

Code of Practice

Installation of Terrestrial and Satellite TV Reception Systems (MDU & Commercial)

CAI COP 1: Ed 5 iss2 November 2021



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Code of Practice

Installation of Terrestrial and Satellite TV Reception Systems (MDU & Commercial)

CAI COP 1: Ed 5 iss2 November 2021

This document has been prepared by the Technical Committee of the Confederation of Aerial Industries Ltd (CAI).
AIMS OF CAI

- To raise standards within the Industry.
- To represent its Members to Government, Local Authorities, National Bodies etc.
- To unite the Industry on its common aims.
- To keep abreast of technological change.
- To promote the membership to its prospective customers.

SOME SERVICES AVAILABLE

- Information Service.
- Training Courses.
- Technical Advice.

CAI actively encourages all companies in the Industry to further its aims and to use the services available.
Full details and application forms to join CAI are available from the Secretary.

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This is issue 2 of the fifth update and contains the following minor changes

Revision to the MER limits with extra explanations.
Improved quality of text for some of the tables and link budget.

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1 INTRODUCTION AND SCOPE

1.1 The Code

This Code of Practice is issued by the Confederation of Aerial Industries Ltd (CAI) to all of its Members registered as systems installers. The observance of this Code is mandatory for all Members who undertake installation and/or maintenance of signal distribution systems independent of the system type. Any deviation from this Code shall only be permitted as a matter of practicality in a particular situation and shall be advised to the Client in writing prior to commissioning of the system. Responsibility for the implementation of this Code rests solely with the Member. CAI assessment officers examine Members' workmanship on any inspection visit as well as in the case of a dispute.

1.2 Scope and Purpose

This Code of Practice is applicable to cable networks intended for television signals, sound signals and interactive services operating between about 5 MHz and 6200 MHz.

This Code of Practice should be read in conjunction with all other CAI Codes (see Annex I) and is based upon British Standards relevant to the industry (also see Annex I for a list of those Standards). The Code covers antennas for the reception of FM radio signals in Band II, Digital Audio Broadcasting in Band III, Digital Terrestrial Television (DTT) signals in Bands IV and V and Digital Satellite Television (DST) at both fundamental and Intermediate Frequency (IF). In addition, it also covers their mechanical supporting structures, reception and distribution equipment, IRS, MATV and SMATV systems located anywhere in the United Kingdom.

- (a) In respect of satellite transmissions, this Code applies to reception in the 3.7 GHz to 40 GHz range.
- (b) In respect of signal distribution by coaxial cable, this Code applies to carrier signals in the range 87.5 MHz to 3850 MHz.
- (c) In respect of signal distribution by fibre optic cable, this Code applies to carrier signals in the range 87.5 MHz to 6200 MHz.

This Code also applies to any locally generated programming to be carried on these distribution networks insofar as it uses carrier frequencies in the range specified above-

This Code also covers the use and installation of telephony and data cables where they form an integral part of an antenna installation.

See Annex I for a list of standards

1.3 Health and Safety

A prerequisite to achieving a high standard of safety is that all those engaged on installation work shall be fully conversant with safety procedures, precautions and use of Personal Protective Equipment (PPE). They shall also be fully competent to perform the tasks required of them and be able to recognise potentially hazardous working conditions. These procedures are detailed in CAI publications:-

Health & Safety in the Aerial & Satellite Industries

Guidelines for Safe Operating Procedures

Code of Practice 3 - Electrical Safety Requirements for Signal Reception Systems (excluding CATV)

It is recommended that before the installation is started or before any work is undertaken on an existing system, a method statement and risk assessment is produced.

Where an existing system is considered unsafe, the Client shall be notified in writing as soon as possible. See Annex F – Dangerous Situation Report.

1.4 Electromagnetic Compatibility

BS EN 50083-2 'Electromagnetic Compatibility of Equipment for Cabled Distribution Systems for Television and Sound Signals' is mandatory for all types of systems covered by this Code. All active equipment shall conform to the EMC requirements and be CE marked.

BS EN 50083-8 + A11 'Electromagnetic Compatibility for Networks' specifies the radiation limits and measurement from cabled distribution systems operating in the frequency range 0.15 MHz to 3.0 GHz.

1.5 Definitions and Glossary of Terms in relation to this document

8PSK	see Modulations.
64QAM	see Modulations.
256QAM	see Modulations.
AM	Amplitude Modulated/Modulation.
Antenna; antennas	Aerial(s) and dishes designed for the reception of Radio Frequency (RF) signals, however constructed.
BCH	Bose Chaudhari-Hacquenghem Cyclic error correcting code.
BER	Bit Error Ratio.
BS	The relevant Standard currently in force as published by the British Standards Institution (BSI) or the harmonized European Standard, BS EN.
CAI	Confederation of Aerial Industries Ltd.
CAI Approved Systems Installer	A member who has one or more engineers who have a qualification in the design, installation and maintenance of systems. (See System Installer)
CATV	Community Antenna Television. A master antenna and distribution system capable of receiving, amplifying and distributing a television signal via a copter or fibre cable to television receivers in a large community. Also known as "Cable Television".
CE Mark	Conformity Europe. Certification Scheme for equipment compliance.
Client	Person or company purchasing the system.
C/N	Carrier to Noise Ratio, difference between modulated carrier and noise floor generally used with analogue signals see also S/N.
COFDM	see Modulation
Code	This or other CAI Codes of Practice as referred in this document.
CPR	Construction Product Regulation : Sets out the standards required by law for the construction industry which includes cable.
Cross Polar Rejection	Difference in level between wanted signal and signal from opposite polarity.
DAB	Digital Audio Broadcast.
Dish sharing	A signal reception system that delivers satellite signals only, via a network, to multiple outlets as if connected to own dish.
DSB	Double Side Band.
DSCR	See SCR.

DTT	Digital Terrestrial Television.
DVB-S	Digital Video Broadcast – Satellite.
DVB-S2	Digital Video Broadcast – Satellite second generation.
DVB-T	Digital Video Broadcast – Terrestrial.
DVB-T2	Digital Video Broadcast – Terrestrial second generation.
EFLI	Earth Fault Loop Impedance.
EMC	Electromagnetic Compatibility.
Engineer	Person competent to work on installation or maintenance of a signal reception system according to CAI Codes of Practice.
FEC	Forward Error Correction.
FM	Frequency Modulated/Modulation.
Headend	Equipment provided for the purpose of filtering, levelling, processing and launching into a distribution network.
IEC	International Electrotechnical Commission
IF	Intermediate Frequency.
Instructed person	Person who has been instructed and trained by a skilled person, or who is supervised by a skilled person, to identify energy sources that may cause pain and take precautions to avoid unintentional contact with or exposure to those energy sources.
IRS	Integrated Reception System. A signal reception system that delivers terrestrial and satellite signals to multiple outlets as if connected to own dish and aerial array.
ISP	Internet Service Provider.
LDPC	Low density parity check, linear error correcting code.
LPS	Lightning Protection System.
LSF	Low Smoke and Fume superseded by CPR grades.
LSZH, LS0H, LSNH	Low Smoke Zero/No Halogen superseded by CPR grades.
MATV	Master Antenna Television. A signal reception system that feeds terrestrial signals to multiple points via a network. If in multiple buildings this would be restricted to a local area.
MDU	Multiple Dwelling Unit.
MER	Modulation Error Ratio.
Modulations	
COFDM	Coded Orthogonal Frequency Division Multiplex.
PSK	Phase Shift Keying uses 2 phases in the modulation.
QPSK	Quadrature Phase Shift Keying uses 4 phases in the modulation.

8PSK	Eight Phase Shift Keying uses 8 phases in the modulation.
64QAM	Quadrature Amplitude Modulation 64 possible signal combinations, with each symbol representing six bits.
256QAM	Quadrature Amplitude Modulation 256 possible signal combinations, with each symbol representing eight bits.
Member	Member of CAI.
Multi-path effect	(Ghosting) Secondary signal received at an aerial caused by a reflection.
Multiplex	A digital transport stream carrying a number of services within a single broadcast channel.
NPRM	Non-Penetrating roof mount.
PPE	Personal Protective Equipment.
PSK	see Modulations.
QPSK	see Modulations.
Receiver	Equipment designed to receive signals in the range specified in 1.2.
Read Solomon	Block error correcting code.
RED	Radio Equipment Directive.
RF	Radio Frequency.
RLR	Return Loss Ratio.
RoHS	Restriction of Hazardous Substances.
SCR DSCR	Single cable router and digital single cable router.
SSB	Single Side Band (see VSB).
SDU	Single Dwelling Unit, be it detached, semi-detached or terraced. This would also include an individual apartment, flat or maisonette etc.
Skilled person	person who has training or experience in the technology of the equipment, particularly in knowing the various energies and energy magnitudes used in the equipment.
SMATV	Satellite Master Antenna Television. Similar to MATV with the addition of locally modulated signals, commonly satellite programmes.
S/N	Signal to Noise Ratio : The ratio of the wanted signal level to the noise level as measured under specified conditions.
System	A network that feeds RF signals to multiple points. See CATV, MATV, SMATV and IRS.
Systems Installer	A member registered with CAI who claims competence in installing systems. (See CAI Approved Systems Installer).
Transponder	The individual transmitting element on a satellite.
UV	Ultraviolet radiation, that part of the Electromagnetic spectrum that causes degradation of certain materials.
Viterbi	Convolutional error correcting code.

Voltage, nominal	Voltage by which an installation (or part of an installation) is designated. The following ranges of nominal voltage (rms values for a.c.) are defined: Extra-low Voltage (ELV) - Not exceeding 50 V a.c. or 120 V ripple-free d.c., whether between conductors or to Earth. Low Voltage (LV) - Exceeding extra-low voltage but not exceeding 1000 V a.c. or 1500 V d.c. between conductors, or 600 V a.c. or 900 V d.c. between conductors and Earth. High Voltage (HV) - Normally exceeding low voltage.
VSB	Vestigial Side Band (see SSB).
WEEE	Waste Electrical and Electronic Equipment.

2 INSURANCE

2.1 Liability Insurance

Members shall comply with current statutory obligations in respect of Public Liability and Employer's Liability Insurance. Notwithstanding the above, Members affected by this Code shall carry a minimum of £5,000,000 Public Liability Insurance cover. This minimum shall be increased if so required by any Client in respect of any installation covered by this Code.

2.2 Accident Cover

Members are advised to take out personal accident insurance consistent with the hazardous nature of the work involved.

3 SUITABILITY OF SITE

At an early stage of development, the architect or Client shall be consulted with regard to the positioning of aerials, satellite antennas, headend equipment and network components. The soundness of the structure to support such aerials/antennas shall also be checked but where this is in doubt, a structural engineer shall be consulted. Architects and Clients shall be made aware of the desirability of mounting aerials and satellite antennas clear of surrounding objects and with a clear "view" towards the appropriate transmitters. It is the responsibility of the Member to determine the suitability of the receiving site prior to the commencement of the installation and to advise the Client of any problems.

4 LICENSING AND PLANNING

In July 2003, the UK implemented an EU framework for the regulation of electronic communications networks and service providers. The framework sets out a harmonised and technology neutral regime for the regulation of communications companies across the EU and is covered by The Communications Act, to which all systems shall legally comply. See Annex J.

Where relevant the Client shall also be made aware of the Government document entitled "Permitted development rights for householders Technical Guidance (p49/50)". See Annex A

The full document is available here:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830643/190910_Tech_Guide_for_publishing.pdf

However this document applies to single dwelling units and not blocks of flats or commercial systems. The Planning Directorate at The Ministry of Housing, Communities and Local Government has issued the following statement:

“The householder permitted development rights allow homeowners to install antenna on their homes as set out in the regulations and the associated technical guidance. These rights do not apply to blocks of flats or commercial buildings. In such cases people would need to check with their local planning authority to see if planning permission would be required.”

5 GROUNDWORK

Provision for all groundworks, mast plinths, king posts, trenching, cable ducts etc, shall be established at an early stage.

6 INSTALLATION STAFF

6.1 Engineers/Technicians

The Senior Engineer of the Member shall be trained to CAI standards of competence in the installation of systems, as determined from time to time by CAI. Where necessary, the installation staff may need to attend CAI approved or recommended training courses. An experienced and trained installer shall be in attendance at all times. Assistants shall accompany the installer, where appropriate.

6.2 Identification

All members of staff shall carry photographic identity cards. It is preferred that all Members display CAI logo on their installation/maintenance vehicles and relevant stationery.

7 CUSTOMER RELATIONS

7.1 Contract Conditions

In addition to the requirements of section 4, the following information shall be provided to the Client, in writing, prior to the commencement of the work:-

The expected quality of signals to be provided for all services required and where it is likely that the full range of signals will not be available this shall be detailed. Where local conditions may not allow all services to be received the client shall be informed— see section 11. Refer to Annex G – Standard Conditions of Trading.

- All signal types that the installation will provide.
- The location of the aerials/antennas, their types and methods of installation.
- The routes of all cable runs, their fixings and their relative visibility.
- The location of any other equipment.
- Type and number of outlets and their locations.
- The expected quality of signals to be provided for all services required - see section 11.
- The equipment which the end user will require to receive the services.

- Programme providers may provide scrambled signals and/or charge for their programmes. Whilst this is the responsibility of the Client or end user, the Member has a duty to point this out as the provider of the installation. The Member shall inform the Client that some programme providers shall be advised, where necessary, of the reception and distribution of their channel for the purposes of copyright or licensing arrangements.
- Programming is beyond the control of the Member who cannot, therefore, make any claims or accept any responsibility for changes to encryption, programming, transmitted frequency, or other technical parameters.
- A quotation or estimate for the work involved where the cost implications of different options may be included.
- To inform the Client that, unless the installation company has a waste carriers registration, the only waste that may be removed from site has to have been brought onto the site by the company in the first place, e.g. off-cuts of coaxial cable and packaging. If redundant electrical or electronic equipment is being removed then the WEEE Directive shall also be complied with.
- The Client shall be informed of the standard Terms and Conditions unless separate arrangements are agreed. Refer to Annex G - Standard Conditions of Trading.

7.2 Installation Liaison

The Member shall liaise with the Client at the commencement of the installation and discuss the siting of the aerial/antenna, method of cable entry, its run, its termination and positioning of the receiving equipment. Attention shall be drawn to any matters concerning the structure of the building, such as defective brickwork, and every effort shall be made to work tidily and to avoid undue dust, debris, etc.

8 INSTALLATION AND TEST EQUIPMENT

8.1 Vehicles

Vehicles shall be adequately equipped, including PPE, to enable the installation staff to execute an installation conforming to this Code.

8.2 Test Equipment

The minimum requirement for test equipment is as follows:-

- (a) Inclinator and compass or other means to identify satellite locations
- (b) Spectrum analyser (see below)
- (c) Multimeter
- (d) Earth Fault Loop Impedance Meter
- (e) The Member shall have available the means to demonstrate the quality of reception, which shall include the applicable set top box, TV or measuring equipment that can demonstrate picture and sound quality on all signal types received
- (f) Optical power meter for fibre optic installations

8.3 Signal Measurement

When measuring signals on any type of system, it is important that the instrument used is within the accuracy limits specified herein and designed for the particular service. Analogue meters will not measure digital terrestrial or satellite correctly so it is essential to use measurement instruments designed for the purpose.

