Code of Practice

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

CAI COP 01 – June 2011
(Revised July 2014)
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Code of Practice

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

This document has been prepared by the Board of Directors of the Confederation of Aerial Industries Ltd (CAI).

AIMS OF THE 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.

The 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 the CAI are available from the Secretary.

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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 such as IRS, MATV or SMATV systems. 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. The CAI inspectorate examines Members’ workmanship on any inspection visit as well as in the case of a dispute.

1.2 Scope and Purpose

This Code of Practice should be read in conjunction with all other CAI Codes (see Appendix H) and is based upon British Standards relevant to the industry (also see Appendix H 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. 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 below:

(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 return paths in coaxial cable, this Code applies to signals in the range 5 MHz to 65 MHz.

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

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 the 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 is produced which leads to a risk assessment.

Where an existing system is considered unsafe, the Client shall be notified in writing as soon as possible. See Appendix 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

AM: Amplitude Modulated/Modulation.
Antenna; antennas: Aerial(s) designed for the reception of Radio Frequency (RF) signals, however constructed.
BER: Bit Error Ratio.
BS...: The relevant Standard currently in force as published by the British Standards Institution 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 coaxial or fibre cable to television receivers in a large community. Also known as “Cable Television”.
CE Mark: Consultants Europe. Certification Scheme for equipment compliance.
C/N: Carrier to Noise Ratio, difference between modulated carrier and noise floor.
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.
DTT: Digital Terrestrial Television.
DVB-S: Digital Video Broadcast – Satellite.
DVB-T: Digital Video Broadcast – Terrestrial.
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.
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.
LPS: Lightning Protection System.
LSF: Low Smoke and Fume.
LSZH, LS0H, LSNH: Low Smoke Zero/No Halogen.
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.
Member: Member of the CAI.
Multi-path effect: (Ghosting) Secondary signal received at an aerial caused by a reflection.

Multiplex: A digital transport stream of all the digital data carrying a number of services within a single broadcast channel.

PPE: Personal Protective Equipment.

Receiver: Can mean a TV, radio or set top receiver for satellite and DVB-T including video recorders, PVRs, recordable DVDs and computers.

RF: Radio Frequency.

RoHS: Restriction of Hazardous Substances.

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.

SMATV: Satellite Master Antenna Television. Similar to MATV with the addition of locally modulated signals, commonly satellite programmes.

System: A network that feeds RF signals to multiple points. See CATV, MATV, SMATV and IRS.

Systems Installer: A member registered with the CAI who claims competence in installing systems. (See CAI Approved Systems Installer).

UV: Ultraviolet radiation, that part of the Electromagnetic spectrum that causes degradation of certain materials.

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.

For additional terms refer to the CAI Website Glossary - http://www.cai.org.uk/site/glossary

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.

Where relevant the Client shall also be made aware of the Government document entitled “A Householders Planning Guide for the Siting of Satellite Television Dishes”. Copies are available from the CAI website.

Refer to Appendix A – Planning Regulations.

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 the CAI. Where necessary, the installation staff may need to attend CAI approved or recommended training courses (such as the CAI SMATV & IRS Networks Distance Learning Course). An experienced and trained installer shall be in attendance at all times. Assistants shall accompany him, where appropriate.

6.2 Identification

All members of staff should carry photographic identity cards. It is preferred that all Members display the 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:-

(a) All signal types that the installation will provide.
(b) The location of the aerials/antennas, their types and methods of installation.
(c) The routes of all cable runs, their fixings and their relative visibility.
(d) The location of any other equipment.
(e) Type and number of outlets and their locations.
(f) The expected quality of signals to be provided for all services required - see section 11.
8 INSTALLATION AND TEST EQUIPMENT

8.1 Vehicles
Vehicles shall be adequately equipped to include ladders, roof ladders and tool kits, 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) Inclinometer and compass or other means to identify satellite locations.
(b) Spectrum analyser (see below).
(c) Multimeter.
(d) 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.

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:

Measurement in the frequency range specific to the services provided. *

*Absolute level accuracy of ± 2 dB.
*C/N accuracy of ± 3 dB.
*Bit Error Ratio (BER).
*Modulation Error Ratio (MER).

within the following bands as appropriate:

87.5 -108 MHz; 117-450 MHz; 470-860 MHz; 950-2150 MHz

*For return path measurements this will require an analyser measuring down to 5 MHz.

It is essential that the accuracy of the meter be checked at least annually, to recognised national standards or 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 options listed are minimum requirements.

9 CHOICE OF MATERIALS

UV stability – the outer covering of all items – cables, paint finish, housings etc – 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 and due regard to 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 EMC compliant with regard to unwanted effects on the system, have been tested to relevant IEC standards and carry the CE mark. All applicable products should be compliant to RoHS and WEEE Directives.

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 installation 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 of 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 usable 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 Aerial Selection

For digital transmissions it is essential that the aerial be matched to 75 Ohms. Where it is possible to use an aerial that has passed the CAI Benchmarking Scheme, then that aerial shall be used.

Whilst grouped aerials have a better gain than wideband aerials, it is recommended that the appropriate aerial is used for the receive location. Where signals are outside Group A, a Group T aerial should be used. It is not recommended that Group W aerials be used due to the possible interference from LTE in the 800 MHz band. Care should also be taken if there is to be possible changes in channel allocation in the future.

