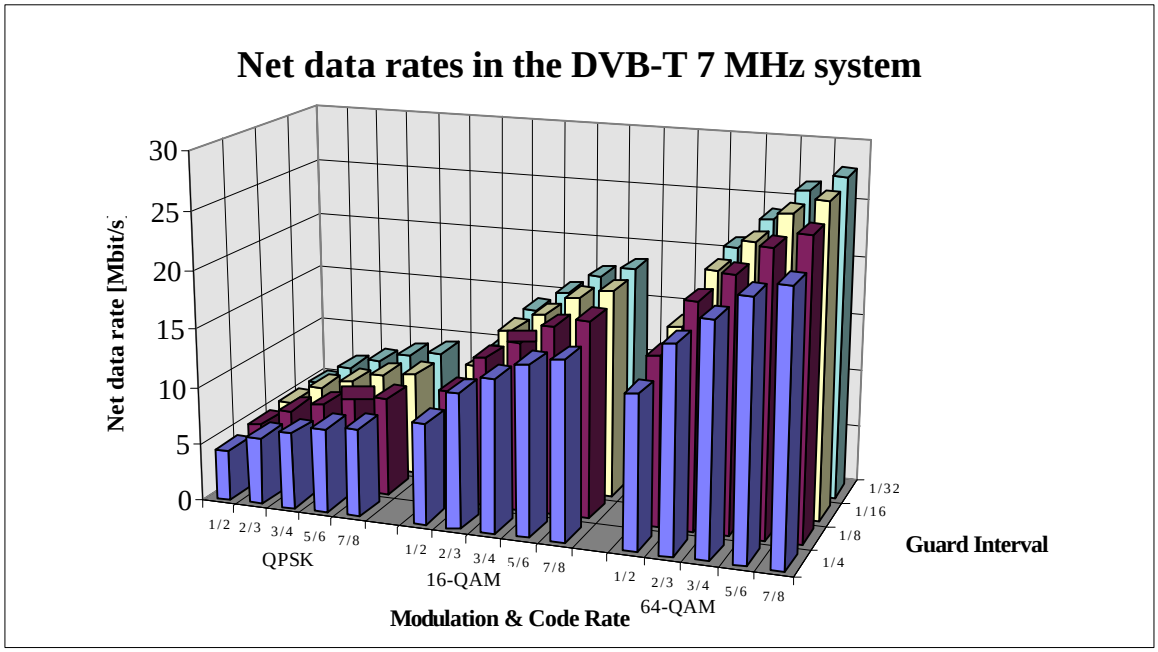
Table 13 Net data rates in the DVB-T 7 MHz system (in Mbits/s)

Modulation	Code Rate	Guard Interval			
5.90625 Ms/s		**1/4**	**1/8**	**1/16**	**1/32**
QPSK	**1/2**	4.354	4.838	5.123	5.278
	2/3	5.806	6.451	6.830	7.037
	3/4	6.532	7.257	7.684	7.917
	5/6	7.257	8.064	8.538	8.797
	7/8	7.62	8.467	8.965	9.237
16-QAM	**1/2**	8.709	9.676	10.246	10.556
	2/3	11.612	12.902	13.661	14.075
	3/4	13.063	14.515	15.369	15.834
	5/6	14.515	16.127	17.076	17.594
	7/8	15.240	16.934	17.930	18.473
64-QAM	**1/2**	13.063	14.515	15.369	15.834
	2/3	17.418	19.353	20.491	21.112
	3/4	19.595	21.772	23.053	23.751
	5/6	21.772	24.191	25.614	26.390
	7/8	22.861	25.401	26.895	27.710

Guard Time: (msec)	**"2K"**	64	32	16	8
	"8K"	256	128	64	32

The net bit rates increase with higher code rates of the inner error protection, short guard intervals and higher stages of sub carrier modulation. The higher data rate can only be achieved by decreasing the amount of error protection.

Figure 3



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