A spectrum analyser capable of the following is required:-

- The ability to scan a full or predefined range of satellite and terrestrial multiplexes, and to record the results for subsequent downloading. Measurements should include signal level, MER, BER before and after correction.

- Absolute level accuracy of ± 2 dB
- S/N accuracy of ± 1 dB
- Bit Error Ratio (BER) accuracy of $\pm 5\%$
- Modulation Error Ratio (MER) accuracy of ± 1 dB

Within the following bands as appropriate:-

- Measurements in the frequency range specific to the services provided, typically:
 - 87.5 -108 MHz (FM)
 - 193-230 MHz (DAB)
 - 470-860 MHz (UHF TV)
 - 950-2150 MHz (legacy satellite)
 - 290 -2350 MHz (wideband satellite)
- Return path measurements will require an analyser measuring down to 5 MHz.

It is essential that the accuracy of the meter be checked in accordance with the manufacturer's guidelines. Where applicable a calibration certificate shall be available for inspection.

A spectrum analyser may have many functions in addition to the above, but for a satisfactory system set-up and commissioning, the capabilities listed are minimum requirements.

9 CHOICE OF MATERIALS

Materials used in an installation shall be chosen to have the following characteristics:

- UV stability: the outer covering of all items (e.g. cables, fixings, paint finish, housings) installed externally in a system shall protect those items from the long term degradation effects of ultra-violet light.
- Weather resistance: all materials used externally in the installation of a system shall be resistant to the adverse effects of weather during the normal life expectancy of the product, taking account of the environment in which it is installed.
- Chemical reactivity: all materials used in the installation of a system shall be chemically neutral and non-reactive to any item, whether solid, liquid or gaseous, with which it might reasonably be expected to contact during its lifetime. This includes the degree of acidity found in rainwater.
- EMC/RoHS/WEEE: all electronic items used in the installation of a system shall be compliant with appropriate EMC standards, have been tested to relevant IEC standards, and carry the CE or UKCA mark. All applicable products should be compliant to RoHS and WEEE Directives.
- All materials used must comply with the Construction Products Regulation (CPR).

10 TERRESTRIAL / SATELLITE RECEPTION

10.1 General

It is essential that suitable quality materials are used and that the work is carried out with due regard for public safety. As the antenna, mast and bracketry is a metal structure it is elastic to some degree. Whenever it is continually flexed by the action of the wind or other vibration, the metal section that is experiencing most strain is subject to change whereby it becomes work hardened and brittle, it ceases to be elastic and may break. The effect is termed 'metal fatigue' and it can be avoided by ensuring the structure is sufficiently robust to resist excessive flexing.

Many of the metal parts of an installation are fabricated in aluminium, which has a natural protective oxide film on its surface. This film can be destroyed if the installation is exposed to a sulphurous or acidic emission from a chimney. The effects of this corrosion can be minimised by positioning the antenna away from the chimney outlet. Where this is not possible a minimum vertical clearance of 1.25 m between the antenna and the top of the chimney shall be maintained. In extremely difficult reception areas, where the antenna will only receive useable signal if positioned closer than 1.25 m to the top of a chimney, the Client shall be informed of a possible reduction in the life expectancy of the antenna.

If dissimilar metals are brought into contact, they and/or their finishes shall be selected so as to minimise galvanic corrosion.

10.2 Terrestrial Reception

10.2.1 Terrestrial TV Aerial Selection

For digital transmissions it is essential that the aerial be matched to 75 ohm. Where possible use an aerial that meets the requirements of the CAI Certification Scheme.

When selecting an appropriate aerial group, note:

- Aerials with a narrow bandwidth generally have higher gain than those with a wide bandwidth
- Group W aerials, and others with a frequency response extending above channel 48, should normally be avoided to reduce the level of interference from LTE in the 700 MHz and 800 MHz bands
- It is possible that frequencies presently used for UHF television may be re-allocated to other services in the future

For aerial parameters, see CAI Aerial Certification Scheme, and refer to industry websites for information on possible changes to channel allocations.

10.2.2 Terrestrial Aerial Groups

Table 1 Aerial Groups

UHF Television		
CHANNELS/ FREQUENCY	GROUP/ BAND	COLOUR CODE
21 to 37	A	Red
35 to 53	B	Yellow
48 to 68	C/D	Green
21 to 48	K	Grey
35 to 68	E	Brown
21 to 68	W	Black
21 to 60	T	White
FM Radio		
87.5 to 108 MHz	Band 2	
Digital Audio Broadcasting		
193 to 230 MHz	Part Band 3	

10.2.3 Siting of Terrestrial Aerials

10.2.3.1 Safety

In selecting a suitable site and carrying out the installation of terrestrial aerials, the requirements described in CAI document 'Health & Safety in the Aerial & Satellite Industries' shall be met.

In order to avoid unnecessary hazard where practicable, aerials shall not be sited directly above any area to which the public has access. In addition, the position of any overhead power lines shall be noted and their close proximity avoided.

10.2.3.2 Performance

As a general rule, all aerials should be positioned to avoid being close to other objects, especially metal. In addition, there should be the maximum possible unobstructed line of sight in the direction of the intended transmitter.

In cases of strong local interference, such as from a mobile phone base station, it may be possible to improve the signal to interference ratio by locating the aerial so that there is an obstruction in the direction of the source of interference, but care must be taken that the wanted signal is not unduly degraded in the process.

Where more than one aerial is mounted on a mast, it is possible for interaction between aerials to cause degradation of performance. This can affect both forward gain and off-axis rejection of unwanted signals, resulting in poor signal quality. To limit such degradation, the separation between aerials operating in the same frequency band should be no less than half the wavelength at the lowest frequency in that band. There may be some additional benefit to using separations greater than this.

Table 2 Wavelengths

Band	Lowest frequency	Half wavelength
Band II, FM radio	87.5 MHz	1.71 m
Band III, DAB radio	193 MHz	0.77 m
Band IV, DTT	470 MHz	0.32 m

Using the dimensions from Table 2, if UHF TV, DAB and FM aerials are required on a single mast, the minimum mast length will need to be 4.2 m (14 ft) to accommodate the required aerial spacing and bracket positioning. This is calculated as follows:

Spacing of wall brackets	0.7 m
Spacing of top bracket from top of wall	0.5 m
Distance band II aerial from roof line	0.5 m
Spacing between band II and band III aerial	1.71 m
Spacing between band III and band IV aerial	<u>0.77 m</u>
Total	4.18 m

Where adjacent aerials operate in different bands or polarities, the magnitude of degradation due to interaction will be much smaller, so while it is best to maximise the separation between aerials, it is acceptable to reduce the separation to less than half a wavelength at the lowest frequency, where necessary.

A spectrum analyser shall be used to ensure that directional aerials are aligned for highest signal strength, and in the case of DTT, also highest MER across all multiplexes, noting that in some locations these may not coincide. In difficult reception areas, it may be necessary to move DTT aerials laterally and/or in height to achieve satisfactory signal quality (see section 11) on the worst multiplexes, perhaps at the cost of some degradation of the best quality signals.

A check of all required services shall be made before final positions of the aerials are established.

10.3 Satellite Reception

10.3.1 Satellite Dish Selection

Care shall be taken to select:-

- (a) a dish of the appropriate size and efficiency,
- (b) a LNB and feed horn that correctly illuminates the dish, with the correct local oscillator/s and of the appropriate gain, noise figure and phase noise, for the chosen satellite transponder's downlink budget calculation.
- (c) the assembly of the antenna and LNB to conform to the manufacturer's instructions.

10.3.2 Satellite Bands

For the purpose of this Code, the frequency ranges are as follows:-

Table 3 Satellite Bands

C Band	4	8	GHz
X Band	8	12	GHz
Ku Band	10.95	14.5	GHz
Ka Band	26.5	40	GHz

10.3.3 Siting of Satellite Dishes

In order to avoid unnecessary hazard, where practicable, antennas shall not be sited directly above any area to which the public has access. In addition the position of any overhead power lines shall be noted and their close proximity avoided.

Reference shall be made to CAI document 'Health & Safety in the Aerial & Satellite Industries'. The antenna shall be kept as clear from local obstruction as possible.

A compass and inclinometer, or other suitable means, shall be used to find a suitable position where the antenna has a clear line of sight to the required satellite(s). The installation shall comply with current planning regulations (see section 4 Licensing and Planning). A spectrum analyser shall be used to ensure that the optimum receivable signal is obtained by adjusting elevation, azimuth, polarity alignment (skew) and, where necessary, focal point positioning for the LNB. In the case of DVB signals check that the quality of the optimum receivable signal is sufficient to allow the signal quality targets described in Section 11 to be met. MER shall be checked and, when appropriate, BER.

10.3.4 Multi-satellite Reception

When reception from more than one satellite is required it is recommended that a separate dish is used for each satellite. Where this is not possible it must be ensured that all signal parameters for each satellite are achieved. (See Section 11 Signal Measurement/System Limits)

10.3.5 Cross Polar Rejection

The minimum cross polar rejection of the LNB and dish combination shall be 26 dB for both analogue and digital.

10.3.6 Painting of Satellite Dishes

Should the antenna require painting to minimise the visual impact, a matt, non-metallic, lead-free paint shall be used.

11 SIGNAL MEASUREMENT / SYSTEM LIMITS

11.1 Levels

Service and frequency range		Minimum level (dB μ V)	Typical design target level (dB μ V)	Maximum level (dB μ V) see note 7
VHF Radio				
	FM radio, 87.5 MHz to 108 MHz, mono	40		70
	FM radio, 87.5 MHz to 108 MHz, stereo	54		70
	DAB radio, 217.5 MHz to 230 MHz (2)	40		65
Locally Modulated Analogue Television				
	Analogue Television, 470 MHz to 862 MHz (3)	60	70	80
Digital Terrestrial Television				
DTT, 470 MHz to 790 MHz (4)(5)				
	DVB-T QPSK 3/4	30	38	74
	DVB-T 64QAM 2/3	45	53	74
	DVB-T 64QAM 3/4	48	56	74
	DVB-T2 QPSK 2/3	28	36	74
	DVB-T2 256QAM 2/3	44	52	74
Digital Satellite Television				
Satellite, 950 MHz to 2150 MHz or 290 MHz to 2340 MHz (6)				
	DVB-S QPSK 2/3	52	65	84 (77)
	DVB-S QPSK 3/4	52	65	84 (77)
	DVB-S QPSK 5/6	52	65	84 (77)
	DVB-S2 QPSK 5/6	52	65	84 (77)
	DVB-S2 QPSK 8/9	52	65	84 (77)
	DVB-S2 8PSK 2/3	52	65	84 (77)

Table 4 Signal level limits at system outlets under clear sky conditions

For up to date FEC refer to <https://www.ofcom.org.uk/spectrum/information/transmitter-frequency> for terrestrial and for satellite use the link www.cai.org.uk

Notes

(1) This table should be read in conjunction with section [11.1.1] "Signal level differences"

(2) Where a separate amplifier is used for DAB signals (i.e. no amplifier carries both DAB and UHF TV signals), the maximum level may be increased up to 94 dB μ V.

Most usually the same amplifier is used for FM, DAB and UHF TV signals. In this case, a check should be made to ensure that intermodulation products and harmonics at and around three times the DAB frequencies are sufficiently low in level at the amplifier output that the MER of TV signals in this frequency range are not significantly affected. For example, DAB signals centred around 215 MHz could cause significant interference to TV channels centred on 645 MHz (channel 43). Note that reducing the DAB signal levels by 1dB should reduce the intermodulation products by about 3dB.

(3) If locally modulated analogue TV signals exceed 75 dB μ V, there is a risk that some DTT receivers may be overloaded. To minimise effects due to ingress of signals from mobile base stations and handsets, when frequencies above the current UHF broadcast band are used for locally modulated signals, it is recommended that signal levels are towards the upper end of the permitted range. Furthermore, steps should be taken to

minimise the level of mobile communications signals on the system, for example by use of appropriate filtering and screening.

(4) At the time of writing the UHF TV broadcast band covers the frequency range 470 MHz – 790 MHz. After the reallocation of 694 MHz – 790 MHz for mobile communications and the UHF TV broadcast band will be reduced to the range 470 MHz to 694 MHz. Note that locally modulated signals added to systems and using frequencies above the UHF TV broadcast band should be subject to the same signal level limits as off-air signals, described in this table.

(5) Note that minimum and typical design target levels for DTT differ from one mode to the next. For smaller systems without channel equalisation, it is acceptable to reproduce the incoming relative levels, provided they remain between the specified minimum and maximum levels at the outlet.

(6) Wideband systems using the intermediate frequency range 290 MHz to 2340 MHz should use the same signal level limits as systems using the IF range 950 MHz to 2150 MHz.

(7) Level in brackets relates to legacy / wideband signals.

Cloud cover and precipitation can have a significant effect on signal level and quality, particularly with satellite frequencies. It is recommended that the prevailing weather conditions are noted whenever satellite signal measurements are made.

11.1.1 Signal level differences

It is normal practice for FM, DAB, DTT and satellite signals to be carried from the headend to each outlet on the same cable. In these circumstances it is important to limit differences in signal levels to ensure that:

- no one set of signals dominates the total power output from the headend
- no set of signals is adversely affected by intermodulation or thermal noise due to being significantly lower in level than the others
- receivers are not presented with unduly high levels of out-of-band signals

Diplexer or triplexer outlet plates should be used, as they can effectively isolate one set of signals from another.

Noting the above, for UHF TV signals the only requirement for level difference is that all signals are within the recommended level range, while simultaneously meeting the requirements for MER.

For IF signals over the range 950 MHz to 2150 MHz. The maximum level difference between any two adjacent satellite multiplexes should not exceed 10 dB and over the whole band there should not be more than 20 dB difference.

For DAB multiplexes carried by the same amplifier as UHF TV multiplexes, the power per DAB multiplex should not exceed the highest TV multiplex power by more than 6 dB. Checks should be made that intermodulation products and harmonics of DAB signals, which can appear in the 600 MHz band, are sufficiently low in level not to cause significant degradation of DTT signals.

11.1.2 Window of Operation

The minimum and maximum signal level limits for each type of service (satellite/terrestrial; analogue/digital) define a Window of Operation (WO) within which all the signal levels shall be maintained. With increasing complexity of systems, the size of the WO can become reduced due to the build-up of effects such as thermal and intermodulation noise, and gain variation with frequency. The size of the WO can normally be increased by equalising the levels of signals. In general, small DTT systems are unlikely to require any equalising. Medium sized systems may require the use of cluster filters or cluster amplifiers, and larger systems may need the use of equalisers on a channel by channel basis.

Fibre optic systems generally have relatively tight requirements for the WO. Refer to the manufacturer's specification for details.