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

10.2.2 Terrestrial Aerial Groups

Table 1

<table>
<thead>
<tr>
<th>CHANNELS/ FREQUENCY</th>
<th>GROUP/ BAND</th>
<th>COLOUR CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHF Television</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 – 37</td>
<td>A</td>
<td>Red</td>
</tr>
<tr>
<td>35 – 53</td>
<td>B</td>
<td>Yellow</td>
</tr>
<tr>
<td>48 – 68</td>
<td>C/D</td>
<td>Green</td>
</tr>
<tr>
<td>21 – 48</td>
<td>K</td>
<td>Grey</td>
</tr>
<tr>
<td>35 – 68</td>
<td>E</td>
<td>Brown</td>
</tr>
<tr>
<td>21 – 68</td>
<td>W</td>
<td>Black</td>
</tr>
<tr>
<td>21 – 60</td>
<td>T</td>
<td>White</td>
</tr>
<tr>
<td>FM Radio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>87.5 – 108 MHz</td>
<td>Band 2</td>
<td></td>
</tr>
<tr>
<td>Digital Audio Broadcasting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>217.5 – 230 MHz</td>
<td>Part Band 3</td>
<td></td>
</tr>
</tbody>
</table>

10.2.3 Siting of Terrestrial Aerials

In order to avoid unnecessary hazard, 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.

Reference shall be made to the CAI document ‘Health & Safety in the Aerial & Satellite Industries’. The aerial shall be kept as clear from local obstruction as possible. Where more than one aerial is mounted on a mast, a vertical distance greater than half the wavelength of the lowest frequency being received shall be maintained between aerial dipoles to avoid possible signal degradation.

Table 2

<table>
<thead>
<tr>
<th>Band</th>
<th>Longest Wavelength</th>
<th>Half Wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>II FM</td>
<td>3.4 m</td>
<td>1.7 m</td>
</tr>
<tr>
<td>III DAB</td>
<td>1.4 m</td>
<td>0.7 m</td>
</tr>
<tr>
<td>IV/V UHF</td>
<td>0.64 m</td>
<td>0.32 m</td>
</tr>
</tbody>
</table>

A spectrum analyser shall be used to ensure that the optimum receivable signal is obtained. The analyser should be used not only to locate the direction of maximum signal strength and quality, but also the optimum height and lateral position of the aerial. In difficult reception areas, a balance between the digital multiplexes should be attempted, rather than have one or two much stronger than the others. In the case of DTT signals, C/N or MER shall be checked and where possible BER. Additionally, a check of all required services on a suitable receiver shall be made before the final position of the aerial is established. Every endeavour shall be made to eliminate multi-path effects.

10.3 Satellite Reception

10.3.1 Satellite Dish Selection

Care shall be taken to select:

- a dish of the appropriate size and efficiency,
- an LNB and feedhorn that correctly illuminates the dish, with the correct local oscillator/s and of the appropriate gain, noise figure and phase noise etc for the chosen satellite transmitter’s downlink budget calculation.

The assembly of the antenna and LNB shall conform to the manufacturer’s instructions.

10.3.2 Satellite Bands

For the purpose of this Code, the frequency ranges according to the IEEE are as follows:

- C Band  4  –  8.0 GHz
- X Band  8.0  –  12.0 GHz
- Ku Band  8.0  –  12.0 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 the 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 “view” of the transmitting satellite(s). The installation shall comply with current planning regulations (Appendix A). 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 C/N or 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 the use of individual dishes is not possible, then a dish specifically designed for multi-satellite reception is recommended.

Where neither of these two options is possible and a ‘conventional’ single dish is employed for multi-satellite reception, it shall be remembered that the overall gain will reduce when an LNB is moved away from the dish focal point. The dish size shall therefore be increased accordingly to compensate and maintain the correct link budget. Due regard shall also be given to the mechanical rigidity of the LNB’s support structure.

See Appendix G for link budget calculations.

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, it is recommended that matt lead-free paint be used. To avoid solar damage, the paint shall not be more than 30% thermally and optically reflective and metallic paint shall be avoided.

11 SIGNAL MEASUREMENT / SYSTEM LIMITS

11.1 Level

Table 3 – Carrier/signal levels at system outlets

<table>
<thead>
<tr>
<th>Frequency range and service</th>
<th>Maximum Level (dBµV)</th>
<th>Minimum Level (dBµV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 MHz to 300 MHz television</td>
<td>74</td>
<td>57</td>
</tr>
<tr>
<td>300 MHz to 1 GHz television</td>
<td>80 (*)</td>
<td>60</td>
</tr>
<tr>
<td>0.95 GHz to 2.3 GHz satellite IF</td>
<td>77</td>
<td>47</td>
</tr>
<tr>
<td>87.5 – 108 MHz VHF band II radio (*)</td>
<td>74</td>
<td>40</td>
</tr>
<tr>
<td>FM sound (mono)</td>
<td>74</td>
<td>40</td>
</tr>
<tr>
<td>FM sound (stereo)</td>
<td>74</td>
<td>54</td>
</tr>
<tr>
<td>Digital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 MHz to 860 MHz television (DVB-T)</td>
<td>65 (*)</td>
<td>45 (#6)</td>
</tr>
<tr>
<td>300 MHz to 860 MHz television (DVB-T2)</td>
<td>65</td>
<td>48</td>
</tr>
<tr>
<td>0.95 GHz to 2.15 GHz Satellite IF</td>
<td>77</td>
<td>52</td>
</tr>
<tr>
<td>217.5 – 230 MHz Digital Audio Broadcasting</td>
<td>65</td>
<td>40</td>
</tr>
</tbody>
</table>

(*) Where no analogue signals are present on the system a maximum level of 80 dBµV is allowable at the outlet.

(6) With the advent of 4G LTE signals in the 800 MHz spectrum it is advised that the minimum level for DTT at the outlet should be 50 dBµV.

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 during the signal measurement and test phase of system commission.

11.1.1 Carrier Level Differences

The difference in carrier levels when the carriers are in the ranges VHF, UHF or satellite IF shall not exceed the values given in Table 4.

The difference in carrier levels when carriers are in both the VHF and UHF range shall not exceed 15 dB.

If FM and/or DAB radio signals are present at any system outlet intended for television signals, the level of any FM and DAB carrier shall be at least 3 dB lower than the lowest television signal level at that outlet.

