625-line television reception

The BBC and ITV uhf 625-line television transmissions using the PAL compatible (black & white and colour) system now cover some 99 per cent of the population. New low-power transmitting stations are still being added to the network at the rate of about 50 a year in order to fill in remaining gaps in the coverage, but 100 per cent coverage will never be achieved – present plans are for the broadcasting authorities to provide transmitting stations for population groups down to 200 people, wherever this is technically and economically feasible. Some small communities will therefore remain unserved by the broadcasters, but in suitable circumstances these communities can obtain licences to operate their own transmitting stations or wired distribution systems – see 'Self-help Systems'.

Uhf Transmitter Networks

The 625-line television services are transmitted in two bands, known as Bands IV and V, lying within the uhf part of the frequency spectrum. Band IV extends from 470 to 582 MHz (channels 21 to 34), and Band V from 614 to 854 MHz (channels 39 to 68), giving 44 channels in all. These channels are allocated in four-channel groups to hundreds of transmitting stations, so each channel must be used many times in different parts of the country.

The uhf transmitter networks are planned on the basis that a minimum field strength of 3 millivolts per metre, or 70 dB relative to 1 microvolt per metre, is required for satisfactory reception using receiving aerials with adequate sensitivity and directivity. With an 8 to 10-element uhf receiving aerial and average feeder losses, this field strength will provide an input to a receiver of about 750 microvolts in Band IV, decreasing to about 350 microvolts in the higher frequency part of Band V. There are, however, substantial variations of field strength from point to point within the service area of each transmitting station. Maps showing the service area therefore give only a general idea of the effective coverage of each station. On these maps, the boundary of the service area of a station includes those towns in which at least 70% (50% for villages) of the population can expect to obtain satisfactory reception. However, reception may be possible in many favourable locations outside this nominal service area boundary. There may also be pockets within the service area where reception is unsatisfactory because of local screening or reflections (causing 'ghosting') or both. As far as proves practicable, these pockets will ultimately be served by low-power relay stations but, where such areas are very small, 'self-help' systems may be the only practicable means of providing a satisfactory service, as described on the back page.

The channels to be used by the main uhf transmitting stations in the European Broadcasting Area are laid down in the 1961 Stockholm Frequency Plan. Four channels are assigned to each UK station – BBC-1, BBC-2, ITV, and Channel 4.

For most stations the channels are spaced according to the scheme n, n+3, n+6, n+10, or n, n+4, n+7, n+10, where n is the lowest channel number at the station concerned. These spacings are chosen to minimise interference. Since the channel spacing is 8 MHz the range of 11 channels embraces 88 MHz, overall, at these stations and it is therefore important that receiving aerials should satisfactorily cover at least this frequency range. At a few stations the channels will span a greater

range. Specially designed aerials are available to operate over these wider bandwidths.

Receiving aerials

Uhf aerials are designed for reception over a specified group of channels and are coded as follows:

Channels	Aerial group	Colour code
21–34	A	Red
39–53	B	Yellow
48–68	C/D	Green
21–68	W	Black

Note that there is also an 'E' classification (colour code brown) for channels 39 to 68. Nowadays when a received aerial group falls into this classification, the usual practice is to install a 'W' group aerial, which covers the complete range of uhf channels used for television broadcasting in the United Kingdom.

All viewers, no matter how close they may live to the transmitting station, must expect to need an outside aerial unless they are in particularly favourable situations. Because uhf transmissions behave in a similar way to rays of light and are attenuated and deflected by even small obstacles, every effort should be made to erect the receiving aerial within visual range of the transmitting aerial. In general, the more open the position in which the receiving aerial is erected, the easier it will be to receive satisfactory sound and vision on all the channels transmitted by the local station. For most viewers whose aerials are virtually within line-of-sight of the transmitting aerial, an aerial of 8 to 10 elements is suitable; these give a gain of up to 10 dB (or about three times the voltage) of a single element and a front-to-back-and-sides ratio of about 20 dB (i.e. signals from back and side directions will produce only one-tenth the voltage compared with one of similar strength coming from the direction in which the aerial is pointed). However, less favourably situated viewers will require bigger aerials with up to 20 or more elements and a gain of 14 dB (i.e. about 5 times the voltage) or more. For greater gain and directivity, arrays of two or more aerials can be used. Even high-gain uhf aerials are small; a dipole element for the top channels in Band V is only about 7 inches long and one for Band IV about 13 inches.