11.2 RF Signal to Noise Ratio and Modulation Error Ratio

RF signal to noise ratio (SNR) is the ratio, normally expressed in dB, of the power of the signal and the power of the noise in the same bandwidth as the signal. SNR is sometimes known as carrier to noise ratio (C/N or CNR). Modulation Error Ratio, MER, is the ratio, normally expressed in dB, of the power of a digital signal with a perfect constellation and the power of a signal representing the error, or deviation from perfect. MER is described in the ETSI Technical Report TR 101 290 as follows:

“MER is the preferred measurement for the following reasons:

- The sensitivity of the measurement, the typical magnitude of measured values and the units of measurement combine to give MER an immediate familiarity for those who have previous experience of C/N or S/N measurement
- MER can be regarded as a form of Signal-to-Noise ratio measurement that will give an accurate indication of a receiver's ability to demodulate the signal, because it includes, not just Gaussian noise, but all other un-correctable impairments of the received constellation as well
- If the only significant impairment present in the signal is Gaussian noise then MER and S/N are equivalent

11.2.1 Locally Modulated Analogue Television

Table 5 Analogue carrier to noise

Service	Minimum C/N (dB)	Noise bandwidth (MHz)
625-line PAL-I, 470 MHz to 862 MHz	43	5.08

11.2.2 FM Radio

Table 6 FM radio carrier to noise

Service	Minimum C/N (dB)	Noise bandwidth (MHz)
FM radio, 87.5 MHz to 108 MHz, mono	38	0.2

11.2.3 Digital Services

Table 7a MER Terrestrial

MER under normal (i.e. not enhance, lift or atmospheric) propagation conditions

Terrestrial	Minimum MER at any system outlet (dB).
DAB Radio DAB radio, 217.5 MHz to 230 MHz	no value available
Digital Terrestrial Television DTT, 470 MHz to 694 MHz	
DVB-T QPSK 3/4	
DVB-T 64QAM 2/3	
DVB-T 64QAM 3/4	
DVB-T2 QPSK 2/3	
DVB-T2 256QAM 2/3	

In some instances it may be necessary to use a low power relay transmitter as a signal source for a system. These relays may radiate signals with significantly lower MER than main stations, making it impossible to meet the values shown in the table for high order modulations. In this event, the installer must bring this to the attention of the customer.

Table 7b MER Satellite

MER under clear sky conditions

Digital Satellite Television	Minimum MER at any system outlet (dB).
Satellite, 950 MHz to 2150 MHz or 290 MHz to 2340 MHz	
DVB-S QPSK 2/3	11
DVB-S QPSK 3/4	11
DVB-S QPSK 5/6	11
DVB-S2 QPSK 5/6	11
DVB-S2 QPSK 8/9	11
DVB-S2 8PSK 2/3	11

Note; Care should be taken in the system design to reduce MER degradation delivered to the outlet

11.2.4 Bit Error Ratio

Bit Error Ratio is the number of bits that are received incorrectly divided by the total number of bits in a given interval of time.

Audio and video compression techniques rely on there being effectively an error-free bit stream, so forward error correction (FEC) codes are added to the transmission to allow the receiver to virtually eliminate received bit-errors under normal reception conditions.

DVB-T and DVB-S use the same forward error correction scheme, involving two error-correcting processes in series. The first process involves a decoding algorithm named after its inventor, Andrew Viterbi, and the second process is named Reed-Solomon after the inventors of the code.

In normal reception conditions, errors after Reed-Solomon decoding are very infrequent, making it impractical to try to measure them in a reasonable time interval. In practice, errors are measured either before or after the Viterbi error corrector, where errors occur at a much higher rate.

For all DVB-T and DVB-S services, a maximum Bit Error Ratio (BER) of 2×10^{-4} (sometimes written as $2e-4$), measured after Viterbi error correction, shall be achieved at the outlet. This corresponds to a BER of about 10^{-11} after the Reed-Solomon decoder.

DVB-T2 and DVB-S2, the second generation standards, similarly use dual error correction schemes, but with more advanced codes known as LDPC and BCH, corresponding to the Viterbi and Reed-Solomon processes for DVB-T and DVB-S.

For all DVB-T2 and DVB-S2 services a maximum Bit Error Ratio of 1×10^{-7} , measured after the LDPC decoder, shall be achieved at the outlet.

11.2.5 Picture quality

Analogue television picture quality is directly affected by the impairments in the RF channel, such as noise, interference, group delay and linearity. In contrast, digital television pictures are typically in one of three states:

- the same quality as the source (quasi error-free, meaning not more than one uncorrected error event per hour)
- impaired by some degree of block errors (also known as pixelation), at a rate exceeding one uncorrected error event per hour
- not working at all

The quality of analogue television pictures should be assessed according to the 5-point impairment scale described in ITU-R BT.500-13 (formerly known as the CCIR 5-point impairment scale):

Table 8 Five Point Impairment

Quality	Grade	Impairment
Excellent	5	Imperceptible
Good	4	Perceptible but not annoying
Fair	3	Slightly annoying
Poor	2	Annoying
Bad	1	Very annoying

The normal targets for picture quality should be Grade 4 or better for analogue signals, and quasi error-free for digital services.

In order to lessen the likelihood of dispute, installers are recommended to agree the quality grade for analogue signals with their clients before the work takes place.

11.3 Interference

Systems may suffer from various forms of impairment, resulting in the inability to meet the performance requirements described in this section. It is important that the installer obtains a clear understanding of the cause of the impairment.

The most common causes include:

- High levels of non-broadcast signals in adjacent frequency bands (e.g. LTE base station signals) overloading an amplifier
- Faulty equipment making unintended emissions that are on the same frequency as the wanted signals
- Inadequate protection against ingress of unwanted signals (electromagnetic compatibility) due to inappropriate materials or installation practices. Systems must be planned and installed in line with the requirements of BS EN 50083-2 ("Cable networks for television signals, sound signals and interactive services. Electromagnetic compatibility for equipment.") and BS EN 50083-8 ("Cable networks for television signals, sound signals and interactive services. Electromagnetic compatibility for networks.")

For further information, refer to Code of Practice 06, "Dealing with interference caused by signal generation into the TV, Radio and Satellite Bands".

12 DISTRIBUTION NETWORK

All equipment should be located in an area that is secure and accessible for future maintenance. This may require the use of a lockable cabinet. It is important that the installer arranges with the Client for a suitable area to be made available. The Client should be advised that equipment contained within this area needs to be accessible at all times for maintenance.

12.1 Types of System

Different types of distribution systems may be utilised depending upon Client requirements - MATV, SMATV, IRS etc. Systems may include terrestrial television in both digital and, locally modulated, analogue plus satellite channels either in their original IF format or re-modulated in the terrestrial band. The system is also likely to carry radio in the form of FM and DAB.

Whilst some demand is still experienced for MATV and specialist SMATV systems, the bulk of new communal build is IRS. By carrying all broadcast radio and television services in their original formats, IRS delivers the most benefit for both landlord and tenant.

12.2 System Planning (see also Annex B)

Whilst technical advice is available from various sources, such as manufacturers and distributors, ultimately it is up to the Member to decide the most suitable layout for the system. It is expected that Members undertaking this type of work will have successfully completed appropriate CAI training courses. The planning of the system shall take account of all appropriate safety requirements.

12.3 Loop Wired Systems

Loop wired systems on new installations shall not be used.

12.4 System Architecture

12.4.1 Coax

Whilst MATV and SMATV systems can be designed as a traditional tree and branch network, the nature of an Integrated Reception System (IRS) means that each subscriber cable needs to be routed back to a central distribution point (or points). Backbone cables terminate at these points into switching units capable of delivering signal to the outlets.

The number of backbone cables required will depend upon the number of satellites to be received and reference shall be made to the specification associated with the installation. Allowance shall be made for terrestrial services on either a dedicated backbone cable or superimposed onto all satellite IF backbone cables.

12.4.2 Fibre

The nature of a Fibre Integrated Reception System (FIRS) means that each subscriber cable needs to be routed back to a central distribution point (or points). Backbone cables terminate at these points into optical splitters capable of delivering signals to the optical terminal device. The layout is flexible and can be designed as either star wired or tree and branch. Regardless of the design optical budgets must be adhered to.

The number of backbone cables required will depend upon the number of satellites to be received and the distribution technology employed. Reference shall be made to the specification associated with the installation. Allowance shall be made for terrestrial services.

12.4.3 Structured Cabling

Structured cabling usually uses twisted pair category cables.

When using category cables signalling is based on differential pair and devices take advantage of common mode rejection. The pairing and matching of conductors in the cable is important to the overall performance. Cables star from a hub, modem or switch to each device and signals can pass between devices as well as between some devices and the internet using IP

The wiring to the hub, modem or switch can be by twisted pair, fibre or coaxial cable and would normally terminate in ISP equipment

13 Headend Equipment

Headend equipment shall be housed in an accessible, secure and well-ventilated area and, where required, fed by a dedicated mains supply.

When designing the headend and its output levels for a system containing cascaded amplifiers, due consideration shall be made both for the number of amplifiers and the total number of channels to be distributed. The derating tables in Annex C shall be followed.

In poorly ventilated areas or where the ambient temperature is likely to rise or fall outside the equipment operating temperatures, due care and attention shall be exercised in order to ensure the equipment is operated within those temperature limits.

13.1 Cascaded Amplifiers

In planning the network, Members shall ensure that cascaded amplifiers run at the appropriate output level. Derating tables shall be used when planning systems with cascaded amplifiers - see Annex C.

13.2 Powering of Systems

13.2.1 Coaxial

Generally MATV and SMATV amplifiers are powered with a local mains supply or by a lower voltage, not exceeding 65 VAC or 50 VDC line power. IRS active equipment can be powered either individually with mains voltage or by lower voltage line power.

The total power requirements should be borne in mind when designing a system. Care should be taken not to exceed the maximum current available from a power source and that the line current requirement does not exceed the capability of the system components.

Where back powering from the subscriber outlet or receiver is incorporated, the system shall comply with the following:-

- The maximum voltage applied between the inner and outer conductor of a coaxial subscriber feeder shall not exceed 24 VAC or 34 VDC and the system designed so that no multi-dwelling system shall be powered by just one receiver
- The equipment shall be so designed and constructed that no dangerous currents can flow under normal operating or single fault conditions
- The unit providing the power shall, if that power is derived from a mains supply, comply with BS EN 60065, BS EN 60950-1, BS EN 50083-2, BS EN 60728-11 and IEC 62368-1 Ed 1.0

13.2.2 Fibre

Powering for a Fibre Integrated Reception System (FIRS) headend is either mains powered or performed over a separate coaxial cable. Voltages are at DC and fall in the range of 12 V-20 V. Care must be taken to ensure volts drop is kept sufficiently low to ensure correct operation of the products connected as power supplies can be located away from the headend.

Distribution in a fibre system can be performed via passive products and powering is only required at the headend and the converter unit. Where optical amplifiers are used additional power will be required. Converter units may be line powered or locally powered using DC between 6 V and 24 V.

13.2.3 Structured Cabling

Where remote powering of Ethernet devices is provided this is normally by POE or POE+ and the power is provided either by an Ethernet switch or by a power inserter. Normally the power available is 50 VDC at powers up to 13 W.

13.3 Signal Splitting and Impedance Matching

Manufacturers/distributors of the equipment can supply information to assist in the selection of splitters and taps and consideration shall be given to performance and mechanical parameters, including the following:-

- Impedance matching (generally measured as Return Loss Ratio (RLR))
- Insertion loss
- Isolation
- Frequency range
- Weatherproofing, if applicable
- Connection method
- For coaxial systems, the line current carrying capacity

13.4 Frequency Planning

Great care shall be taken when allocating locally modulated services, especially if analogue, in both the UHF and VHF bands to avoid possible interference, including that caused to or by digital multiplexes whether intended for redistribution or not. Refer to Annex D.

13.5 Modulators

Double sideband type modulators, such as those commonly fitted in typical domestic set top boxes should not be used on distribution systems. In order to preserve the digital nature of the systems it is preferable to use digital modulators on all new and upgraded systems.

14 CABLE AND WIRING

14.1 General Cabling Requirements

Electrical wiring shall be carried out in accordance with the current IET Wiring Regulations. All electrical work in dwellings shall comply with Part P requirements of the Building Regulations and be carried out by a electrically skilled person or electrically instructed person (see BS EN 60728-11). It may be necessary for the Member to check if and how the installation falls within the Scope of Compliance and Notification parameters of Part P.

All pipes, conduits, ducts and cable shall be identified in accordance with the requirements of BS 1710. Some plasters and cements have a corrosive effect on metals and precautions against this may be necessary, particularly where cables or conduits are installed in damp situations.

All cables for outdoor runs shall be adequately protected against damage.

If distribution cables are used where their temperature is likely to exceed 50° Celsius or fall below -20° Celsius, advice shall be sought from the cable manufacturer.

Cables must be rated to the appropriate CPR Classification for the project and be marked in accordance with CAI certification scheme.

14.2 Coaxial Cables

All coaxial cable runs shall be continuous lengths where possible. If joints cannot be avoided care shall be taken by using only connectors intended for the purpose so as to maintain the impedance and screening properties. In selecting the cable due regard shall be paid to the signal levels available from the aerial/antenna or other inputs and the signal loss requirements of the distribution system.

Cables are chosen for distribution systems on their characteristics of screening efficiency, return loss ratio and attenuation. Cables are typically constructed in the form of a copper centre conductor surrounded by an insulating dielectric then a screen in the form of a longitudinal tape, complying with the cable certification scheme, and braid with a further insulating outer sheath.

All cable used shall be properly screened, conform to BS EN 50117 and, where available, have achieved the relevant CAI certification for MDU / commercial systems. For outdoor runs, cable shall be adequately protected against prevailing weather conditions.

With any system it is essential that suitable connectors and/or adapters be used. These shall be of a robust mechanical design and shall match the cable dimensions. Where there is doubt, the cable manufacturer/distributor should be consulted to confirm the correct connector type and method of termination. Refer to CAI Code of Practice 03 "Electrical Safety Requirements for Signal Reception Systems (excluding CATV)". Screw-on connectors shall not be used on communal systems.

14.2.1 IRS Cable Colour Coding

A standard colour coding has been adopted for the IRS 5 cable backbone to assist identification of cables carrying individual polarisations and bands, as follows:-

Table 9 Polarity Colour Code

Yellow	Horizontal High Band	HH
Green	Horizontal Low Band	HL
Red	Vertical High Band	VH
Black	Vertical Low Band	VL
White	Terrestrial	T

14.3 Labelling

All cables shall be indelibly labelled to identify source or destination and any other relevant information as applicable.

14.4 Cable Connections

External cable connections shall be made in such a manner as to prevent any ingress of moisture to either the cable or the component to which it is connected. External cables shall always enter terminal or junction boxes in an upward slope so that any water drains away from the point of entry. Terminations shall be adequately weather protected.