Table 4 – Maximum level differences at system outlets between distributed analogue television channels

<table>
<thead>
<tr>
<th>Frequency range and service</th>
<th>Interval</th>
<th>Maximum level difference (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 MHz to 300 MHz VHF</td>
<td>Entire range</td>
<td>12</td>
</tr>
<tr>
<td>300 MHz to 850 MHz UHF</td>
<td>60 MHz range</td>
<td>8</td>
</tr>
<tr>
<td>Adjacent channel</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>300 MHz to 950 MHz UHF</td>
<td>Entire range</td>
<td>15</td>
</tr>
<tr>
<td>850 MHz to 2.15 GHz Digital</td>
<td>100 MHz range</td>
<td>9</td>
</tr>
<tr>
<td>Adjacent channel</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

11.1.2 Window of Operation

The minimum and maximum signal levels for each type of service (satellite/terrestrial; analogue/digital) define a “Window of Operation”, within which the signal levels shall be maintained. Since terrestrial analogue and digital signals are transmitted at different power levels, this window can be relatively small and care is needed to achieve and maintain the correct criteria. The size of the “window” is further reduced as the system increases in complexity due to the build up of equipment effects such as noise, slope and flatness.

For small digital terrestrial systems, the use of a cluster filter or cluster amplifier may increase the relative size of the “window”. For larger systems, satisfactory operation may only be achievable by using individual channel processors or channel specific amplifiers to equalize the digital multiplexes and, where necessary, change their amplitude with respect to the analogue channels (where carried), ideally to 15 dB below analogue.
11.2 Carrier to Noise (C/N)

11.2.1 Analogue Broadcast

Table 5 – Analogue Broadcast – Minimum Carrier to Noise Ratios

<table>
<thead>
<tr>
<th>Service</th>
<th>System</th>
<th>Minimum carrier/noise ratio (dB)</th>
<th>Noise bandwidth (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Television</td>
<td>625 line terrestrial</td>
<td>43</td>
<td>5.08</td>
</tr>
<tr>
<td>Television</td>
<td>PAL I  terrestrial</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>VHF FM sound</td>
<td>mono</td>
<td>25</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>stereo</td>
<td>45</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Signal/cross modulation ratio shall not be worse than $46 + 10 \log (N - 1)$ dB, where $N$ is the total number of analogue channels for which the system is designed.

11.2.2 Digital Broadcast

11.2.2.1 Carrier to Noise Ratio

Table 6 – Digital Broadcast – Minimum Carrier to Noise Ratios

<table>
<thead>
<tr>
<th>Service</th>
<th>System</th>
<th>Minimum Carrier/Noise Ratio (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Television</td>
<td>DVB – terrestrial</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>DVB - T2</td>
<td>30</td>
</tr>
<tr>
<td>Television – satellite</td>
<td>DVB – S2</td>
<td>13</td>
</tr>
<tr>
<td>Radio - DAB</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

11.2.2.2 Modulation Error Ratio (MER)

MER measurement is a useful feature of a spectrum analyser when identifying reception problems, particularly where C/N and BER appear satisfactory.

European Telecommunications Standards Institute (ETSI) document ETR290, ‘Measurement Guidelines for DVB Systems’, states “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 impairments of the received constellation as well. If the only significant impairment present in the signal is Gaussian noise then MER and signal to noise ratio are equivalent.”

Table 7 – Digital Broadcast – Modulation Error Ratios

<table>
<thead>
<tr>
<th>Service</th>
<th>Fail</th>
<th>Marginal</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Television – terrestrial</td>
<td>&lt;18 dB</td>
<td>19 – 22 dB</td>
<td>&gt;23 dB</td>
</tr>
<tr>
<td>DVB – T2</td>
<td>&lt;21 dB</td>
<td>22 – 25 dB</td>
<td>&gt;26 dB</td>
</tr>
<tr>
<td>Television – satellite</td>
<td>&lt;7 dB</td>
<td>8 – 10 dB</td>
<td>&gt;11 dB</td>
</tr>
<tr>
<td>DVB – S2</td>
<td>&lt;7 dB</td>
<td>8 – 10 dB</td>
<td>&gt;11 dB</td>
</tr>
</tbody>
</table>

The table refers to broadcasts with FEC of 2/3 via terrestrial and 2/3 ASTRA & 5/6 Eurobird via satellite and include a margin for variation in transmission conditions and receiver performance. Different FECs require different minimum MER values; consult your meter manufacturer for details.

11.2.2.3 Bit Error Ratio

For all digital services, a maximum Bit Error Ratio (BER) of $2 \times 10^{-4}$ (2e-4), measured post Viterbi, shall be achieved at the outlet.

11.3 CCIR – 5 Point Impairment Scale - Analogue

In order to avoid dispute and prior to the work taking place, it is up to the Member to obtain the Client’s written acceptance of the agreed quality grade.

Table 8 – CCIR (ITU-R) 5-Point Impairment Scale:

<table>
<thead>
<tr>
<th>Quality</th>
<th>Grade</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>5</td>
<td>Imperceptible</td>
</tr>
<tr>
<td>Good</td>
<td>4</td>
<td>Perceptible but not annoying</td>
</tr>
<tr>
<td>Fair</td>
<td>3</td>
<td>Slightly annoying</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>Annoying</td>
</tr>
<tr>
<td>Bad</td>
<td>1</td>
<td>Very annoying</td>
</tr>
</tbody>
</table>

11.4 Interference

The installation may suffer from various forms of impairment. On a normal installation, the technician shall aim for a minimum of Grade 4 for analogue services and quasi error free for digital services (see above), unless prior agreement has been made with the Client. Where there is interference, all efforts to minimise it shall be made including the fitting of suitable filters if required and advice given to the Client as to the suitability of distributing at the frequencies concerned.

All systems shall be planned and installed in line with the relevant requirements of BS EN 50083-2 and BS EN 50083-8 (EMC) to minimise signal egress/ingress.

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, where still broadcast, 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 services both terrestrial and satellite radio and television in their original formats, IRS delivers the most benefit for both landlord and tenant.

