Digital Terrestrial TV Reception

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from *Television*, February and April 2001

The introduction of digital terrestrial television brought with it a host of challenges for the aerial installer. Here are some of the problems and their solutions. This articles concentrates on off-air reception rather than signal distribution.

Channel congestion

When Channel 5 arrived a few years ago the broadcasters had great difficulty in fitting this one extra channel into the UHF band. Coverage was not, and will never be, complete, because sufficient clear channels were not available. At the time it seemed impossible for any further transmissions to be squeezed into the band. Nevertheless, digital terrestrial television (DTT) came along and was duly slotted in, although the coverage achieved was, and is, a severe compromise. This is the cause of many of the reception problems that we now face.

The digital transmitter network

The DTT transmissions consist of six multiplexes. Each multiplex carries about eight television services, and occupies one standard 8MHz UHF channel. The DTT transmitter network is closely modelled on the analogue one, using the same main transmitter sites. The congestion of the UHF band, and the fact that the network build is still in its early stages, means that the transmissions fall short of the ideal in the following ways:

- Some multiplexes are transmitted on permanent low power.
- About a third of the transmitters have a restricted radiation pattern. In other words, they send out little or no signal in certain directions. This can apply to some multiplexes or all of them from each site.
- In many cases the DTT channels are outside the analogue channel group.
- As yet very few of the low powered relay sites transmit DTT.
- Some multiplexes are on channels adjacent to analogue signals from the same site, precluding the use of simple filters to allow individual channel processing.

Characteristics of digital reception

If an analogue TV signal weakens, the quality of the picture will decline gracefully. Even when the signal is 20dB below the recommended minimum, there will still be a picture of sorts. Digital TV is quite different. There is a very narrow margin between perfect reception and no reception at all. When signals are just on the margin the picture will freeze and break up into blocks. Because there is an inevitable variation in signal strength over time, it is vital that a safety margin is built into the installation. The simple way to check this is by temporarily attenuating the signal by 6dB. This should have no effect whatsoever on reception. The attenuator should be fitted at the input to the receiver. If a masthead amplifier or distribution amplifier is in use, the attenuator should be fitted to its input.

I think all of us in this trade have been astonished sometimes by the terrible TV reception that some people will endure. But those who now stare uncritically at a horribly snowy analogue TV picture will not be so tolerant of the digital equivalent, which is a small red square on a black background. This denotes ‘no signal’, and even your thickest customers will soon realise that it has little entertainment value. Once the signal slips even a fraction of a dB below the threshold, there is no picture or sound.

DTT uses a modulation system that provides a lot of protection against multipath reception—the cause of analogue ghosting. This seems to work very well, and it is often possible to get perfect digital reception in places where the analogue pictures have clearly visible ghost images. This is proving to be a godsend on occasions. It doesn’t get the customer out of buying an expensive aerial, because digital needs good signal levels and won’t tolerate really atrocious multipath. But whereas slight ghosting may well mar the analogue result, the digital pictures will be perfect.

Signal levels

DTT transmissions 20dB below analogue ones will give similar coverage. This is because DTT will work with a signal to noise ratio of about 24dB, whereas analogue TV needs a s/n ratio of about 44dB for a clean picture. This is, at first, quite difficult to get used to. It seems unnatural to regard a signal of –10dB/mV as 'good'!

Analogue signal strength meters will not give an accurate reading, although installers might be able to learn from experience what reception quality can be expected from a particular reading on their meter. There is, however, no real substitute for a proper digital meter or spectrum analyser.

DTT within the analogue channel group
As far as possible the six multiplexes have been shoehorned into the channel group already used by the analogue transmissions from the same site (see panel).

Transmitters with all DTT within the analogue channel group

Angus, Darvel, Eitshal, Keelylang Hill, Rosemarkie, Rosneath, Torosay, Brougher Mountain, Limavady, Aberdare, Carmel, Kilvey Hill, Llanddona, Presely, Chatton, Emley Moor, Lancaster, Oliver's Mount, Pendle Forest, Pontop Pike, Saddleworth, Selkirk, Winter Hill (but not Winter Hill B), Brierley Hill, Bromsgrove, Fenton, Sutton Coldfield, Beacon Hill, Bristol Ilchester Cres., Crystal Palace, Dover, Guildford, Huntshaw Cross, Huntshaw Cross B, Midhurst, Redruth, Salisbury, Stockland Hill, and Whitehawk Hill. (Disregarding analogue Channel 5, Tacolneston and Mendip are Group C/D, and Storeton is Group A for all analogue and digital transmissions).