Cable joints shall be avoided wherever possible. However, where a join is imperative, it shall be made with a recognised type of coaxial connector (see Section 14.2). Terminations shall be mechanically and electrically sound.

Cables shall not be terminated directly to, or by means of, a different metal where there is a possibility of electrolytic corrosion.

Cable connections shall not be made in a way that exerts strain or pressure on the cable or termination.

14.5 Cable Fixing

Coaxial cables with a diameter equal to or greater than 7 mm shall be fixed at the following spacing:-

- On masts - intervals no greater than 230 mm
- On other vertical runs - intervals no greater than 750 mm
- On horizontal runs - intervals no greater than 460 mm

Coaxial cables and telephone/data cables with a diameter less than 7 mm shall be fixed at the following spacing:-

- On masts – intervals no greater than 230 mm
- On vertical runs – intervals no greater than 450 mm
- On horizontal runs – intervals no greater than 300 mm

Fixing shall be such that deformation of the cable does not occur. Staples may be used providing they are specifically designed for the purpose and for the cable being used.

In accordance with section 521.10.202 of the 18th edition of BS7671 (The Wiring Regulations), wiring systems shall be supported such that they will not be liable to premature collapse in the event of a fire.

Where cable clips are used then CAI recommends that a metallic P type clip is used for clipped cables and metal cable ties where cables are fixed beneath cable trays etc. These fixings should be at a maximum of every third fixing and at a maximum separation between metal fixings of 1400 mm either horizontally or vertically.

If plastic trunking or conduit is used then this too must be fixed with suitable metallic fixings.

14.6 Installation and Routing of Cables

Cable installation shall be carried out in a neat and workmanlike manner.

Bending radii shall be consistent with good aesthetics and never less than the manufacturer's specifications. In the event of such specifications being absent, the radius of the bend shall be at least 10 times the outside diameter of the cable.

The cable route employed from the aerial/antenna shall be chosen so as to keep the length of cable to a reasonable minimum and conform to the aerial manufacturer's instructions.

If cable entry into a building is through a hole it shall be no greater than 3mm in diameter than the cable used and drilled at a slight downward angle towards the exterior of the building. After installation of cables, the hole shall be sealed against water ingress.

Internal cable holes/ducts shall be sealed to meet the appropriate fire regulations. Internal runs of cable shall be routed in as inconspicuous a manner as practicable.

Where cables are routed through joists, consideration shall be given to the positioning of any drilled holes or cut-outs. Limitations may restrict where and how cables are routed with respect to position in the joist and to other services using a similar route. Where doubt exists, it is recommended that the advice of a Structural Engineer be sought.

Cables shall be terminated in accordance with the manufacturer's recommendation (see CAI Code of Practice 03 "Electrical Safety Requirements for Signal Reception Systems (excluding CATV)". Drip loops shall always be formed at entry points into buildings and on the output connections of an LNB. Cable shall not be coiled, however, it is recommended that where a cable terminates a service loop should be left consisting of one turn greater in diameter than twice the minimum-bending radius of the cable used.

ELV cables (which include signal carrying cables) should be a minimum of 10 mm away from LV cables when installed internally and 20 mm externally. However care should be taken that the screening of the cable is also sufficient to cope with EMC, the use of CAI certified cable would cover this.

14.7 Overhead Spans

Overhead cable spans shall be supported either by:-

- A catenary or lashing wire*, with a loop of coax at each end to aid with expansion and contraction, and erected at a height to be agreed with the Client. Short spans of up to 1.5 m, or as agreed, may be supported by enclosure in ducting
- The use of specially designed coaxial cables incorporating steel catenary wires, installed in accordance with the manufacturer's instructions

Where a span of greater than 10 m is to be installed it is recommended that advice be sought from a Structural Engineer. The span shall be at a minimum height of 6 m above any road surface, but in any case where a span is to cross a highway it is essential to consult with the Local Authority for current planning regulations.

Due consideration shall be taken of the possible resultant fouling as birds will settle on the cable.

* The minimum specifications for each of these wires are:-

Catenary wire - all wires shall be between 0.8 mm and 1 mm in diameter with six wires wound around the central core wire. The tensile strength is to be a minimum of 440 Nmm⁻².

Lashing wire - all wires shall be a minimum of 1.20 mm in diameter with six wires wound around the central core wire. The tensile strength is to be a minimum of 490 Nmm⁻².

14.8 Underground Cables

Unless specified differently by the relevant Local Authority, underground cables are to be installed at a recommended minimum depth of 450 mm, shall be of a type provided with an integral water barrier designed specifically for underground use and coloured green. It is recommended that PVC sheathed cables are not used in any underground situation due to moisture absorption over a period of time.

Coaxial cable installed underground, not designed for direct burial, shall be enclosed in a duct with a cross sectional area not less than 3 times that of the cable and, in any case, a minimum external diameter of 25 mm. The duct shall have a wall thickness of not less than 2.5 mm and, where available, be coloured green for network identification purposes.

The pulling load applied to a cable drawn into a duct shall not exceed that specified for the cable by the manufacturer.

Where necessary, local utility companies shall be consulted to determine routes of other services.

14.9 Fibre Cables

Commonly single mode (monomode) optical fibre is used for the distribution of signals and data associated with the industry. Many fibres can be grouped together in a single jacket.

14.9.1 Cleaning

Cleaning and cleanliness is vital for a successful fibre optic installation. Before every connection, the fibre connector should be cleaned and safely inspected to ensure a pristine end face. Dust caps should only be removed prior to cleaning and connection.

14.9.2 Jointing Techniques

Fibre optic cable shall be cleaned and inspected prior to being joined using the appropriate method to keep insertion losses to a minimum. All joints shall be adequately protected from moisture and physical damage by housing them inside a cabinet or box where the incoming and outgoing cables are rigidly secured.

14.9.3 Safety Aspects

Fibre optic cables made of silica glass shall be handled with care. Offcuts can be hazardous as can the cleaning materials and adhesives used in jointing and all these items shall be disposed of properly.

Optical transmitters use lasers that produce an intense beam of invisible light that can damage the skin and eyes. The transmitter shall always be switched off before making splices or fitting connectors, never use a magnifying glass to inspect a live fibre. Always use the appropriate PPE and refer to CAI safety guide.

14.10 Multi Pair Telephone Cable / Data Cable (types CW1308 or Category 5/6 etc.)

The installation of telephone extension points (other than an extension lead plugged into an existing socket) for connection to a digital Set Top Box, should only be carried out by a trained technician. The front of any existing line-box belonging to a PSTN operator should only be removed if it does not expose live cabling, and slave wiring shall be connected to the front safety plate using the appropriate tool.

Consideration shall be given to lines with DSL present and the appropriate filters fitted.

Bend radius is the minimum radius a cable can be bent without kinking it, damaging it, or shortening its life. The minimum bend radius for Category 5, 5e, 6, and 6a cables is four times the cable diameter, which is approximately 25 mm. When cabling is bent beyond this specified minimum bend radius, it can cause transmission failures. All pathways must maintain no less than the minimum bend radius wherever the cable makes a bend.

The wire pairs must not be untwisted and the outer jacket must not be stripped back more than 0.5 in (1.27 cm).

All shielded cables must be grounded for safety and effectiveness and a continuous shield connection maintained from end to end. Ground loops develop when there is more than one earth connection and the difference in common mode voltage potential at these ground connections introduces noise into the cabling.

All telephone cables shall be fixed with either clips or staples. All external telephone cable shall be UV stabilised.

15 AERIAL INSTALLATION

15.1 Mast, Brackets and Fixings

When installing an aerial, a suitable mast shall be employed to withstand wind speeds of 160 km/h (100 mph). Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems for information on the correct size mast and brackets to be used. Where the size or strength of the structure may be in doubt, it is recommended that a structural report is obtained from a competent person.

Ferrous metals do not have the natural protective coating of aluminium and should have a separate protective finish to BS EN ISO 15614 for galvanisation and BS EN 12329:2000 Fe/Zn5 for passivation/plating.

When an aerial or satellite dish is added to an existing installation, the strength and suitability of the installation shall be checked to ensure that it will sustain the additional stresses introduced. Due attention shall also be made to aerial spacing as shown in Table 2.

15.2 Tubular Masts

It is preferred that masts shall be of a non-ferrous metal, e.g. aluminium. If a steel mast is used it shall have a fully galvanised finish, to ensure that the inside is adequately protected.

With all installations, care shall be taken that no water can be trapped inside the mast. This is particularly important where steel masts are used.

Mast diameter alone is no indication of mast strength; the wall thickness shall also be adequate (see Table 10) as shall the method of manufacture and the grade of material used. When aluminium masts are used they should be of a seam welded construction.

Any mast above 6 m (20') in height shall be guyed to a minimum of 3 equidistant points.

On communal systems, 50 mm minimum diameter masts shall be used for terrestrial aerials.

Table 10 - Tubular Mast, tube diameter wall thickness and length

Maximum Tube length	Minimum Tube diameter	Minimum wall thickness	
		Alloy wall	Steel wall
1.8 m (6')	25 mm (1")	1.2 mm	1.2 mm
2.5 m (8')	32 mm (1.25")	1.6 mm	1.2 mm
3.0 m (10')	38 mm (1.5")	1.6 mm	1.2 mm
6.0 m (20')	51 mm (2")	2.0 mm	1.6 mm

16 Brackets and Lashings

16.1 Installation

Masts are generally secured to buildings by one of 4 methods:-

- A bracket and lashing kit attached to a chimney stack
- A bracket attached to the wall of a building
- By passing a mast through a roof seal into the loft space where it is attached to the roof timber work by appropriate brackets
- Non-Penetrating Roof Mounts (NPRM) for flat roof

For brackets of a welded construction, it is essential that the welds are of a good quality with a clean surface for final finishing. In preference all brackets should be galvanised. Painted brackets should never be used. All assembly nuts and bolts shall be either stainless steel or plated to British Standards 7371.

Care shall be taken to ensure that the surface, onto which the aerials are to be mounted, is sufficiently strong and durable to withstand the expected loadings. The use of mortar courses for fasteners shall not be used for fixings. Holes shall always be drilled to the correct diameter and depth for the chosen fastener, e.g. expansion bolt for concrete or plug and coach screw for brick. Where there is doubt about the security of fixing, advice shall be sought from the builder or architect. For exceptionally thin or weak walls, additional support and measures to spread the loading over a large area shall be provided. Guy wires, where used, shall be properly terminated with provision for adjustment of the tension.

When fitting the mast to the bracket, all nuts shall be spanner tightened. Care shall be taken to avoid distortion of the mast. Distortion can result in metal fatigue and fracture after a period of time.

(Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems.)

16.2 Chimney Mounted Brackets

These are available in several types; the most appropriate for a particular installation will depend on the type of aerial and the mast.

Lashing wire shall not be less than 7 strands of galvanised wire each of 1.2 mm minimum diameter or have the overall equivalent cross sectional area. Lashing wires shall be either pre-terminated, ferruled lashing or terminated by the 'spliced' method. If thimbles are used they should be metal and suitably protected.

Protective corner plates shall be installed between the brickwork and the lashing wire at each corner to protect the structure of the stack.

Chimney fixing kits are also available that use a galvanised, stainless steel or nylon strap with a width of 18 mm to 30 mm. This method can have great strength and may be useful in supporting large chimney mounted installations. Due to the width of the strap, it may not be necessary to use protective corner plates.

The top of the lashing bracket shall be at least 3 courses of brickwork or not less than 250 mm from the top of the stack.

A lashing bracket shall have the minimum vertical spacing between V bolt centres as follows:-

Table 11 Lashing bracket V bolt centres

Masts up to 0.9 m	150 mm spacing
Masts up to 1.8 m	300 mm spacing
Masts up to 3.0 m	500 mm spacing

Masts over 3.0 m shall be fitted with a double lashing with spacing of no less than one-sixth of the mast length.

16.3 Wall Mounted Brackets

For wall fitting, only brackets with at least 4 fixings shall be used and all appropriate fixings shall be utilised. When brackets are secured to brickwork, the bolts shall enter the brick and not the mortar joint. The top of any bracket shall be a minimum of 6 brick courses or 500mm from the top of the wall.

Bracket size should be determined by mast length and shall have the minimum vertical spacing between V bolt centres as follows:-

Table 12 Wall bracket V bolt centres

Masts up to 0.9 m	150 mm spacing
Masts up to 1.8 m	300 mm spacing
Masts up to 3.0 m	500 mm spacing

Masts over 3.0 m shall be fitted with a double bracket with spacing of no less than one-sixth of the mast length.

In addition the K bracket shall be at the bottom to spread the load. Where there is a possibility of high bending moments being applied to the top bracket, for example the addition of an extra aerial, then two K brackets shall be used or brackets designed with additional support. Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems.

16.4 Pitched Roof Mounts

If the property has no chimney stacks or gable ends, but requires an outdoor installation in an elevated position, it may be possible to pass a mast through a roof seal and support it internally with secure brackets. It is vital to make sure the roof seal is watertight and the top of the mast is capped. If in doubt consult a roofing contractor. Installers should be aware that this method of mounting can exaggerate any resonance characteristics of the mast length or aerial/antenna used. Maximum mast length will be governed by the available spacing between joists.

Brackets that fix to the roof covering (tiles, slates or felted wood etc) should not be used for work undertaken within the scope of this document.

16.5 Flat-Roof Mounts

When proposing an installation on a flat roof, it is advisable to check the wind loads and roof structure carefully; if necessary, a qualified structural engineer shall be engaged by the Client. No attempt shall be made to pierce the roof structure with fixing bolts. A non-piercing roof mount with suitable ballast is recommended. A suitable membrane should be installed between the mount and roof.

Wind loading specified by the manufacturer shall be taken into account when planning the installation. Exposed areas should be avoided. Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems.

16.6 Loft Fixing

It is not recommended to fit aerials, for services operating between 40 – 860 MHz, in lofts and the Client shall be made aware that, as far as interference is concerned, Ofcom designate any internally installed aerial as providing an unprotected service.

16.7 Wall Fixings

Fixings shall be suitable for the material to which the bracket is to be attached. Generally, coach screws and nylon plugs should be used in brickwork and expansion bolts in concrete. When mounted on wood, care shall be taken to ensure that the timber is thoroughly secure and sound. The fixings shall be coach screws or through-bolted.

For breeze-block, thermalite or low density materials a resin type anchor should be used.

Due to the possibility of bricks splitting, it is recommended that plug sizes above M10 are not used for brickwork. Avoid over-tightening a wall bolt by following manufacturer's recommended torque settings.

A margin of safety shall be taken into consideration when selecting a fixing by adhering to a safety factor of 7 for nylon plugs and 4 for steel anchors.

17 Masthead Amplifiers

Before considering the use of an amplifier, every step shall be taken to increase the signal levels received by adjusting the location of the aerial or by using one of higher gain.