12.2 System Planning (see Appendix 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
12.3 Loop Wired Systems

Loop wired systems on new installations shall not be used.

12.4 System Architecture

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.

12.5 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 Appendix C shall be followed.

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

12.6 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 Appendix C.

12.7 Network Powering

Generally MATV and SMATV amplifiers are powered with a local mains supply or by a lower voltage, not exceeding 65 V AC or 50 V DC 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:

(a) The maximum voltage applied between the inner and outer conductor of the subscriber feeder shall not exceed 24 V AC or 34 V DC and the system designed so that no multi-dwelling system shall be powered by just one receiver.

(b) The equipment shall be so designed and constructed that no dangerous currents can flow under normal operating or single fault conditions.

(c) 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.

12.8 Signal Splitting and Impedance Matching

When selecting splitters and taps, 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.
- Line current carrying capacity.
- Weatherproofing, if applicable.
- Connection method.

Manufacturers/distributors of the equipment can supply this information.

12.9 Frequency Planning

Great care shall be taken when allocating analogue channels 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 Appendix D.

12.10 Modulators

Double side band type modulators, such as those commonly fitted in typical domestic set top boxes are not recommended for use on distribution systems and in order to preserve the digital nature of the systems it is preferable to use digital modulators on all new and upgraded systems. Once the off air analogue channels have been switched off, all TVs will either have to have a built-in DTT receiver or be connected to a DTT STB to facilitate this requirement.

13 CABLE AND WIRING

13.1 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 ‘competent person’. It may be necessary for the Member to check if and how the installation falls within the Scope, Compliance, and Notification parameters of Part P.

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 requirements of the distribution system.

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.
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. PVC cables may be used internally. Where appropriate, use Low Smoke Zero Halogen (LSZH) or Low Smoke and Fume (LSF) which should be indelibly marked to indicate this. Polyethylene cables may only be used on parts of the distribution network situated outside the building.

13.1.1 Coaxial Cables

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 copper tape and braid with a further insulating outer sheath.

All cable used for reception systems shall be properly screened, conform to BS EN 50117 and, where available, have achieved the relevant CAI Benchmark certification. 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 the CAI Code of Practice 03 “Electrical Safety Requirements for Signal Reception Systems (excluding CATV)”. Screw-on connectors shall not be used on communal systems.

13.1.2 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>
<thead>
<tr>
<th>Colour</th>
<th>Polarisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Horizontal High Band</td>
</tr>
<tr>
<td>Green</td>
<td>Horizontal Low Band</td>
</tr>
<tr>
<td>Red</td>
<td>Vertical High Band</td>
</tr>
<tr>
<td>Black</td>
<td>Vertical Low Band</td>
</tr>
<tr>
<td>White</td>
<td>Terrestrial</td>
</tr>
</tbody>
</table>

13.1.3 Labelling

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

13.2 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 proofed.

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 13.1). 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.

13.3 Cable Fixing

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

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

(a) On masts – intervals no greater than 230 mm.
(b) On vertical runs – intervals no greater than 750 mm.
(c) On horizontal runs – intervals no greater than 460 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.

13.4 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.

Cable entry into a building shall be through a hole 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 the 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 benchmarked cable would cover this.

13.4.1 Overhead Spans

Overhead cable spans shall be supported either by:-

(a) 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.
13.5.2 System Planning

13.5 Fibre Cables

The output power of a typical fibre optic transmitter is between +3 and +16 dBm. The receiver sensitivity is typically -15 to -3 dBm. It is useful to have an optical power meter available with the appropriate connectors to ensure that the optical signal is being transmitted and/or received at the correct level.

(b) 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 N/mm².
  - 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 N/mm².

13.4.2 Underground Cables

Unless specified differently by the relevant Local Authority, underground cables are to be installed at a recommended minimum depth of 450 mm and shall be of a type provided with an integral water barrier designed specifically for underground use. 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.

13.5 Fibre Cables

Commonly 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.

13.5.1 Jointing Techniques

Fibre optic cable shall be joined using the appropriate connector and jointing technique 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.

13.5.2 System Planning

The output power of a typical fibre optic transmitter is between +3 and +16 dBm, the receiver sensitivity is typically -15 to -3 dBm. It is useful to have an optical power meter available with the appropriate connectors to ensure that the optical signal is being transmitted and/or received at the correct level.

13.5.3 Safety Aspects

Fibre optic cables are made of silica glass and shall be handled with care. Off cuts 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.

13.6 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.

The connections to the new extension shall be made before connecting the cable to the telephone line. On no account should a REN of four be exceeded without the provision of a REN booster.

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

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

14 AERIAL INSTALLATION

14.1 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 Appendix 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.

14.2 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 9) as shall the method of manufacture and the grade of material used. When
14.3.2 Chimney Mounted Brackets

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 9 - Tubular Mast, tube diameter wall thickness and length

<table>
<thead>
<tr>
<th>Tube length</th>
<th>Tube diameter minimum</th>
<th>Alloy wall thickness minimum</th>
<th>Steel wall thickness minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8 m (6')</td>
<td>25 mm (1&quot;)</td>
<td>1.2 mm</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>2.5 m (8')</td>
<td>32 mm (1.25&quot;)</td>
<td>1.6 mm</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>3.0 m (10')</td>
<td>38 mm (1.5&quot;)</td>
<td>1.6 mm</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>6.0 m (20')</td>
<td>51 mm (2&quot;)</td>
<td>2.0 mm</td>
<td>1.6 mm</td>
</tr>
</tbody>
</table>

14.3.1 Installation

Masts are generally secured to buildings by one of 3 methods:-

(a) A bracket and lashing kit attached to a chimney stack.
(b) A bracket attached to the wall of a building.
(c) By passing a mast through a roof seal into the loft space where it is attached to the roof timber work by appropriate brackets.
(d) 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 BS Standards.