The transmitted signals may have either horizontal or vertical polarisation: usually main stations use the former and relay stations the latter. Receiving aerials should be installed with their elements horizontal for horizontally polarised transmissions and vertical for vertically polarised transmissions.

The need to allocate four channels from the presently available forty-four to each of several hundred stations clearly necessitates the same channels being shared by many stations. Even with the maximum geographic separation and the best use of natural screening between sites at which the same channels are to be used, it is essential to use uhf receiving aerials having sufficient directivity to prevent other transmissions on the same channel from interfering with reception.

At all receiving locations, an indirect signal resulting from reflections from the ground, buildings, etc., is present in addition to the direct signal. Over flat, open terrain, the variation in resultant signal strength will follow a simple pattern, but over irregular terrain, and particularly above the rooftops and in urban areas, the pattern is complex. As a result, in any situation it may be necessary to vary the position of the aerial by up to a few feet in all directions to find the point giving comparable reception on *all* channels. The signal strength pattern will vary from channel to channel, and from sound to vision frequencies within each channel, so the optimum position may have to be a compromise. The use of a cranked arm as the support for a uhf aerial is recommended. This allows easy adjustment of the position of the aerial in the horizontal plane.

In some difficult locations it may be found impossible to achieve satisfactory reception on all channels with any one aerial position. This problem can sometimes be solved by aerials of greater vertical and/or horizontal directivity which more strongly reject the unwanted reflected signals. Aerials of the 'log periodic' type can be helpful in this respect. At a very small number of locations, there may be more than a 10 dB difference (i.e. more than a 3 to 1 voltage ratio) in signal strengths due to propagation differences between the highest and lowest numbered channels. In these extreme cases, it may be necessary to use a separate aerial in a different position to obtain satisfactory reception on the most difficult channel, as described later.

The field strength inside a building may be more than 20 dB less than (i.e. one-tenth

the voltage of) that available outside at roof level, but viewers living in very favourable positions may find that they are satisfied with reception from an aerial in the loft. Set-top aerials rarely give entirely satisfactory results even in the most favourable conditions. A particular difficulty liable to affect reception with this type of aerial is a blurring of fine definition, caused by close-spaced reflections. If this effect is not recognised for what it is, it may arouse unjustified suspicions that the receiver is defective. Reception with set-top aerials may also vary as a result of people moving about near to the receiver.

Viewers living in areas where the direct transmission path from the transmitting aerial is blocked by a hill or other obstructions may have some difficulty in obtaining satisfactory reception. Provided the transmitter is not too distant, enough of the signal will probably pass round the obstacle to make reception possible at some points in the shadow area, but this reception will nearly always be accompanied by unwanted reflections, giving rise to 'ghosting' troubles. In such locations, it is necessary to use an aerial of greater horizontal directivity, to exclude the reflections, and mount it in a position where it does at least have an unobstructed view of the skyline over which the direct signals are being diffracted, again taking care to find the optimum position by experiment. Reflected signals usually have poor definition and tend to vary according to weather conditions, so it is rarely possible to get consistently satisfactory results by aligning an aerial on a strong reflection. Aerials with a good front-to-back-and-sides ratio should always be used to reject reflections from hills or buildings behind and to the sides of the receiving point.

Because of the sharp directivity of the multi-element aerials used for uhf reception, considerable care is required in correctly orientating them and they must be rigidly mounted so that reception does not vary because of movement in rough weather. Uhf aerial erection is made considerably easier by using a signal-strength meter to find the best balance between signal strengths and satisfactorily uniform chrominance-to-luminance ratio for multi-channel colour reception. Care must also be exercised to ensure that aerials are erected with the correct polarization, i.e. with the cross-arms horizontal or vertical as appropriate for the transmissions to be received.

Use of more than one aerial

In certain special circumstances it may be necessary to use more than one uhf aerial to get the best possible reception of all services available. These are:

where viewers have a choice of regional programmes from different transmitting stations and wish to take advantage of this; they may, however, be liable to interference if the receiving location is outside the nominal service area of the desired alternative station.

at a small minority of locations where reception is difficult and it may prove impossible to find a position for one aerial to provide satisfactory reception of the uhf services available from one transmitting station.

Usually, the best solution to all these problems is to use two aerials, each with its own downlead, the appropriate aerial being selected by a change-over switch mounted near the receiver. It is important to use a type of switch suitable for use at uhf.