When choosing any amplifier the following criteria should be considered:-

- RED Compliance
- Noise figure
- Maximum output capability
- Gain
- Bandwidth and out of band filtering
- Screening

- Durability to weather conditions
- EMC conformity to BS EN 50083-2 (refer to section 1.5)

18 SATELLITE ANTENNA INSTALLATION

18.1 General

Care shall be taken to select an antenna for the correct channels or bands required and of an appropriate size for the location of the receive site with respect to the satellite(s) to be received.

Equipment shall be chosen so as to deliver sufficient signal as defined for adequate reception in Section 11 and shall be installed according to manufacturers' instructions.

All antenna installations shall remain operational at wind speeds up to 80 km/h (50 mph) and be capable of surviving wind speeds of 160 km/h (100 mph). Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems.

For ground mounting of king posts, civil engineering or consultancy advice may be required before the installation, and the installation cleared with the Client. It is also essential that the antenna installation conforms to the general development orders and local planning requirements etc. The visual effects of the siting shall be taken into account, plus the aesthetics of the building such that there is a minimum effect on the environment.

18.2 Structural Supports for Satellite Antennas

The same criteria apply to fixing satellite antennas to buildings as any other antenna. Refer to section 15 for details.

When an additional antenna is added to an existing satellite installation, the strength and suitability of this installation shall be confirmed.

18.3 Ground Level Mounting

Where a satellite antenna is to be mounted at ground level, a suitable base is required depending on dish size and location.

Small dishes, up to 85 cm, may be secured to a patio stand or tripod mount affixed to concrete flags or blocks using appropriate fixings. However if a tripod mount is used it is recommended that a concrete plinth is used.

Large dishes, above 85 cm, shall be secured to a suitable concrete plinth using weatherproof high tensile bolts, locking nuts and washers.

Where a concrete plinth is used it must be constructed in accordance with the appropriate building regulations. If in doubt, a local builder shall be engaged to carry out the work. Planning permission may be required in certain areas - see Annex A.

18.4 Roof Mounting

Where an antenna is to be installed above roof level, the following points shall be considered:-

- Planning Requirements. Site plans, photographs and antenna details are to be provided to the Client
- Building Regulations. Site plans, photographs, structural details, existing roof covering and wind force calculations are to be provided to the Client

For pitched roof installations see section 16.4.

For flat roof installations see section 16.5.

Wind loading specified by the manufacturer shall be taken into account when planning the installation. Exposed areas should be avoided. Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems.

18.5 Wall Mounted Brackets

See section 16.3.

Dishes above 1.2 m are not recommended for wall mounting, unless specific stress requirements are taken into consideration prior to installation.

Areas exposed to high winds shall be avoided. Refer to Annex E – Mechanical Stability of Outdoor Aerial Systems.

19 Electrical Safety

It is a requirement that all systems comply with BS EN60728-11 which is covered by CAI Code of Practice 03 – “Electrical Safety Requirements for Signal Reception Systems (excluding CATV)”. Which include the considerations that cover the Low Voltage Directive and precautions against damage and interference from atmospheric electricity.

Where appropriate the readings for EFLI and subfeed resistance should be recorded.

20 COMPLETION OF INSTALLATION

20.1 Reporting and Registration of Final Installation

On completion of the installation a commissioning report, including a record of all appropriate signal levels and quality for all required services, shall be produced. This shall be submitted to the Client for his information and records and include a completion certificate for the Client’s signature. Standard CAI reporting forms are available from CAI office – see Annex F.

Records shall be made of all signals taken at all distribution points

20.2 Subsequent Reports on Installations

If required, the member shall be able to produce an accurate and meaningful report on any existing IRS, MATV SMATV or Optical Fibre system and be able to advise correctly on the requirement and suitability of headend equipment to upgrade the system. It is suggested that the member company use a standard form of report, sample copies of which are available from CAI – see Annex F.

21 MAINTENANCE

21.1 General

The Member shall offer a full maintenance service in respect of the entire system and preferably conduct an annual certificate of compliance inspection. If required, this is to include a next working day call out service; however, this may not be possible under certain adverse weather conditions.

21.2 Dangerous Situations

If, when installing or servicing a system, the engineer comes across a situation that may cause harm to life or damage to property or equipment it is their duty to inform the client by issuing a Dangerous Situation Report (Annex F). This report covers all dangerous situations to do with the system including electrical and mechanical

stability and must be issued regardless if the engineer has had any direct connection to the situation (e.g. a terrestrial aerial bracket is not secure whilst working on a satellite dish). The last instructed or skilled person to see the issue becomes legally responsible should injury or damage occur.

22 CUSTOMER CARE

CAI has issued a Code of Conduct booklet to which all Members shall adhere.

Annex A Planning regulations

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830643/190910_Tech_Guide_for_publishing.pdf

Extract from the above publication

Class H – microwave antenna

This provides permitted development rights for the installation, alteration or replacement of a microwave antenna, such as a satellite dish, on a house or within the curtilage of a house.

H.1 Development is not permitted by Class H if –

- permission to use the dwelling house as a dwelling house has been granted only by virtue of Class M, N, P, PA or Q of Part 3 of this Schedule (change of use)
- it would result in the presence on the dwelling house or within its curtilage of-
 - more than 2 antennas;
 - a single antenna exceeding 1 metre in length;
 - 2 antennas which do not meet the relevant size criteria;
 - an antenna installed on a chimney, where the length of the antenna would exceed 0.6 metres;
 - an antenna installed on a chimney, where the antenna would protrude above the chimney; or
 - an antenna with a cubic capacity in excess of 35 litres
- in the case of an antenna to be installed on a roof without a chimney, the highest part of the antenna would be higher than the highest part of the roof
- in the case of an antenna to be installed on a roof with a chimney, the highest part of the antenna would be higher than the highest part of the chimney, or 0.6 metres measured from the highest part of the ridge tiles of the roof, whichever is the lower; or
- in the case of article 2(3) land, it would consist of the installation of an antenna -
 - on a chimney, wall or roof slope which faces onto, and is visible from, a highway;
 - in the Broads, on a chimney, wall or roof slope which faces onto, and is visible from, a waterway; or
 - on a building which exceeds 15 metres in height

H.2 Development is permitted by Class H subject to the following conditions –

- an antenna installed on a building shall, so far as practicable, be sited so as to minimise its effect on the external appearance of the building; and
- an antenna no longer needed for reception or transmission purposes shall be removed as soon as reasonably practicable

H.3 For the purposes of Class H –

- the relevant size criteria for the purposes of paragraph H.1(b)(iii) are that –
 - only one of the antennas may exceed 0.6 metres in length; and
 - any antenna which exceeds 0.6 metres in length must not exceed 1 metre in length.
- the length of the antenna is to be measured in any linear direction, and shall exclude any projecting feed element, reinforcing rim, mounting or brackets. Guidance on the 'highest part of the roof' is covered under Class A (c) (see page 11)

Annex B **SYSTEM PLANNING**

B.1 General

BS EN 50083 series and BS EN 60728 series apply to all cable networks for terrestrial and satellite signals. These refer to all installations and equipment for headend reception, processing and distribution of all television, sound and interactive services together with their associated data signals.

These Standards apply to the entire installation, including all the equipment from the antenna, and any other signal source inputs on the system right through the network up to and including the system outlets, or the terminal points where no system outlet exists.

They apply to all kinds of networks, including:-

- CATV networks
- MATV and SMATV networks
- IRS networks
- Individual receiving networks

The purpose of this Code is to specify the overall system limits to produce, from an unimpaired signal source a maximum BER of $2e^{-4}$ (2×10^{-4}) for digital television signals and, where still broadcast or locally generated, analogue picture and sound signals with no impairment worse than Grade 4 on the ITU-R BT.500-13 5-grade impairment scale.

B.2 System Planning

When planning systems it is important to ensure all outlets supply no less than the minimum and no more than the maximum recommended signal level for any channel or band (refer to Tables 3 and 4 of this Code of Practice). Cable runs shall be measured accurately and the losses calculated across all frequencies to be distributed by the network. Cable losses shall be calculated using the manufacturers quoted attenuation figures plus a 5% contingency allowance.

System planners should use the quoted maximum, not typical, loss figures for all passive equipment and quoted minimum gain figures for all equipment applying amplification.

The following graphs and tables can be useful in determining system performance.

B.3 Radiation from Complete Systems

Table 13 Maximum Permitted Field Strengths (from BS EN 50083-8:2002)

Frequency range MHz			Maximum permitted interfering field strength at 10 m distance from the system dB μ V/m	
30	-	41	+26	(Note 1)
41	-	50	+6	
50	-	54	-8	
54	-	68	+6	
68	-	74.8	+6	
74.8	-	75.2	Use prohibited	(Note 2)
75.2	-	108	+5	(Note 1) (Note 3)
108	-	117.975	Use prohibited	(Note 2)
117.975	-	121.3	+29	
121.3	-	121.7	Use prohibited	(Note 2)
121.7	-	136	+29	
136	-	144	+6	(Note 1)
144	-	146	-18	
146	-	156.6	+6	(Note 1)
156.6	-	157	Use prohibited	(Note 2)
157	-	225	+5	
225	-	235	+21	
235	-	242.8	+11	
242.8	-	243.2	Use prohibited	(Note 2)
243.2	-	328.6	+11	
328.6	-	335.4	Use prohibited	(Note 2)
335.4	-	400	+11	
400	-	405.85	+21	
405.85	-	406.25	Use prohibited	(Note 2)
406.25	-	425	+32	(Note 1)
425	-	432	+12	
432	-	440	-15	
440	-	470	+12	
470	-	854	+13	(Note 1) (Note 3)
854	-	1000	+18	

Note 1: Where systems operate close to radio astronomy and space service stations, tighter radiation limits may be necessary in one or more of the frequency ranges 37.75 – 38.25, 80.5 – 82.5, 136 – 144, 150.05 – 153, 406.25 – 410 and 608 – 614 MHz to protect such services.

Note 2: The use of vision, sound, pilot and narrow band data carriers and colour sub-carriers in this frequency range is prohibited. The radiated levels of any sidebands or of any intermodulation products or spurious frequencies on the system falling within this frequency range shall not exceed -21 dB μ V/m at a distance of 10 m from the system. However, broadband digitally modulated signals with a noise-like characteristic are permitted provided that the radiated levels do not exceed -59.0 dB μ V/m/ $\sqrt{\text{frequency}}$ at a distance of 10 m from the system. This is equivalent to:-

- 10 dB μ V/m in 8 MHz bandwidth.
- 19 dB μ V/m in 9 kHz bandwidth.
- 23 dB μ V/m in 4 kHz bandwidth.

Note 3: This limit will apply where distribution in a cabled system is on the same, or overlapping, frequencies as used for off-air television and FM radio reception in the area and at frequencies used by locally modulated equipment that may be connected to the system. In cases where distribution in a cabled system is not on the same or overlapping frequencies as used for off-air reception, consideration may be given to a relaxation of this limit.

B.4 Change of Attenuation with Temperature for Coaxial Cables with Copper Conductors

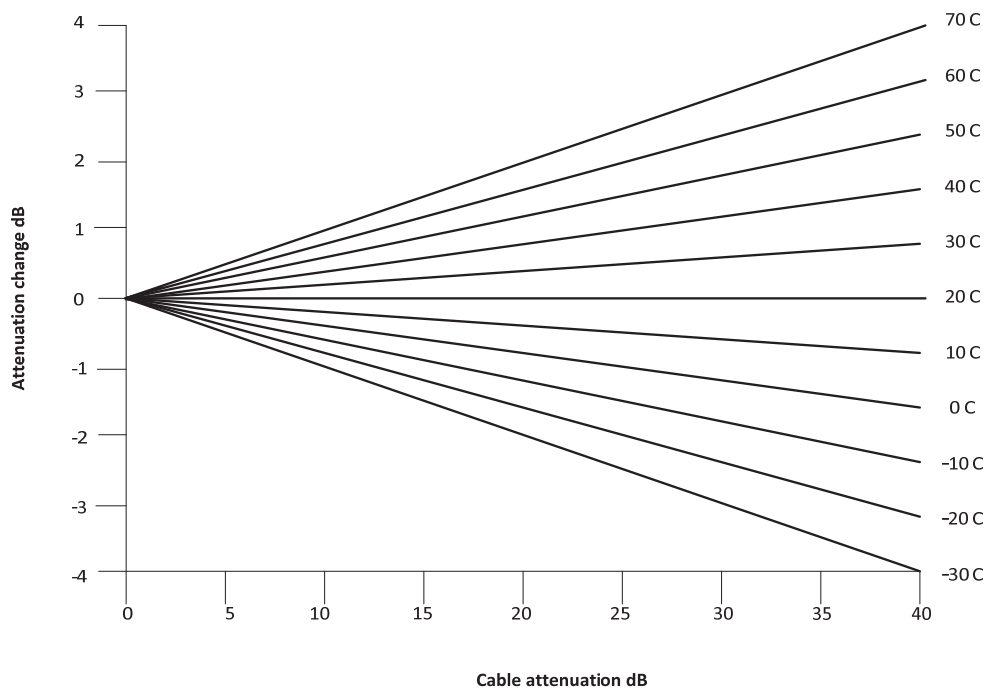


Figure 1 Change of Attenuation with Temperature for Coaxial Cables with Copper Conductors

Example

A cable run has a loss of 30 dB at 20 °C and the temperature drops to -10 °C. By drawing vertical line at 30 dB it can be noted where it crosses the -10 °C line. Draw a horizontal line at this point and note where it crosses the vertical axis. This shows a drop in attenuation of approximately 2 dB. (i.e. the attenuation on the cable will be 28 dB)

B.5 FIBRE SYSTEMS

B.5.1 System Planning

The output power of a typical fibre optic transmitter is between +3 and +20 dBm, and the receiver sensitivity is typically -15 to +3 dBm. It is important to ensure that the receiver is operated above the photodiodes noise floor and below the maximum permitted levels and this should be confirmed by the manufacturer

An optical power meter shall be available with the appropriate connectors to ensure that the optical signal is being transmitted and/or received at the correct level.

Care should be taken not exceed manufacturer's optical budget when planning a fibre system. Making note of both maximum and minimum optical input levels into the converter unit and ensuring the system design falls between these parameters. This also applies to the input levels for fibre optic amplifiers (EDFA's).

There are multiple types of fibre connector available with FC (ferrule connector) and SC (subscriber/square connector) being two of the more common. There are also two main types of polish to the end face, PC (Physical contact) and APC (Angled Physical contact). Whilst they can be mixed and matched with relevant adapters/patch leads it is recommended to keep to just one type of connector throughout the system. Where this is not possible extra care should be taken not to join the different types of end face (PC to APC).

Annex C Amplifier derating

C.1 DERATING

C.1.1 COAXIAL SYSTEMS

Broadband terrestrial amplifiers shall be de-rated: (a) if they are cascaded and (b) where the channel total is increased. It is good practice to run an amplifier at 3 dB below its maximum output rating to allow for signal variations. Any derating necessary is then calculated on this new figure.