If the customer has really good noise-free analogue reception, all full-power multiplexes should normally be received without difficulty. Since all signals are in the same channel group there shouldn't be large variations in propagation loss (or 'path loss'), so the analogue field strength will usually give a good indication of expected digital field strength. Don't make rash promises on the strength of this, however. In an unfamiliar reception area climb onto the roof and make proper checks with test equipment before you commit yourself. The reason for this caution is that, as already mentioned, the digital radiation pattern from some transmitters does not always correspond to the analogue one.

Transmitter radiation patterns

Transmitter output might be restricted in one or more directions, in order to prevent interference to another service. A good example of this occurs at the Crosspool transmitter, which serves Sheffield and its surroundings. The Crosspool multiplexes are on channels 39, 42, 45, 53, 57, and 60. Unfortunately, a low-powered relay on the edge of the city (Totley Rise) provides analogue TV on channels 39, 42, 45 and 49 for a small residential district. If Crosspool transmitted digital signals in the direction of the Totley Rise service area, analogue reception would be wiped out on channels 39, 42, and 45. Despite their low power, digital signals can play havoc with co-channel analogue reception (the effect, by the way, is to make the picture 'snowy', as if the analogue signal is weak). To avoid this, digital transmissions from Crosspool transmitter are dramatically attenuated across an arc of about 15˚, centred on the direction of the Totley Rise service area. This leaves a large, wedge-shaped area of the city with little or no digital reception. This situation is typical of the compromises that have had to be made with digital transmissions all over the country, and as long as digital and analogue have to share the UHF band it seems that there will be little improvement.

In this situation digital reception might be impossible, even in places very near to the transmitter and with clear line-of-sight to it. Although the digital signal levels might be adequate in absolute terms, the difference in level between them and the analogue channels—possibly as much as 50dB—might be enough to prevent digital reception. If the digital signals are presented to the receiver at useable strength, the analogue ones will cause cross-modulation. The use of a masthead amplifier is out of the question, for the same reason. When all signals are in the same group it is not practicable to use filters to separate the digital and analogue channels.

Further from the transmitter, it will simply be impossible to obtain an adequate s/n ratio. If reception from an alternative transmitter is not possible, my only advice is to throw in the towel. Sell them Sky Digital instead!

Since the digital and analogue transmissions are, in a sense, competing for bandwidth, perhaps transmitter powers and radiation patterns will be modified as more and more viewers change over to digital.

Basic aerial problems

Let's go back to the 'all signals in the same group' scenario, but this time with no transmitter peculiarities. Suppose the analogue reception appears to be all right, but the digital reception is not. Some digital channels might be fine, but others might be 'blocking', or not present at all. Even before you reach for the test equipment, look closely at the analogue pictures. The chances are, one or more channels will be just slightly 'snowy'—probably not bad enough for the customer to notice, but nevertheless not perfect. A check with the meter will show marginal analogue signal strengths at the receiver. This can be treated as a standard aerial rigging problem: improve the signal/noise ratio of the analogue signals and the digital ones will surely follow. Inadequate aerials, damaged downleads, dodgy splitters in the loft, and so on: look for all the usual suspects.

If the analogue reception is really snowy and there is no simple remedy, then the challenge presented by digital is roughly the same as the challenge of obtaining noise-free analogue reception. In areas of low field strength this can involve high gain aerials, masthead amplifiers, and careful aerial positioning. As a rule of thumb look for no less than +3dB/mV (63dB/mV) from the aerial on the analogue channels, to give reliable digital signals when the latter are the usual 20dB down.

DTT outside the analogue channel group

In aerial design there is always a trade-off between bandwidth (the range of frequencies covered) and 'gain' (sensitivity). For this reason, the UHF TV band is split into channel groups (see fig 1). In the good old days, all channels from a particular transmitter were within a group, so a 'grouped' aerial, with less bandwidth but more gain and directivity, could be used. Only a few transmitters did not comply. This happy situation ended with the arrival of Channel 5, which was often transmitted 'out of group'. Things got much worse when DTT came on the scene, with many transmitter sites using channels from the top to the bottom of the band.