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 be avoided. Holes shall always be drilled to the correct diameter and depth for the chosen fastener, e.g. expansion bolt or plug and coach bolt. 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 Appendix E – Mechanical Stability of Outdoor Aerial Systems.)

14.3.2 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:-

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.

14.3.3 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 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:-

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 Appendix E – Mechanical Stability of Outdoor Aerial Systems.

14.3.4 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.

14.3.5 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 Appendix E – Mechanical Stability of Outdoor Aerial Systems.

14.3.6 Masthead Amplifiers

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.

14.3.7 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.

Expansion anchors shall not be used with any type of breeze-block, thermalite or low density material. For these materials a resin type anchor is recommended.

Due to the possibility of bricks splitting, it is recommended that bolt sizes above M10 are not used for brickwork. Avoid overtightening 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.

14.4 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:-

- 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).

15 SATELLITE ANTENNA INSTALLATION

15.1 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 Appendix 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.

15.2 Structural Supports for Satellite Antennas

The same criteria apply to fixing satellite antennas to buildings as any other antenna. Refer to section 14 for details.

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

15.2.1 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. A concrete base of suitable size and mass is recommended for tripod mounts. The antenna mount shall be secured to this concrete base using weatherproof high tensile bolts, locking nuts and washers. Planning permission may be required in certain areas - see Appendix A.

Small dishes, up to 85 cm, can be secured to a patio stand or tripod mount affixed to concrete flags or blocks using appropriate fixings.

Large antennas, above 85 cm, shall be secured to a suitable concrete base using weatherproof high tensile bolts, locking nuts and washers. Ensure that the plinth is properly constructed in accordance with the appropriate building regulations. If in doubt, a local builder shall be engaged to carry out the work.

15.2.2 Roof Mounting

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

(a) Planning Requirements. Site plans; photographs and antenna details are to be provided to the Client.
(b) 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 14.3.4.

For flat roof installations see section 14.3.5.

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

15.3 Wall Mounted Brackets

See section 14.3.3.

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 Appendix E – Mechanical Stability of Outdoor Aerial Systems.
16 PRECAUTIONS AGAINST DAMAGE AND INTERFERENCE FROM ATMOSPHERIC ELECTRICITY

Refer to separate CAI Code of Practice 03 – “Electrical Safety Requirements for Signal Reception Systems (excluding CATV)”.  

17 COMPLETION OF INSTALLATION

17.1 Reporting and Registration of Final Installation

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

17.2 Subsequent Reports on Installations

If required, the member shall be able to produce an accurate and meaningful report on any existing IRS, MATV or SMATV 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 the CAI – see Appendix F.

18 MAINTENANCE

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

19 CUSTOMER CARE

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

PLANNING REGULATIONS FOR THE INSTALLATION OF ANTENNAS, INCLUDING SATELLITE DISHES

Do you need planning permission or listed building consent?

Section 1

- Do you live in a large block of flats 15 m or more in height? [YES] Go to Section 2 below

  - NO

  - Will there be more than 2 antennas on the house or block of flats? [YES] YOU NEED PLANNING PERMISSION

    - NO

    - Will there be one or two antennas on the building? [TWO]

      - ONE

      - Is the antenna greater than 100 cm in any linear dimension? [YES]

        - NO

        - Is the smaller antenna greater than 60 cm in any linear dimension? [YES]

          - NO

          - If any antenna is to be sited on the chimney, is it more than 60 cm in any linear dimension or does it protrude more than 60 cm above the highest part of the roof or highest part of the chimney, whichever is the lower? [NO] YOU DO NOT NEED PLANNING PERMISSION

            - YES

              - Is the volume occupied by any antenna greater than 35 litres? [NO]

                - YES

                  - Is the antenna to be installed on a chimney, wall or roof slope that faces onto, and is visible from, a road or a Broads waterway? [YES] YOU DO NOT NEED PLANNING PERMISSION

                    - NO

                    - Do you live in a designated area? (See note (a) below) [YES]

                      - NO

                      - Is the volume occupied by any antenna greater than 35 litres? [NO] YOU DO NOT NEED PLANNING PERMISSION

                          - YES

                            - Is the antenna greater than 100 cm in any linear dimension? [NO]

                              - YES

                                - Will there be one or two antennas on the building? [ONE]

                                  - TWO

                                  - Is either antenna greater than 100 cm in any linear dimension? [YES] YOU NEED PLANNING PERMISSION

                                    - NO

                                    - Will there be more than 2 antennas on the house or block of flats? [NO] YOU DO NOT NEED PLANNING PERMISSION
Section 2

(a) Designated areas are:-

Conservation Areas, National Parks, Areas of Outstanding Natural Beauty and The Broads.

For further information refer to the government document:-

“A Householder’s Planning Guide for the Installation of Antennas, including Satellite Dishes”, which can be downloaded from CAI website.
APPENDIX B

SYSTEM PLANNING

B.1 General

BS EN 50083 and 60728 apply to all cable networks for terrestrial and satellite signals and 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 and 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 $2 \times 10^{-4}$ 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 CCIR 5-grade impairment scale.

B.2 System Planning

a) 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 the 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.

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

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

**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(μV/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(μV/m/√(Hz)) at a distance of 10 m from the system. This is equivalent to:

- 10 dB(μV/m) in 8 MHz bandwidth.
- -19 dB(μV/m) in 9 kHz bandwidth.
- -23 dB(μV/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 video cassette recorders, or other 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

B.5 Addition of Cross-modulation and Noise

Note: For each ratio scale use the factor indicated by the corner arrows.

(a) For overall signal-to-noise ratio add the factors corresponding to the (S/N) for each cascaded amplifier or device and from their sum obtain (S/N)m.

(b) For overall signal-to-cross-modulation ratio add the factors corresponding to the (S/X) for each cascaded amplifier or device and from their sum obtain (S/X)m.
APPENDIX C

DERATING

Broadband terrestrial amplifiers shall be derated: (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:-

(a) 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 analogue signal levels.