The basic rules for broadband amplifiers are:-

- Every time the number of channels is doubled, each amplifier output shall be reduced by 3 dB including the broadband headend. Include DTT channels unless their level is more than 15 dB below the locally modulated analogue signal levels
- Every time the number of broadband amplifiers in a cascade is doubled, each amplifier output shall be de-rated by 3 dB

Most broadband distribution amplifiers for use in MATV/SMATV and cable systems are quoted by the manufacturer for maximum output level of 2 channels being amplified. Where these amplifiers are to be employed for amplification of a larger number of channels, then the maximum output level is to be reduced according to the following table.

Table 14 Derating Where maximum output is specified for 2 channel operation

Number of Channels		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Derating Figure dB		0	1.7	3	3.9	4.7	5.4	6	6.5	7	7.4	7.7	8.1	8.4	8.7	9

Number of Channels	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Derating Figure dB	9.3	9.5	9.7	10	10.2	10.4	10.6	10.8	10.9	11.1	11.3	11.4	11.6	11.7	11.9	12

Example:

If a particular broadband amplifier has a maximum output of 110 dB μ V when rated for 2 channels and it is necessary to amplify 10 channels, then according to the above table the derating figure of 7 dB should be used. Including the 3 dB reduction for signal variation gives a total deration of 10 dB. Therefore, the maximum output of this amplifier would be 100 dB μ V rated for 10 channels.

Similarly, where a cascade of similar amplifiers (Trunk or Distribution) is to be used, the maximum output of each amplifier in the cascade should be derated according to the following table.

Table 15 Cascade Derating example

Total number of Amplifiers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Derating Figure dB	0	3	4.7	6	6.9	7.7	8.4	9	9.5	10	10.4	10.7	11.1	11.4	11.7	12

Annex D Channel Selection Guidance

D.1 Channel Allocation

To avoid 'built in' problems on a network the frequency allocation of both digital multiplexes and locally modulated analogue channels shall conform to certain rules, particularly where analogue channels are carried. For the purposes of this Annex reference to 'channel' includes digital multiplexes.

There were many instances, during the terrestrial digital switchover, where digital channels were transmitted adjacent to analogue. Severe bandwidth restriction made this poor practice necessary but problems were avoided by transmitting the DTT signals at substantially lower levels than analogue. Switching off the analogue broadcasts in each region allowed the DTT signals to be correspondingly increased.

Where locally modulated analogue channels are used no other channel or multiplex should be allocated to the adjacent $N \pm 1$ channel.

In cases where analogue channels are distributed then $N \pm 5$ should also be avoided. This is because, in UHF reception, signals carried 5 channel spaces away from Ch 'N' can interfere with the TV tuner local oscillator, the severity of the interference depending on the quality of the tuner.

Analogue channel allocation within VHF is more complex and not amenable to chart production. Where VHF distribution is necessary reference should be made to a specialist in the field.

D.2 UHF Allocation Notes for Systems

Decide which off-air digital multiplexes and, where applicable, analogue channels are to be distributed.

Filter the off-air channels to avoid potential interference from unwanted transmissions.

Ensure the levels of any unwanted carriers entering the network, such as off-air transmissions from overlapping transmitters, are at least 60dB below the wanted transmissions.

Using an $N \pm 1$ / $N \pm 5$ chart allocate other distributed channels, such as locally generated services, to available channel numbers.

Channels above those used for UHF TV broadcast are not recommended for locally modulated services without adequate filtering before the headend.

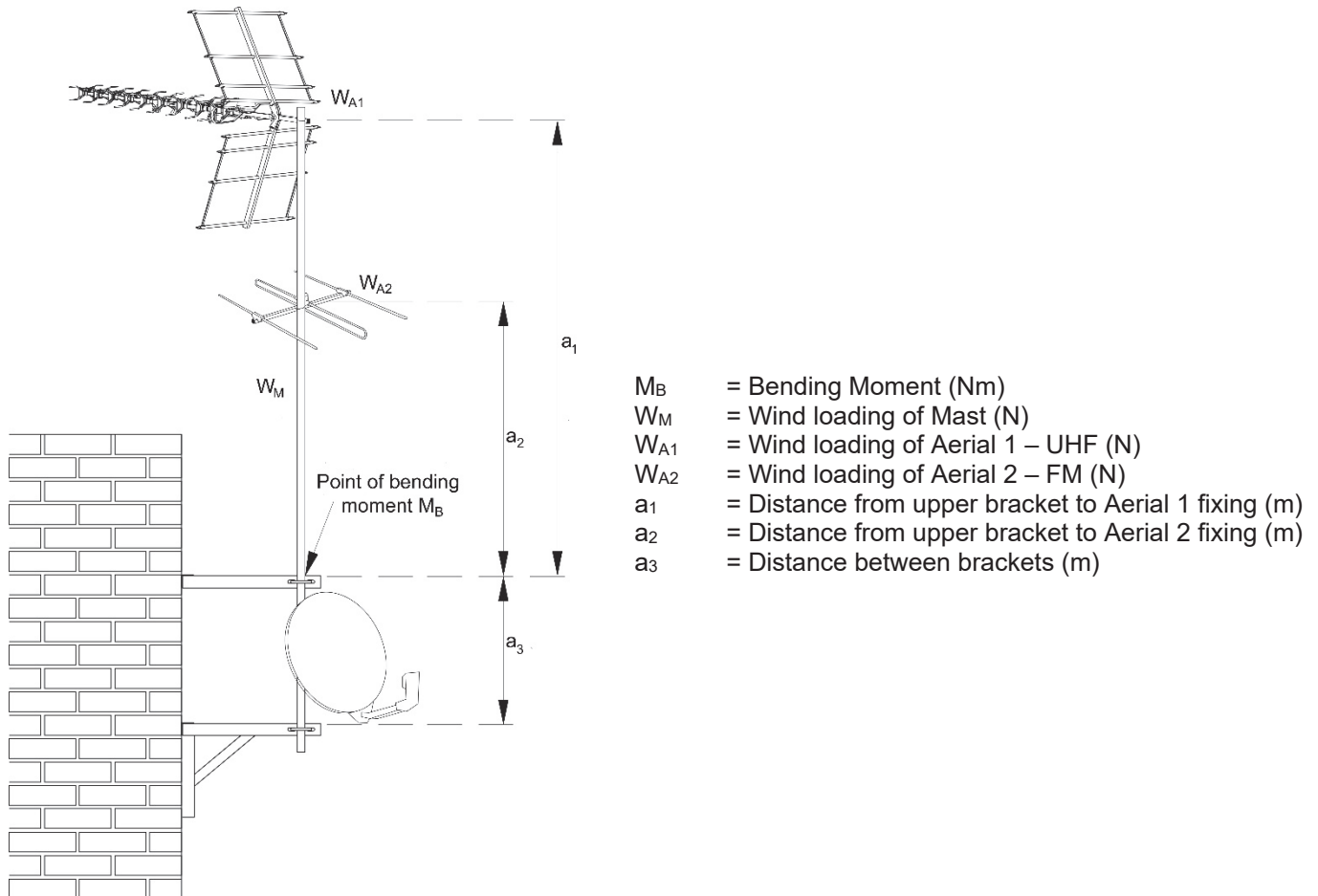
D.3 Channel Chart

N – 5	N – 1	Channel Used (N)	N + 1	N + 5	N – 5	N – 1	Channel Used (N)	N + 1	N + 5
		21	22	26	41	45	46	47	51
	21	22	23	27	42	46	47	48	52
	22	23	24	28	43	47	48	49	53
	23	24	25	29	44	48	49	50	54
	24	25	26	30	45	49	50	51	55
21	25	26	27	31	46	50	51	52	56
22	26	27	28	32	47	51	52	53	57
23	27	28	29	33	48	52	53	54	58
24	28	29	30	34	49	53	54	55	59
25	29	30	31	35	50	54	55	56	60
26	30	31	32	36	51	55	56	57	61
27	31	32	33	37	52	56	57	58	62
28	32	33	34	38	53	57	58	59	63
29	33	34	35	39	54	58	59	60	64
30	34	35	36	40	55	59	60	61	65
31	35	36	37	41	56	60	61	62	66
32	36	37	38	42	57	61	62	63	67
33	37	38	39	43	58	62	63	64	68
34	38	39	40	44	59	63	64	65	69
35	39	40	41	45	60	64	65	66	
36	40	41	42	46	61	65	66	67	
37	41	42	43	47	62	66	67	68	
38	42	43	44	48	63	67	68	69	
39	43	44	45	49	64	68	69		
40	44	45	46	50					

Table 17 Channel Chart

Annex E MECHANICAL STABILITY OF OUTDOOR AERIAL SYSTEMS

Figure 2 Wind Loading of Structure



E.1 General Requirements

All parts of the aerial system shall be so designed that they will withstand the maximum wind forces defined below, without breakage. However, in general terms, it would be wise to limit the antenna mast installation to:-

Minimum mast wall thickness	$\geq 2 \text{ mm}$
Maximum free length of mast, a_1	$\leq 6 \text{ m}$
Distance between brackets, a_3	$\geq 1/6$ of total mast length

E.2 Bending Moment

Masts have a strength dependent upon their dimensions and materials used. This strength can be transformed into a maximum permitted bending moment (not to be exceeded) that should be forthcoming from mast manufacturers. There will necessarily be a pre-defined safety margin built into these bending moment figures so as to avoid the possibility of mast breakage when loaded in excess of the maximum permitted bending moment.

E.3 Wind Pressure Values

For the purpose of establishing mast loadings, the following values of wind pressure P (in Pascals i.e. Nm^{-2}) shall be used.

In general, where aerial systems are established on buildings with a height of less than 20 m, the value of P shall be assumed to be 800 Nm^{-2} corresponding to a wind speed of 130 km/h (80 mph).

For aerial systems established on buildings with a height greater than 20 m, the value of P shall be assumed to be 1100 Nm^{-2} corresponding to a wind speed of 150 km/h (93 mph).

Where adverse environmental conditions apply, a higher wind pressure value may need to be assumed, e.g.

- for a wind speed of 160 km/h (100 mph), the wind pressure shall be 1250 Nm^{-2} .
- for a wind speed of 200 km/h (124 mph), the wind pressure shall be 1900 Nm^{-2} .

For a mast, the wind loading figure can be calculated from the following formulae:-

$$W_M = cPA$$

where:-

W_M is the wind loading of the mast (N)
 c is the area correction coefficient = 1.2 for mast
 P is the wind pressure in Pascals (Nm^{-2})
 A is the component area (m^2)

For a mast, the component area, A , is equal to the product of the mast diameter and the free length, i.e. that part of the mast above the topmost bracket (a^1).

$$A = a_1 \times D_M \quad D_M \text{ is the mast diameter (m)}$$

For antennas, the wind-loading figure shall be obtained from the manufacturers for the corresponding wind pressure relevant to the site of the antenna installation.

From the diagram, the bending moment can be calculated from the following formula:-

$$M_B = (W_{A1} \times a_1) + (W_{A2} \times a_2) + (W_M \times a_1/2)^*$$

* Load on mast is taken at mid-point of free length

This bending moment, M_B , shall not exceed the maximum permitted bending moment for the mast employed. See Table 18.

Mast Size		Max bending moment before distortion (Nm)		
Diameter	Wall Thickness	Alloy		Steel
mm	mm	Seam Welded	Extruded	
25	1.2	128	79	147
32	1.2	206	127	231
32	1.6	262	162	294
38	1.2	-	-	344
38	1.6	389	240	444
50	1.6	711	440	796
50	2	867	536	970

Table 18 Maximum permissible bending moment before distortion

Note: Additional loadings due to ice formation on the aerials and supporting structure have not been considered.

E.4 Mast Construction

Where the mast is constructed from steel, the steel shall have a guaranteed extension limit and the maximum loading shall not exceed 90% of the extension limit.

E.5 Data to be published

The aerial and mast manufacturers shall publish wind loading of aerials and masts for various wind pressures within the range of acceptability for the recommended usage.

E.6 Example: Calculation for bending moment on a mast.

Three aerials mounted 1 m apart on a 6 m x 50 mm (0.05 m) mast, 1 m of which is between the brackets, leaving 5 m of mast free.

Wind load of each aerial at a wind speed 150 km/h (93 mph) and wind pressure 1100 Nm^{-2}

UHF aerial (A_1)	185 N
DAB aerial (A_2)	50.2 N
FM aerial (A_3)	157 N

$$\begin{aligned}
 W_M &= cPA \\
 &= [1.2 \times 1100 \times (5 \times 0.05)] = 330 \text{ N} \\
 M_B &= (W_{A1} \times a_1) + (W_{A2} \times a_2) + (W_{A3} \times a_3) + (W_M \times a_1/2) \\
 &= (185 \times 5) + (50.2 \times 4) + (157 \times 3) + (330 \times 5/2) \\
 &= 2421.8 \text{ Nm}
 \end{aligned}$$

A mast with 2 mm wall thickness will not withstand this bending moment and the manufacturer/distributor should be contacted to suggest a mast of suitable dimensions and corresponding bracketry.

E.7 Correct method for terminating lashing wire

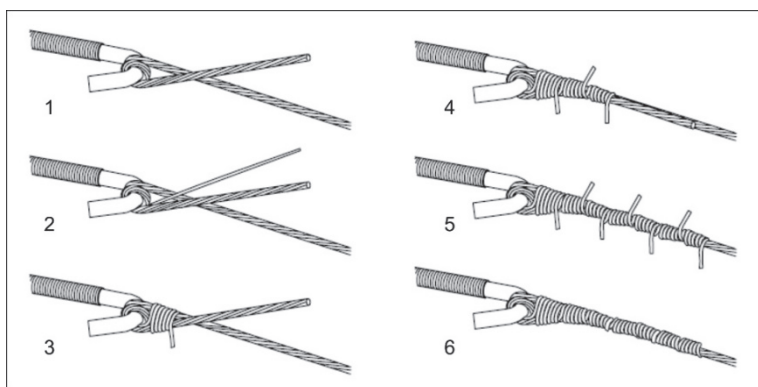


Figure 3 Lashing wire

Splice method - whereby the wire bundle is bent around the thimble and laid back alongside the incoming wire for a minimum of 150 mm.

Where thimbles are not supplied the wire should be wrapped twice around the J bolt. A single strand is unwound from the bundle and wrapped tightly around both wire bundles. The next strand is uncoiled and similarly wound but in the opposite direction around both bundles below the first strand. Each individual strand is treated in the same way until all strands are secured.

Annex F SAMPLE FORMS

The following pages contain sample forms, electronic copies can be downloaded by members from CAI website as Microsoft Office files or in .pdf format. Hard copies are available from CAI office at a cost.