Grouped aerials work very badly on channels outside their intended group. A Group A aerial, for instance, used in the middle of Group B, can be expected to have little or no gain and virtually no useful directional characteristics. The likely outcome is that the new digital customer will ring to say 'I can only get a few of the channels, but the ones I can get are perfect'. This is because one or two of the multiplexes will be in or near the analogue channel group, with the rest far away. The 'sudden death' nature of digital reception means that during the auto-tuning process the multiplexes outside the channel group will yield nothing, and the channel list will consequently be shorter than it should be. If the receiver has previously been installed elsewhere, the dreaded red square signifying 'no signal' will appear in place of the missing channels. This will even happen in 'attenuator country'—areas of extremely high field strength.

The higher channels

Where the analogue signals are all within Group A, and the digital ones are further up the band, the field strength of the higher signals might be much lower than expected. In general, higher frequencies are affected more by screening, so if there is no direct line-of-sight to the transmitter, the field strength of multiplexes in the high fifties and above might be pretty dismal.

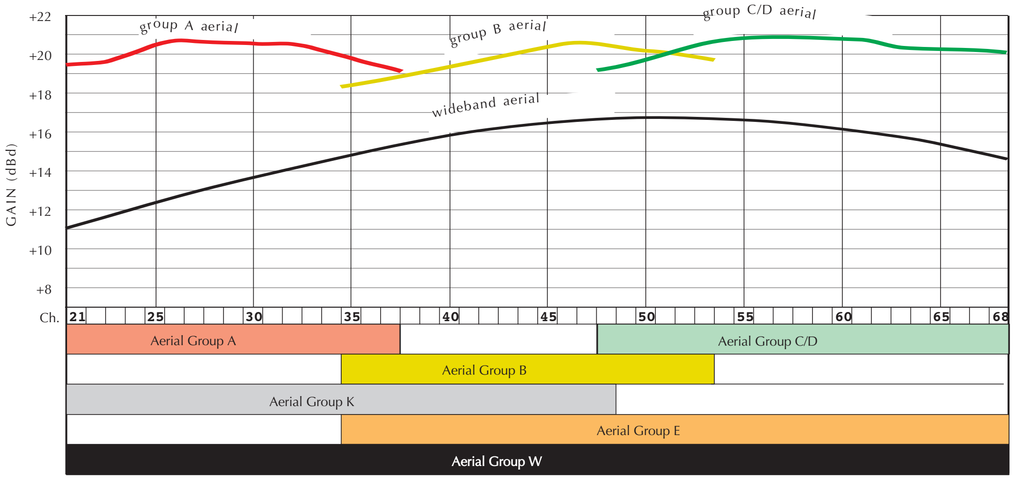

Fig 1. The forward gain of the wideband and grouped versions of a good quality high-gain aerial. The inferior performance of the wideband version is obvious, with the greatest deficiency being at the bottom of the band. The colours shown correspond to the channel group identification colour.

There are lots of Group A analogue transmitters with Groups B and C/D digital multiplexes, so the problem will be common. Relevant transmitters are: Craigkelly, Durris, Bressay, Knock More, Rumster Forest, Divis, Belmont, Bilsdale, Caldbeck, Ridge Hill, Sandy Heath, The Wrekin East and West, Caradon Hill, Rowridge, Nottingham, Sheffield, Chesterfield, Idle, Hastings, Fenham, and Lark Stoke. Some of these transmitters also carry 'out of group' Channel 5 analogue signals.

Cable losses are greater on the higher channels, of course, so a downlead that has been fine for Group A will probably be unacceptably lossy on the top channels. Cables that have taken up moisture will often have almost normal losses on the lower channels, but will lose a massive amount at the top of Group C/D. Change the downlead as a matter of course when fitting a new aerial for digital reception, especially when some multiplexes are on high channels. Use a good quality cable with copper braid over copper foil, such as Raydex CT100 or Ace QC100. For long runs use CT125 or QC125. Ensure that the cable ends are well sealed against moisture, and avoid kinking, twisting, or deforming the cable during installation.

Performance of wideband aerials

When the DTT signals are outside the analogue channel group a wideband aerial will have to be fitted, but there are pitfalls for the unwary. In 'attenuator country' it's likely to be a doddle – fit a wideband aerial and take the cash. But in districts less well endowed with field strength, the existing array is likely to be a good quality, high gain grouped one. The performance of a wideband array will not be as good as the grouped equivalent. Analogue reception might be visibly degraded, and digital reception could be disappointing.

UHF aerials derive most of their gain and directivity from the fact that they are resonant at the desired frequencies. The lengths of the individual elements are adjusted for resonance, as are the distances between them. The driven element is designed to transfer the collected energy to the feeder most efficiently at the desired frequencies. The wider the bandwidth, the more each factor must be a compromise. Fig 1 shows the forward gain of the grouped and wideband versions of a good quality high gain aerial. It is clear from the graph that where signal strength from a grouped aerial is only just adequate, replacing it with a wideband one is not an option.