(b) Every time the number of broadband amplifiers in a cascade is doubled, each amplifier output shall be derated 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 either 2 or 4 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.

Where maximum output is specified for 2 channel operation

<table>
<thead>
<tr>
<th>Number of Channels</th>
<th>Derating Figure dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
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<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>5.5</td>
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<td>8</td>
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<tr>
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<tr>
<td>11</td>
<td>7.4</td>
</tr>
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<td>12</td>
<td>7.8</td>
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<td>13</td>
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<tr>
<td>14</td>
<td>8.4</td>
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<tr>
<td>15</td>
<td>8.7</td>
</tr>
<tr>
<td>16</td>
<td>9</td>
</tr>
</tbody>
</table>

Where maximum output is specified for 4 channel operation

<table>
<thead>
<tr>
<th>Number of Channels</th>
<th>Derating Figure dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>2.5</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>3.5</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>4.4</td>
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<td>12</td>
<td>4.8</td>
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<tr>
<td>13</td>
<td>5.1</td>
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<tr>
<td>14</td>
<td>5.4</td>
</tr>
<tr>
<td>15</td>
<td>5.7</td>
</tr>
<tr>
<td>16</td>
<td>6</td>
</tr>
</tbody>
</table>

Example:

If a particular broadband amplifier has a maximum output of 110 dBµV 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 dBµV 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>
<thead>
<tr>
<th>Number of amplifiers in cascade</th>
<th>Derating Figure dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
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<td>7</td>
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<td>6</td>
<td>7.7</td>
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<tr>
<td>7</td>
<td>8.5</td>
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<tr>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>9.5</td>
</tr>
<tr>
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<td>11.4</td>
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<tr>
<td>15</td>
<td>11.7</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

Due to the complex nature of how amplifiers behave with the loading of digital only systems the current advice for derating in post-switchover areas is as follows:-

Calculate the de-rating in the normal way (as if there were five analogue channels plus any locally modulated services), then reduce the resulting figure by 3 dB, and use that for the maximum power level of each multiplex.
APPENDIX D

CHANNEL ALLOCATION

D.1 Channel Allocation

To avoid ‘built in’ problems on a network the frequency allocation of both digital multiplexes and analogue channels shall conform to certain rules, particularly where analogue channels are carried. For the purposes of this Appendix 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.

For UHF distribution, where a channel frequency ‘N’ is allocated no other channel or multiplex should be allocated to the adjacent N ± 1 channel.

In cases where analogue channels are distributed then N ± 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

(a) Decide which off-air digital multiplexes and, where applicable, analogue channels are to be distributed.
(b) Filter the off-air channels to avoid potential interference from unwanted transmissions.
(c) 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.
(d) Using an N ± 1 / N ± 5 chart allocate other distributed channels, such as locally generated services, to available channel numbers.
(e) Due to the sell off of spectrum for the Digital Dividend it is not recommended that channels above UHF 60 plus those between 31 and 40 be used for locally modulated services in either digital or analogue format.

D.3 Channel Chart

<table>
<thead>
<tr>
<th>N – 5</th>
<th>N – 1</th>
<th>Channel Used (N)</th>
<th>N + 1</th>
<th>N + 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>20</td>
<td>21 22 23 24 25 26</td>
<td>41</td>
<td>45 46 47 51</td>
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<tr>
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<td>44</td>
<td>45 46 50</td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E

MECHANICAL STABILITY OF OUTDOOR AERIAL SYSTEMS

Wind Loading of Structure

\[ M_b = \text{Bending Moment (Nm)} \]
\[ W_M = \text{Wind loading of Mast (N)} \]
\[ W_{A1} = \text{Wind loading of Aerial 1 – UHF (N)} \]
\[ W_{A2} = \text{Wind loading of Aerial 2 – FM (N)} \]
\[ a_1 = \text{Distance from upper bracket to Aerial 1 fixing (m)} \]
\[ a_2 = \text{Distance from upper bracket to Aerial 2 fixing (m)} \]
\[ a_3 = \text{Distance between brackets (m)} \]

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, \( a_2 \geq \frac{1}{6} \text{ of total mast length} \)

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. \( \text{Nm}^{-2} \)) 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 \( 800 \text{ Nm}^{-2} \) 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 (\( a_1 \)).

\[
A = a_1 \times D_M
\]

\( D_M \) 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:

\[
M_B = (W_{A1} \times a_1) + (W_{A2} \times a_2) + (W_M \times a_1/2)^* + (W_{A3} \times a_3)
\]

* 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.

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 the following data for various wind pressures within the range of acceptability for the recommended usage.

(a) Wind loading of aerials and masts.
(b) Maximum permitted bending moments of masts.

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\(^{-2}\)

<table>
<thead>
<tr>
<th>Aerial Type</th>
<th>Load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHF aerial (( A_1 ))</td>
<td>185 N</td>
</tr>
<tr>
<td>DAB aerial (( A_2 ))</td>
<td>50.2 N</td>
</tr>
<tr>
<td>FM aerial (( A_3 ))</td>
<td>157 N</td>
</tr>
</tbody>
</table>

\[
W_M = cPA
\]

\[
= (1.2 \times 1100 \times (5 \times 0.05)) = 330 N
\]

\[
M_B = (W_{A1} \times a_1) + (W_{A2} \times a_2) + (W_{A3} \times a_3) + (W_M \times a_1/2)
\]

\[
= (185 \times 5) + (50.2 \times 4) + (157 \times 3) + (330 \times 5/2)
\]

\[
= 2421.8 \text{ Nm}
\]

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
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.
APPENDIX F

SAMPLE FORMS

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

- Terrestrial and Satellite Reception System Standard Report Form p.24
- Signal Records p.25
- Certificate of Completion and Compliance p.28
- Dangerous Situation Report p.29
- Standard Conditions of Trading p.30
## Terrestrial and Satellite Reception System