Terrestrial and Satellite Reception System Standard Report Form
Full Signal Records
Client's apartment completion certificate and signal record
Certificate of Compliance
Dangerous Situation Report



Association For
Audio Visual Professionals

**Terrestrial and Satellite
Reception System**

Standard Report Form

Date Commissioned:				Order/Contract No.		No. of copies
Date Form Completed:				By:		
Client/Customer:				Site Address:		
Address:						
Postcode:				Postcode:		
Contact:		Tel:		Contact:		Tel:
Installing Company:				Engineers:		
Address:						
Postcode:						
Contact:						
E-mail:		Tel:		System planner:		
A	UHF Aerial(s)	Details (Manufacturer, Model, Polarity)				
B	FM/DAB Aerial(s)	Details (Manufacturer, Model)				
C	Mast(s)	Material	Height (m)	Diameter (mm)	Additions	
D	Bracketry	Details (Type, size etc)				
E	Satellite Dish(es)	Orb. Pos.	Make & Size (cm)	Mount	LNB Make, Type (Quad/Quatro/Fibre) & NF	
		Orb. Pos.	Make & Size (cm)	Mount	LNB Make, Type (Quad/Quatro/Fibre) & NF	
		Orb. Pos.	Make & Size (cm)	Mount	LNB Make, Type (Quad/Quatro/Fibre) & NF	
		Orb. Pos.	Make & Size (cm)	Mount	LNB Make, Type (Quad/Quatro/Fibre) & NF	
F	Headend	Location		Housed	Locked (Yes/No)	
	Launch Levels	DTT		Locally Modulated	Satellite IF	
G	System Architecture	Coax	Fibre	Hybrid	Structured Cable	
	Design	Tree/Branch		Star Wired	Switched IF	
	Cable types and size	Antenna Feeds		Trunk Feeds	Subscriber Feeds	
	Splitter/Tap/Switch/Cable Location	Internal		External	Both	
H	System Safety	Location of building's main bonding point				
	Positions of sub bonding points					
	Building equipped with LPS (Yes/No)	Type of LPS (Cross bonded/Isolated)			Antennas bonded to LPS (Yes/No/NA)	
	Surge Protection Devices fitted (Yes/No)	SPD type and locations (if applicable)				
	EFLI value (Z_s)		Ω	Cable resistance from furthest point to MET		Ω
I	Summary Info	No. Of Outlets		Location of Terrestrial Aerials		
	System plan attached (Yes/No)		Location of Satellite Dish(es)			
	Summary of Signal Parameters attached (Yes/No)					

Figure 4 Terrestrial and Satellite Reception System Standard Report Form

For IRS and satellite only systems it is necessary to record all signals in both high and low bands and with both polarities as in the example given in figure 5. Readings shall be taken at all points in apartments as well as at headends and sub-headends/repeaters to be stored for later reference. The results should be analysed and maximum and minimum results of each test point presented to the client in accordance with figure 6.. Sky provide CAI with Channel Plan updates as and when they happen –use this link www.cai.org.uk

CUSTOMER:

NOTES:

DATAFILE: 201b1 SOURCE: A1K19M TEMPERATURE: 36 °C DATE: NOT AVAILABLE

Prg	Mode	Freq. [MHz]	Prg.Name	Local Osc [MHz]	S.Rate or CH.BW.	Lnb Pol SEGMENTS	DiSeqC LAYER	Stand. or Constel	Level or Power [dBu]	C/N MER EVM [dB]	bBER	aBER PER	N.MA. [dB]	FEC HP/LP CODE RATE	QLTY
40	QPSK S1	11568.0	TP96	9750	22.000 MS/s	V L	NONE	DVB						5/6	
36	8PSK S2	11508.0	TS92	9750	23.000 MS/s	V L	NONE	DVB						8PSK 2/3	
25	QPSK S1	11265.0	TP108	9750	27.500 MS/s	V L	NONE	DVB						2/3	
38	QPSK S1	11538.0	TP94	9750	22.000 MS/s	V L	NONE	DVB						5/6	
34	QPSK S1	11479.0	TP90	9750	22.000 MS/s	V L	NONE	DVB						5/6	
42	QPSK S1	11597.0	TP98	9750	22.000 MS/s	V L	NONE	DVB						5/6	
44	QPSK S1	11626.0	TP100	9750	22.000 MS/s	V L	NONE	DVB						5/6	
48	8PSK S2	11685.0	TS104	9750	23.000 MS/s	V L	NONE	DVB						8PSK 2/3	
46	QPSK S1	11656.0	TP102	9750	22.000 MS/s	V L	NONE	DVB						5/6	
23	8PSK S2	11225.0	TS106	9750	23.000 MS/s	V L	NONE	DVB						8PSK 2/3	
17	QPSK S1	11082.0	TP65	9750	22.000 MS/s	H L	NONE	DVB						5/6	
19	QPSK S1	11112.0	TP67	9750	22.000 MS/s	H L	NONE	DVB						5/6	
43	8PSK S2	11612.0	TS99	9750	23.000 MS/s	H L	NONE	DVB						8PSK 2/3	
39	QPSK S1	11552.0	TP95	9750	22.000 MS/s	H L	NONE	DVB						5/6	
47	8PSK S2	11670.0	TS103	9750	23.000 MS/s	H L	NONE	DVB						8PSK 2/3	
22	QPSK S1	11170.0	TP71	9750	22.000 MS/s	H L	NONE	DVB						5/6	
21	QPSK S1	11141	TP69	9750	22.000 MS/s	H L	NONE	DVB						5/6	
14	QPSK S1	11038	TP62	9750	22.000 MS/s	V L	NONE	DVB						5/6	
41	QPSK S1	11582	TP97	9750	22.000 MS/s	H L	NONE	DVB						5/6	
58	QPSK S1	12070	TP19	10600	27.500 MS/s	H H	NONE	DVB						5/6	
35	QPSK S1	11493	TP91	9750	22.000 MS/s	H L	NONE	DVB						5/6	
45	8PSK S2	11641	TP101	9750	23.000 MS/s	H L	NONE	DVB						8PSK 2/3	
24	QPSK S1	11265	TP107	9750	27.500 MS/s	H L	NONE	DVB						2/3	
50	QPSK S1	11778	TP4	10600	27.500 MS/s	V H	NONE	DVB						2/3	
53	8PSK S2	11856.0	TS8	10600	29.500 MS/s	V H	NONE	DVB						8PSK 2/3	
33	QPSK S1	11464.0	TP89	9750	22.000 MS/s	H L	NONE	DVB						5/6	
60	QPSK S1	12110.0	TP21	10600	27.500 MS/s	H H	NONE	DVB						5/6	
62	QPSK S1	12148.0	TP23	10600	27.500 MS/s	H H	NONE	DVB						5/6	
55	QPSK S1	11934.0	TP12	10600	27.500 MS/s	V H	NONE	DVB						5/6	
66	8PSK S2	12226.0	TP27	10600	27.500 MS/s	H H	NONE	DVB						8PSK 2/3	
54	QPSK S1	11914.0	TP11	10600	27.500 MS/s	H H	NONE	DVB						5/6	
70	8PSK S2	12343.0	TS33	10600	27.500 MS/s	H H	NONE	DVB						8PSK 2/3	
64	8PSK S2	12188.0	TS25	10600	27.500 MS/s	H H	NONE	DVB						8PSK 2/3	
67	8PSK S2	12246.0	TS28	10600	27.500 MS/s	V H	NONE	DVB						8PSK 2/3	
59	8PSK S2	12090.0	TS20	10600	27.500 MS/s	V H	NONE	DVB						8PSK 2/3	
32	QPSK S2	11426.0	TS116	9750	29.500 MS/s	V L	NONE	DVB						QPSK 8/9	
56	QPSK S1	11953.0	TP13	10600	27.500 MS/s	H H	NONE	DVB						2/3	
68	8PSK S2	12266.0	TS29	10600	29.500 MS/s	H H	NONE	DVB						8PSK 2/3	
52	QPSK S1	11836.0	TP7	10600	27.500 MS/s	H H	NONE	DVB						5/6	
57	8PSK S2	12012.0	TS16	10600	27.500 MS/s	V H	NONE	DVB						8PSK 2/3	
31	QPSK S2	11386.0	TS114	9750	29.500 MS/s	V L	NONE	DVB						QPSK 8/9	
49	8PSK S2	11758.0	TS3	10600	29.500 MS/s	H H	NONE	DVB						8PSK 2/3	
65	QPSK S1	12207.0	TP26	10600	27.500 MS/s	V H	NONE	DVB						5/6	
51	8PSK S2	11797.0	TS5	10600	29.500 MS/s	H H	NONE	DVB						8PSK 2/3	
61	QPSK S1	12129.0	TP22	10600	27.500 MS/s	V H	NONE	DVB						5/6	
2	QPSK S1	10758.0	TP44	9750	22.000 MS/s	V L	NONE	DVB						5/6	
4	QPSK S1	10788.0	TP46	9750	22.000 MS/s	V L	NONE	DVB						5/6	
6	QPSK S1	10818.0	TP48	9750	22.000 MS/s	V L	NONE	DVB						5/6	
72	QPSK S1	12382.0	TP35	10600	27.500 MS/s	H H	NONE	DVB						5/6	
7	8PSK S2	10847.0	TS50	9750	23.000 MS/s	V L	NONE	DVB						8PSK 3/4	
12	QPSK S1	10994.0	TP59	9750	22.000 MS/s	H L	NONE	DVB						5/6	
28	QPSK S1	11343.0	TP112	9750	27.500 MS/s	V L	NONE	DVB						5/6	
30	QPSK S2	11386.0	TS113	9750	29.500 MS/s	H L	NONE	DVB						QPSK 8/9	
69	8PSK S2	12324.0	TS32	10600	27.500 MS/s	V H	NONE	DVB						8PSK 2/3	
13	8PSK S2	11023.0	TS61	9750	23.000 MS/s	H L	NONE	DVB						8PSK 3/4	
27	QPSK S1	11307.0	TP110	9750	27.500 MS/s	V L	NONE	DVB						5/6	
8	QPSK S1	10891.0	TP53	9750	22.000 MS/s	H L	NONE	DVB						5/6	
5	QPSK S1	10803.0	TP47	9750	22.000 MS/s	H L	NONE	DVB						5/6	
18	8PSK S2	11097.0	TS66	9750	23.000 MS/s	V L	NONE	DVB						8PSK 3/4	
20	QPSK S1	11126.0	TP68	9750	22.000 MS/s	V L	NONE	DVB						5/6	
10	QPSK S1	10935.0	TP56	9750	22.000 MS/s	V L	NONE	DVB						5/6	
3	QPSK S1	10773.0	TP45	9750	22.000 MS/s	H L	NONE	DVB						5/6	
15	8PSK S2	11052.0	TS63	9750	23.000 MS/s	H L	NONE	DVB						8PSK 3/4	
9	QPSK S1	10906.0	TP54	9750	22.000 MS/s	V L	NONE	DVB						5/6	
16	8PSK S2	11068.0	TS64	9750	23.000 MS/s	V L	NONE	DVB						8PSK 3/4	
1	QPSK S1	10714.0	TP41	9750	22.000 MS/s	H L	NONE	DVB						5/6	
29	QPSK S1	11344.0	TP111	9750	27.500 MS/s	H L	NONE	DVB						5/6	
26	QPSK S1	11307.0	TP109	9750	27.500 MS/s	H L	NONE	DVB						5/6	
11	QPSK S1	10964.0	TP57	9750	22.000 MS/s	H L	NONE	DVB						5/6	

Figure 5 Full Satellite Signal Records

CUSTOMER:

NOTES:

DATAFILE: SOURCE: TEMPERATURE: 29°C DATE: NOT AVAILABLE

Prg	Mode	Ch	Freq. [MHz]	Prg.Name	Bandwidth	Encoding	Modulation	Level or Power [dBu]	C/N MER EVM [dB]	V/A MODE G.INT [dB]	bBER	aBER PER	N.MA. [dB]	FEC HP/LP CODE RATE	QLTY
1	COFDM				8 MHz	8K DVB-T	64QAM								
2	COFDM				8 MHz	8K DVB-T	64QAM								
3	COFDM				8 MHz	8K DVB-T	64QAM								
4	COFDM				8 MHz	8K DVB-T	64QAM								
5	COFDM				8 MHz	8K DVB-T	64QAM								
6	COFDM T2				8 MHz	32K DVB-T2	256QAM								
7	COFDM				8 MHz	8K DVB-T	QPSK								
8	COFDM T2				8 MHz	32K DVB-T2	256QAM								
9	ANALOG				8 MHz	----	----								
11	RADIO														
12	RADIO														
13	RADIO														
14	DAB														
15	DAB														
16	DAB														

Figure 6 Full Terrestrial Signal Records

CERTIFICATE OF PRACTICAL COMPLETION

Works carried out at: -

Name of Site / Block

Apartment – number

Address

Date:

System:

IRS

The completion and final testing of the system described above has been carried out on the date of this Certificate and was found to be satisfactory in whole or in part. The system or systems were accepted, any defects or changes were noted. Any works remaining due to circumstances beyond the control of xxxxxx have been noted below.

The figures below are the minimum and maximum result of a test of all satellite transponders.

Defects or changes noted: None

Items not completed: None

Broadcast	Lounge		Bed 1		Bed 2		Bed 3		Over-all MER	Optical Power dBm
	Min. dBμV	Max. dBμV	Min. dBμV	Max. dBμV	Min. dBμV	Max. dBμV	Min. dBμV	Max. dBμV		
Astra @ 28°	62	77	60	76	60	77			10-19	-8
Eutelsat Hotbird	64	78	65	79	61	77			10-19	-8
Turksat										-8
Badr										-8
Digital Terrestrial	56	65	55	63	56	65			26-34	
VHF Radio	49	50	50	51	49	50				
DAB Radio	50	51	49	50	50	51				

Signed for and on behalf of xxxxx xxxx

Signature

Name of Signatory

Position Commissioning Engineer

Name and Address of Contractor
or Agent of End User, party from
whom instructions were received

Signed for and on behalf of the above client:

Position in Company:

Commissioning Engineer

Figure 7 Client's apartment completion certificate and signal record



CAI
Communications House
41a Market Street
Watford
Hertfordshire
WD18 0PN

Tel: 01923 803030

Certificate of Compliance

This is to certify that the system detailed below has been installed by a Registered Member of the Confederation of Aerial Industries Ltd, and who has made a binding declaration that all work done will comply in every respect to British Standards 50083 and 60728.

All systems installed by the Registered Member are subject to random inspection by a duly authorised assessor of the CAI. Any deviations from the Standard or agreed specification will have to be corrected within 21 days at the Member's expense.

This certificate does not express or imply that CAI gives any warranty or accepts any responsibility for any failure or defect that may occur now or hereafter relating to the products or services supplied by the Member.

Installer: _____ **Client:** _____
Address: _____ **Address:** _____

Tel: _____ **Tel:** _____

Site Address: _____

CAI Membership No: _____ **Installation Ref. No:** _____
Maintenance Contract: YES/NO **Date Commissioned:** _____

Tick all applicable boxes			
Type of Premises		Type of System	System Architecture
Domestic SDU	☐	IRS	☐ Coax
Domestic MDU	☐	SMATV	☐ Fibre
Commercial	☐	MATV	☐ Hybrid
	☐		☐ Structured Cable

Installer's Signature: _____ **Print Name:** _____

Date: _____

Dispute Procedure

If you, the Client, have a dispute relating to quality or compliance with standards then CAI will, at your written request, inspect and report on the installation. Should the complaint be upheld, then it must be put right at the Registered Member's expense and they will be liable for the cost of the inspection. Should no deviation be found the Client will be liable for the inspector's visit and charged the amount current at that time and available from CAI office.