Aerial downleads

It is necessary to use low-loss feeder cables of the coaxial screened type between the aerial and the receiver to reduce the loss of signal strength. The most usual type of low-loss cable introduces a loss of about 6 dB (i.e. it reduces the signal voltage to one half of the value available from the aerial) for each 100-ft length used. Cables are also available which introduce less loss and although these are more expensive, they may be necessary where signal strengths are marginal and where long cable runs are unavoidable. It is very important to ensure that good connections are made at both ends of the cable.

The use of wideband, low-noise, aerial amplfiers mounted with or as close as possible to the aerial will sometimes be found helpful in producing acceptably noise-free pictures, i.e. pictures free from 'graininess'. However, where interference is the cause of unsatisfactory reception, the fitting of an aerial amplifier is unlikely to improve matters because the interference will also be amplified along with the signal.

Aerial preamplifiers and/or power units should not be mounted on the backs of, or close to, receivers.

Cross modulation
Close to the transmitting station, the strengths of the received signals can be too great for the receiver and can cause cross-modulation, in which either one programme is superimposed on another or a patterning interference to the picture becomes evident. New relay stations may give rise to the effect in areas which have previously had weak but tolerable reception from distant stations. The answer is to install a lower-gain aerial of the correct group or to fit an attenuator between the aerial downlead and the receiver to reduce the strength of the signals. Attenuators are not expensive and are available in a range of values, commonly 6, 12, 18 and 24 dB.

There have also been instances of receivers themselves producing interference possibly affecting only one of the channels received. In such cases, the television engineer may have to seek the advice of the manufacturer or of the DTI Radio Investigation Service. A form called 'Good Radio and Television Reception' can be obtained from any main Post Office.

Lightning Protection
In most circumstances, a television aerial and its downlead introduce extremely slight risk of attracting a lightning discharge and the majority of people do not take any special steps to reduce this possibility, other than the normal good practice of connecting the outer conductor of a coaxial feeder cable to earth immediately on entry into the premises.

Some viewers are concerned about the risk of damage to their television sets in the event of a lightning discharge striking their aerial and it is true that such damage does occasionally occur. However, removing the aerial and/or mains plug overnight is not recommended, as frequent manipulation of the leads can result in premature failure of the insulation of the mains lead or of the protective components inside the receiver. Thus the risk of sustaining a dangerous electric shock from the mains is greatly increased.

In no circumstances should an aerial lead be disconnected during a thunderstorm, for should a lightning discharge take place at that moment, grave personal injury or death could result.

Teletext
BBC and ITV 625-line television transmissions carry teletext information services, known respectively as Ceefax and Oracle, on television lines 17, 18, 330 and 331 transmitted in the field blanking interval of the television signal. The teletext services can be received using a receiver equipped with an integral teletext decoder, or on a standard receiver used in conjunction with a separate teletext adaptor. Usually the teletext information pages can be received substantially free of errors even in fringe areas. The only circumstances where teletext reception is likely to be poor while the normal picture is adequate is where there are strong reflected signals from nearby buildings: the difference in path length between the direct and reflected signals may be too small to show as an obtrusive ghost on the picture, but may be sufficient to corrupt the digital teletext information. In most cases the problem can be solved by repositioning the aerial or by installing a better, highly directional, aerial array.

Self-help Systems
Some people living in small communities, particularly those situated in remote hilly areas, may never be able to receive the 625-line television services directly from a network transmitter. In many cases, however, it is possible for a community to install at its own expense a wired distribution system or a small transmitter. Both make use of a communal receiving aerial situated on nearby high ground or on a high building. In the case of a wired distribution system the signals are distributed by coaxial cable to the homes of those participating in the scheme; with a transmitter the signals are re-radiated from a second communal aerial, and are received on rooftop aerials in the normal way.

The broadcasting authorities (the BBC and the IBA) are not able to provide financial or material assistance in establishing these 'self-help' systems, but they are very willing to provide technical advice. A licence is required to operate any such system and this will not be granted unless the system conforms to certain requirements. Representatives of communities interested in installing their own systems should write in the first instance to the BBC or the IBA for guidance on procedures.

Further information

Anyone with a radio or television reception problem is invited to contact the address below, by letter or telephone, for advice.

Engineering Information Department, BBC Broadcasting House, London W1A 1AA **01-927 5040**