### A UHF Aerial(s)
- Details (Manufacturer, Model, Polarity)

### B FM/DAB Aerial
- Details (Manufacturer, Model)

### C Mast(s)
- Material
- Height (m)
- Diameter (mm)
- Additions

### D Bracketry
- Details (Type, Size etc)

### E Satellite Dish(es)
- Size (cm)
- Mount
- LNB (Quad/Quatro/OMT)

### F Headend
- Location
- Housed
- Locked (Yes/No)
- Launch Levels
- DTT
- Locally Modulated
- Satellite IF

### G System Architecture
- Tree/Branch
- Star Wired
- Switched IF
- Cable(s)
- Antenna Feeds
- Trunk Feeds
- Subscriber Feeds
- Splitter/Tap/Switch/Cable Location
- Internal
- External
- Both

### H System Safety
- Building’s Main Bonding Point
- Positions of necessary Bonding
- Building equipped with LPS? (YES/NO)
- Antennas Bonded to LPS? (YES/NO/NA)

### I Summary Info
- No. of Outlets
- Location of Terrestrial Aerials
- System Plan attached? (YES/NO)
- Location of Satellite Dish(es)
- Summary of Signal Levels attached? (YES/NO)
Signal Records

For IRS and satellite only systems it is necessary to record signals in both high and low bands and with both polarities. Readings should be taken from both the bottom and top of each band.

Suggested frequencies for the common satellites are available on the CAI website.

Records should be taken at a minimum of 10% of the outlets or 6 points whichever is the greater.
### SIGNAL RECORDS

<table>
<thead>
<tr>
<th>Service</th>
<th>Digital Transmitter</th>
<th>Satellite Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Locally Modulated</td>
<td>Terrestrial Digital</td>
</tr>
<tr>
<td></td>
<td>BCCA</td>
<td>D&amp;4</td>
</tr>
<tr>
<td></td>
<td>Low band Satellite MHz</td>
<td>High band Satellite MHz</td>
</tr>
<tr>
<td>Channel</td>
<td>A/D</td>
<td>Programme</td>
</tr>
<tr>
<td></td>
<td>Launch</td>
<td>Level - dBµV</td>
</tr>
</tbody>
</table>

### RESIDENTIAL RECORDS

<table>
<thead>
<tr>
<th>Flat No</th>
<th>Level</th>
<th>CN or MER - dB</th>
<th>BER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>CN or MER - dB</td>
<td>BER</td>
</tr>
</tbody>
</table>
Certificate of Completion and 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 Inspector 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 nor imply the 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.

Please tick relevant boxes

<table>
<thead>
<tr>
<th>Type of Premises</th>
<th>Type of System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic SDU</td>
<td>Domestic MDU</td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
</tr>
</tbody>
</table>

Installer: ...........................................  Client: .............................................
Address: ...........................................  Address: .............................................
Tel: ..................................................  Tel: ..................................................
CAI Membership No: .......................  Installation Ref. No: .........................

Maintenance Contract: YES/NO  Date Commissioned: .........................

Installers Signature: .........................  Print Name: .................................
Client’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 justified, then it shall be put right at the Registered Member’s expense and he will be liable for the cost of the inspection. Should no deviation be found then the Client will be liable for the cost of the inspector’s visit and charged the amount current at that time and available from the CAI office.
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 the CAI office.

CAI Dangerous Situation Report
For reporting an observed dangerous situation.

Please complete all the unshaded areas.

Owner/Occupier/Client

Address

Site address
If different

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 this dangerous situation
Yes  No

I give my permission to make the dangerous situation safe
(In not agreeing to make safe I understand that I take responsibility)
Yes  No

Owner/Occupier/Client

Method of making safe

Confederation of Aerial Industries Ltd, Communications House, 41a Market Street, Watford, WD18 0PN
Standard Conditions of Trading

A copy of the latest version of the suggested Standard Conditions of Trading may be downloaded from the CAI website.

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.

The CAI will not be held liable for any Member adopting these standard Conditions as their own. The CAI do 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.
APPENDIX G

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 Eb/N0 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:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite orbital location</td>
<td>25.0°E</td>
</tr>
<tr>
<td>Downlink Frequency</td>
<td>11.5GHz</td>
</tr>
<tr>
<td>EIRP in the direction of the receiving dish</td>
<td>41dBW</td>
</tr>
<tr>
<td>Gain of the receiving dish at the downlink frequency</td>
<td>44.5dBi</td>
</tr>
<tr>
<td>Noise temperature of the dish at the operating elevation</td>
<td>40K</td>
</tr>
<tr>
<td>Noise figure of the LNB</td>
<td>0.5dB</td>
</tr>
<tr>
<td>Bandwidth of the signal</td>
<td>33MHz</td>
</tr>
<tr>
<td>Symbol rate</td>
<td>27.5Mysym/s</td>
</tr>
<tr>
<td>Modulation</td>
<td>DVB-S QPSK</td>
</tr>
<tr>
<td>FEC</td>
<td>3/4</td>
</tr>
<tr>
<td>Threshold Eb/N0</td>
<td>5.5dB</td>
</tr>
<tr>
<td>Latitude of the receiving dish</td>
<td>51.032°N</td>
</tr>
<tr>
<td>Longitude of the receiving dish</td>
<td>-1.544°E</td>
</tr>
</tbody>
</table>

If the satellite is west of the Greenwich meridian, use a negative number.

First calculate the look angles from the receive dish to the satellite.