Figure 8 Certificate of Compliance

Dangerous Situation Report

To be used by an engineer to inform a Client of a dangerous situation that the engineer feels needs rectifying, either by himself or a third party. This form enables the engineer to complete his work and also exonerates him if the Client does not wish the situation to be made safe. A copy of this form should be kept for your records and a further copy sent to CAI office.

		CAI Dangerous Situation Report For reporting an observed dangerous situation. Please complete all the unshaded areas	
		Job No.	
		Page	of
Owner/Occupier/Client		Date	
Address		Postcode	
Site address if different		Postcode	
Inspector		Member No.	
		Signature	
To the owner/occupier/client: A dangerous situation has been observed. It is recommended that it is rectified immediately/made safe until remedial works can be undertaken. Details of the dangerous situation are recorded below.			
Defect details			
I have been informed of the dangerous situation		Yes	☐ No ☐
I give my permission to make the dangerous situation safe		Yes	☐ No ☐
<i>(In not agreeing to make safe I understand that I take responsibility)</i>			
Owner/Occupier/Client		Signature	
Method of making safe			
CAI, Communications House, 41a Market Street, Watford, WD18 0PN			

Figure 9 Dangerous situation report

Annex G Standard Conditions of Trading

A copy of the latest version of the suggested Standard Conditions of Trading may be downloaded from CAI website <https://www.cai.org.uk/index.php/contact/downloads/members-only/templates/terms-of-trading-cancellation-of-contracts/96-terms-of-trading-systems>

Disclaimer

The conditions suggested are provided as an example only and it is not intended that members should rely on these conditions and adopt them entirely as their own, without first obtaining legal advice. Each member may have different circumstances necessitating different conditions and some of the clauses contained within the standard conditions may not be appropriate for every member company.

As an example, these conditions include an arbitration clause that commits both the company and the client to arbitration to determine any dispute or difference between them. This then means that the parties are not at liberty to pursue such a matter through the courts. Some members may prefer to resolve matters through the courts without first either using arbitration or may prefer to have the ability to use the court procedure if the outcome of arbitration is unsatisfactory. We do, however, recommend arbitration.

CAI will not be held liable for any member adopting these standard conditions as their own. CAI does not represent or warrant that the terms and conditions comply with the Unfair Contract Terms Act 1977 (or any re-enactment thereof or any supplemental regulations) or Trading Standards' requirements nor that they are the most appropriate conditions for each member company or organisation

Annex H Link Budget

The link budget is an important calculation which will show whether reception of a satellite signal is feasible at a given location. The calculation reveals the expected received signal power level and noise level, so the E_b/N_0 of the signal (closely related to the carrier to noise ratio, C/N) at the receiver can be found. Note that the link budget shown here takes no account of interference, and a site survey must be made so that visibility from the proposed receiving dish location is assured.

The first step in calculating a link budget is to gather all the required information. For the purposes of illustrating how the calculation is done, typical figures are used here, but in practice real data must be found for all parameters for each specific installation.

The following data are required:

Satellite orbital location	25.0°E	If the satellite is west of the Greenwich meridian, use a negative number
Downlink frequency	11.5 GHz	From the satellite operator
EIRP in the direction of the receiving dish	41 dBW	From the satellite operator
Gain of the receiving dish at the downlink frequency	44.5 dBi	Typical of a 1.8m dish at 11.5GHz
Noise temperature of the dish at the operating elevation	40 K	From the dish manufacturer
Noise figure of the LNB	0.5 dB	From the LNB manufacturer
Bandwidth of the signal	33 MHz	
Symbol rate	27.5 Msym/s	
Modulation	DVB-S QPSK	
FEC	3/4	
Threshold E_b/N_0	5.5 dB	See EN300421, section 5
Latitude of the receiving dish	51.032°N	Use negative values if in the southern hemisphere
Longitude of the receiving dish	-1.544°E	Negative value because the receiver is west of the Greenwich meridian

Table 19 Link budget data

Link Budget Calculations

First calculate the look angles (elevation, azimuth) from the receive dish to the satellite. To do this, first calculate an intermediate value, A , which will be used later:

$$A = \arccos(\cos(\text{receiver latitude}) \times \cos(\text{receiver longitude} - \text{satellite longitude}))$$

$$A = \arccos(\cos(51.032) \times \cos(-1.544 - 25.0))$$

$$A = \arccos(0.6289 \times 0.8946)$$

$$A = 55.76^\circ$$

Then calculate the elevation and azimuth:

$$\text{Elevation} = \arctan\left(\frac{6.62 - \cos(A)}{\sin(A)}\right) - A$$

$$\text{Elevation} = \arctan\left(\frac{6.62 - \cos(55.76)}{\sin(55.76)}\right) - 55.76$$

$$\text{Elevation} = 26.47^\circ$$

$$Azimuth = \arccos\left(\frac{\tan(\text{receiver latitude})}{\tan(A)}\right)$$

$$Azimuth = \arccos\left(\frac{\tan(51.032)}{\tan(55.76)}\right)$$

$$Azimuth = 32.71^\circ \text{ east of south}$$

Next calculate the distance, D , in kilometres to the satellite:

$$D = 42644 \times \sqrt{1 - (0.2954 \times \cos(A))}$$

$$D = 42644 \times \sqrt{1 - (0.2954 \times \cos(55.76))}$$

$$D = 38939 \text{ Km}$$

Calculate the path loss, L_{path} , from the satellite to the receiving location:

$$L_{path} = 20 \times (\log(\text{frequency in Hz}) + \log(\text{path length in Km})) + 32.45$$

$$L_{path} = 20 \times (\log(11500) + \log(38939)) + 32.45$$

$$L_{path} = 205.5 \text{ dB}$$

The total system noise temperature, T_{system} is the sum of the LNB noise temperature T_{LNB} and the dish noise temperature T_{dish}

Convert the LNB noise figure to a noise temperature:

$$T_{LNB} = T_0 \times \left(10^{\frac{LNB \text{ noise figure}}{10}} - 1\right)$$

Where LNB noise figure is in dB and T_0 is 290 K (290 Kelvin is about 17°C)

$$T_{LNB} = 290 \times (10^{0.05} - 1)$$

$$T_{LNB} = 35.4 \text{ K}$$

Calculate T_{system}

$$T_{system} = T_{dish} + T_{LNB}$$

$$T_{system} = 40 + 35.4 = 75.4 \text{ K}$$

Calculate the noise power, P_{noise} in the signals bandwidth:

$$P_{noise} = k \times T_{system} \times B$$

where k is Boltzmann's constant, $-228.6 \text{ dB}(\text{JK}^{-1})$, and B is the bandwidth of the signal in Hz.

$$P_{noise} = -228.6 + (10 \times \log(75.4)) + (10 \times \log(36 \times 10^6))$$

$$P_{noise} = 41 - 105.5 + 45.5 = -120 \text{ dBW} = -90 \text{ dBm}$$

The threshold or failure point of the signal is defined in terms of E_b/N_0 so calculate the E_b/N_0 of the signal in this system in order to calculate the margin above the threshold:

$$\frac{E_b}{N_0} = (P_{\text{signal}} - (10 \times \log(\text{useful bit rate}))) - (P_{\text{noise}} - (10 \times \log(\text{signal bandwidth}))) \text{ dB}$$

The useful bit rate is obtained from the symbol rate and FEC (Forward error correction) rates:

Useful bit rate = symbol rate x number of bits per second x inner FEC rate x outer FEC rate

Where

Symbol rate is the number of QPSK or 8PSK symbols per second

Number of bits per symbol is 2 for QPSK of 3 for 8PSK

Inner FEC rate of $\frac{3}{4}$ in this example (can have other values)

Outer FEC rate is for reed Solomon FEC and is always 188/204 (applies to DVB-S only)

$$\text{Useful bit rate} = (27.5 \times 10^6) \times 2 \times 0.75 \times \frac{188}{204} = 38.01 \text{ Mbs}^{-1}$$

Therefore, using the equation above for E_b/N_0 :

$$\frac{E_b}{N_0} = (-90 - (10 \times \log(38.01 \times 10^6))) - (-104.3 - (10 \times \log(33 \times 10^6))) = 13.7 \text{ dB}$$

For this transmission mode the threshold value of E_b/N_0 is 5.5 dB, so:

$$\text{margin to failure} = \text{actual } \frac{E_b}{N_0} - \text{threshold } \frac{E_b}{N_0} = 13.7 - 5.5 = 8.2 \text{ dB}$$

Note that this link budget calculation deals only with clear sky conditions. Atmospheric gas, cloud and rain will cause attenuation of the signal and an increase in the system temperature, both of which will act to reduce the E_b/N_0 of the signal. Interference, such as that from cross-polar transponders, adjacent satellites, and terrestrial sources, is not accounted for. Calculation of the availability, i.e. the percentage of time for which the E_b/N_0 of the signal remains above threshold, is derived from rainfall statistics and is best carried out using specialised software.

A simple link budget calculator (spreadsheet) is available to members on CAI website at <https://tinyurl.com/CAI-link-budget-calculator>

Annex I LIST OF RELEVANT STANDARDS AND OTHER REFERENCE DOCUMENTS

BS and BS EN standards are available from the British Standards Institution.

BS EN 50083/60728 Series	Cabled distribution systems for television, sound and interactive multimedia signals.
BS EN 60728-11	Part 11: Safety requirements.
BS EN 50083-2	Part 2: Electromagnetic compatibility for equipment.
BS EN 60728-3	Part 3: Active wideband equipment for coaxial cable networks.
BS EN 50083-4	Part 4: Passive wideband equipment for coaxial cable networks.
BS EN 50083-5	Part 5: Headend equipment.
BS EN 60728-6	Part 6: Optical equipment.
BS EN 50083-7	Part 7: System performance.
BS EN 50083-8	Part 8: Electromagnetic compatibility for networks.
BS EN 50083-9	Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams.
BS EN 60728-10	Part 10: System performance for return paths.
BS EN 60728-7-1	Hybrid fibre coax outside plant status monitoring.
BS EN 60728-7-2	Part 7-2: Hybrid fibre coax outside plant status monitoring. Media access control (MAC) layer specification.
BS EN 60728-7-3	Part 7-3: Hybrid fibre coax outside plant status monitoring. Power supply to transponder interface bus (PSTIB). Specification.
EN 50117 Series	Coaxial cables used in cabled distribution networks.
BS EN 50117-1	Coaxial cables. Generic specification.
BS EN 50117-2-1	Coaxial cables. Sectional specification for cables used in cabled distribution networks. Indoor drop cables for systems operating at 5 MHz - 1000 MHz.
BS EN 50117-2-2	Coaxial cables. Part 2-2. Sectional specification for cables used in cabled distribution networks. Outdoor drop cables for systems operating at 5 MHz - 1000 MHz.
BS EN 50117-2-3	Coaxial cables. Part 2-3: Sectional specification for cables used in cabled distribution networks. Distribution and trunk cables for systems operating at 5 MHz - 1000 MHz.
BS EN 50117-2-4	Coaxial cables. Part 2-4: Sectional specification for cables used in cabled distribution networks. Indoor drop cables for systems operating at 5 MHz - 3000 MHz.
BS EN 50117-2-5	Coaxial cables. Part 2-5. Sectional specification for cables used in cabled distribution networks. Outdoor drop cables for systems operating at 5 MHz - 3000 MHz.
BS EN 50117-3	Coaxial cables used in cabled distribution networks. Sectional specification for outdoor drop cables.
BS EN 50117-3-1	Coaxial cables. Sectional specifications for cables used in telecom applications. Miniaturized cables used in digital communication systems.
BS EN 50117-4	Coaxial cables used in cabled distribution networks. Sectional specification for distribution and trunk cables.
BS EN 50117-5	Coaxial cables used in cabled distribution networks. Sectional specification for indoor drop cables for use in networks operating at frequencies between 5 MHz and 2150 MHz.
BS EN 50117-6	Coaxial cables used in cabled distribution networks. Sectional specification for outdoor drop cables for use in networks operating at frequencies between 5 MHz and 2150 MHz.

Miscellaneous Standards and Regulations

BS EN 62368-1	Audio/video, information and communication technology equipment Safety requirements
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BS 1710	Specifications for labelling pipe lines
BS 5640-1	Aerials for the reception of sound and television broadcasting in the frequency range 30 MHz to 1 GHz. Specification for electrical and mechanical characteristics.
BS 5640-2	Aerials for the reception of sound and television broadcasting in the frequency range 30 MHz to 1 GHz. Methods of measurement of electrical performance parameters.
BS 7371	Coatings on metal fasteners.
BS 7671	UK wiring regulations
Building Regulations	Part P Electrical Safety.
ETR290	ETSI Document Measurement Guidelines for DVB Systems.

Other Reference Documents

CAI	Code of Practice 02 - Installation of Aerials/Antennas and Receiving Equipment in the SDU (Single Dwelling Unit).
CAI	Health and Safety in the Aerial and Satellite Industries
CAI	Guidelines on Safe Operating Procedures.
CAI	Code of Conduct.
CAI	Method Statements and Risk Assessments.
CAI	Code of Practice 03 - Electrical Safety Requirements for Signal Reception Systems (excluding CATV).
CAI	Aerial Certification Specification.
CAI	Cable Certification Specification.
DTG	R-book 7 - Installing Digital Television (MATV and IRS), available as a download from the DTG website https://dtg.org.uk/publication/r-book/

Ofcom Communications Act 2003, available from:-
<http://www.legislation.gov.uk/ukpga/2003/21/contents>

Environment Agency for Waste Carriers Registration
<http://www.environment-agency.gov.uk/business/sectors/wastecarriers.aspx>

VCA for information regarding Waste Electrical and Electronic Equipment (WEEE)
<https://data.gov.uk/dataset/abb9485-bdee-4609-a70c-f9741fb1bc36/weee-enforcement>

Note: The above URLs were correct at the time of printing.

Annex J EU Regulatory Framework

A significant proportion of the Communications Act 2003 consists of the transposition of the EU Regulatory Framework for communications into UK law. Ensuring a sound and effective framework at EU level is therefore a key priority in Ofcom's international work. In 2009, revisions to the Framework were adopted and subsequently transposed into national law by 25 May 2011.

Existing Framework

The Electronic Communications Framework is the regulatory Framework that applies to all transmission networks and services (including access) for electronic communications including telecommunications (fixed and mobile), e-mail and access to the internet. The Framework is intended to raise standards of regulation and competition across all 28 European Member States' communications markets. It consists of the following five Directives:

- the "Framework" Directive (2002/21/EC);
- the "Access" Directive (2002/19/EC);
- the "Authorisation" Directive (2002/20/EC);
- the "Universal Service" Directive (2002/22/EC); and
- the "E-Privacy" Directive (2002/58/EC).

Setting the Standard for the Future



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