Calculate an intermediate value, A, which will be used later:

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

\[
= \arccos (\cos (51.032) \times \cos (-1.544 - 25.0))
\]

\[
= \arccos (0.6289 \times 0.8946)
\]

\[
= 55.76°
\]

Calculate the elevation and azimuth:

\[
\text{Elevation} = \arctan (\frac{42644 - \cos(A)}{\sin(A)}) - A
\]

\[
= \arctan (\frac{42644 - \cos(55.76)}{\sin(55.76)}) - 55.76
\]

\[
= 26.47°
\]

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

\[
= \arccos \left( \frac{\tan (51.032)}{\tan(55.76)} \right)
\]

\[
= 32.71° \text{ east of south}
\]

Calculate the distance, D in kilometres, to the satellite:

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

\[
= 42644 \sqrt{1-(0.2954 \times \cos(55.76))}
\]

\[
= 38939 \text{ km}
\]
Calculate the path loss \( L_P \) from the satellite to the receiving location:

\[
L_P = 20 \times \left( \log{\text{frequency in MHz}} + \log{\text{path length in km}} \right) + 32.45
\]

\[
= 20 \times \left( \log{11500} + \log{38939} \right) + 32.45
\]

\[
= 205.5 \text{ dB}
\]

The total system noise temperature, \( T_{SYS} \), is the sum of the LNB noise temperature and the dish noise temperature.

Convert the LNB noise figure to a noise temperature:

\[
T_{LNB} = T_0 \left( 10^{\frac{\text{Noise Figure}}{10}} - 1 \right)
\]

Where

- Noise Figure is in dB
- \( T_0 = 290 \text{K} \)

\[
T_{LNB} = 290 \left( 10^{0.05} - 1 \right)
\]

\[
= 35.4^\circ
\]

Calculate \( T_{SYS} \):

\[
T_{SYS} = T_{DISH} + T_{LNB}
\]

\[
= 40 + 35.4
\]

\[
= 75.4 \text{ K}
\]

Calculate the noise power \( P_N \) in the signal's bandwidth:

\[
P_N = kT_B
\]

Where

- \( k = -228.6 \text{dB} (JK^{-1}) \)
- \( T = T_{SYS} \)
- \( B = \text{bandwidth in Hz} \)

\[
P_N = -228.6 + 10 \log(7.54) + \log(36 \times 10^6)
\]

\[
= -134.3 \text{ dBW}
\]

\[
= -104.3 \text{ dBm}
\]

Calculate the level of received signal power, \( P_{SIG} \):

\[
P_{SIG} = EIRP - L_P + G_{DISH}
\]

\[
= 41 - 205.5 + 44.5
\]

\[
= -120 \text{ dBW}
\]

\[
= -90 \text{ dBm}
\]

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 threshold:

\[
E_b/N_0 = (P_{SIG} - 10 \log (\text{useful bit rate})) - (P_N - 10 \log (\text{bandwidth}))
\]

The useful bit rate (UBR) is obtained from the symbol rate and FEC rates:

\[
\text{UBR} = \text{symbol rate} \times \text{no. of bits per symbol} \times \text{FEC} \times \text{RS}
\]

Where

- FEC is Forward Error Correction of 3/4
- RS is Reed Solomon correction for a packet length of 188 bytes with 16 error protection bytes

\[
= 27.5 \times 10^6 \times 2 \times 0.75 \times \frac{188}{204}
\]

\[
= 38.01 \text{ Mbit/s}
\]
Therefore:

\[
\frac{E_b}{N_0} = (-90 - 10 \log (38.01 \times 10^6)) - (-104.3 - 10 \log (33 \times 10^6))
\]

\[
= 14.2 \text{ dB}
\]

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

Margin to failure = actual $E_b/N_0$ - threshold $E_b/N_0$

\[
= 14.2 - 5.5
\]

\[
= 8.7 \text{ dB}
\]

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. 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 calculator is available on the CAI website.
APPENDIX H

LIST OF RELEVANT STANDARDS AND OTHER REFERENCE DOCUMENTS

1  BS EN 50083/60728 Series

Cabled distribution systems for television, sound and interactive multimedia signals.

- **BS EN 60728-11:2005**  Part 11: Safety requirements.
- **BS EN 50083-5:2002**  Part 5: Headend equipment.
- **BS EN 60728-6:2003**  Part 6: Optical equipment.
- **BS EN 50083-7:1997**  Part 7: System performance.
- **BS EN 60728-10:2006**  Part 10: System performance for return paths.
- **BS EN 60728-7-1:2005**  Part 7-1: Hybrid fibre coax outside plant status monitoring.
- **BS EN 60728-7-2:2005**  Part 7-2: Hybrid fibre coax outside plant status monitoring. Media access control (MAC) layer specification.

2  EN 50117 Series

Coaxial cables used in cabled distribution networks.

- **BS EN 50117-1:2002**  Coaxial cables. Generic specification.
- **BS EN 50117-2-1:2005**  Coaxial cables. Sectional specification for cables used in cabled distribution networks. Indoor drop cables for systems operating at 5 MHz - 1000 MHz.
- **BS EN 50117-2-2:2002**  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 50117-2-3:2004**  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 50117-2-4:2004**  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 50117-2-5:2004**  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 50117-3-1:2002**  Coaxial cables. Sectional specifications for cables used in telecom applications. Miniaturized cables used in digital communication systems.
- **BS EN 50117-5:1997**  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 50117-6:1997**  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.

3  Miscellaneous Standards and Regulations

- **BS EN 60065:2002**  Electrical Safety requirements for Audio, video and similar electronic apparatus.
- **BS 5640-1:1978**  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 5640-2:1978**  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.
- **Building Regulations**  Part P Electrical Safety.

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

4  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.
Method Statements and Risk Assessments.

Code of Practice 03 - Electrical Safety Requirements for Signal Reception Systems (excluding CATV).

Aerial Benchmark Specification.

Cable Benchmark Specification.

R-book 5 - Installing Digital Television (MATV and IRS), available as a download from the DTG website.

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

Environment Agency for Waste Carriers Registration

VCA for information regarding Waste Electrical and Electronic Equipment (WEEE)
www.vca.gov.uk/enforcement/weee-enforcement.asp

Note: The above URLs were correct at the time of printing.
Setting the Standard for the Future