We have to accept that wideband reception is now unavoidable in many areas – after all, the multiplexes simply couldn't be fitted in otherwise—but installers need to familiarise themselves with the performance deficit of the various wideband aerials available, compared to the familiar grouped ones.

In the early stages of the changeover to digital, the VCR and all the TV sets except the main one will still need good analogue signals. Where the household has an existing distribution system for analogue reception, fed by a large, grouped, high gain aerial, there is no reason at all to alter the arrangement. The digital box can have its own aerial, with a separate cable from the roof. At some locations the best digital and analogue signals will come from different transmitters. Even when all signals come from the same transmitter, separate aerials can in some cases be used to advantage. The Malvern transmitter, for example, requires (ideally) a Gp C/D aerial for analogue, but a Gp B aerial for digital. In a difficult reception area the use of two grouped aerials rather than a single wideband one could make a real difference.

If the RF output of the digital box is not used, there will be no complications when a separate aerial is used. If the RF output has to be distributed to all the TV sets, this can be done via a single channel pass filter, or a one-channel combiner, such as the Taylor TCFL1-1CH (fig 2).

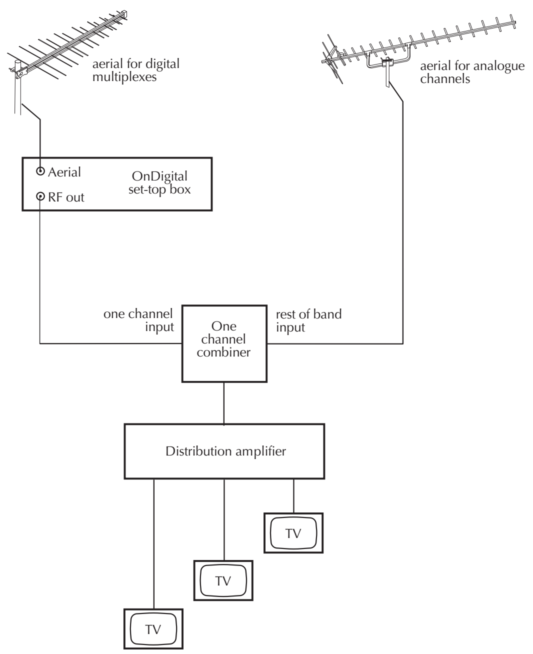

Fig. 2.

Incidentally, if anyone has an easy, reversible method of disabling the UHF loopthrough on an OnDigital box, please let me know.

Not all transmitters need receiving aerials that cover the whole UHF band. In some cases only Groups A and B, or Groups B and C/D, are used. For the former use a Group K aerial, and for the latter a Group E (fig 1). These aerials can be expected to perform better than the equivalent Group W array, which covers the whole band. The following table shows the bandwidth of each channel group as a percentage of centre frequency. This gives some indication of the likely relative performance of aerials of different channel groups.

Channel group	Bandwidth
A	24
B	19
C/D	20
E (B & C/D)	34
K (A & B)	43
W (A, B, & C/D)	57

Broadly speaking, there are three types of wideband aerial in common use.

The wideband yagi

The wideband yagi is similar to the conventional grouped yagi, with its familiar reflector, folded dipole, and director chain. The tuning of the array is much broader, though. The reflector is long enough to function on the lower channels, the director chain is scaled down so that it will function on the higher channels, and the dipole is, well, an uneasy compromise (fig 3). In general these aerials perform reasonably well in the middle portion of the band, but are not so clever at the ends, especially the bottom end (fig 1). Reputable manufacturers go to a lot of

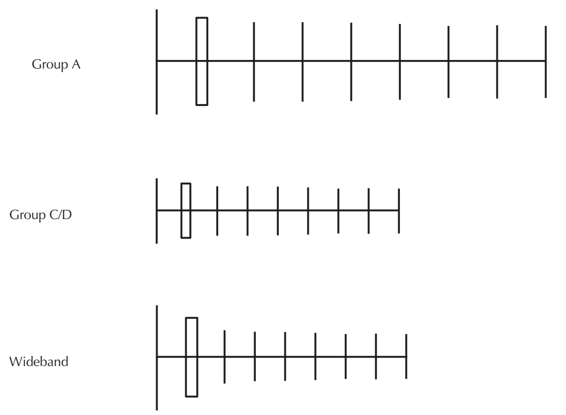

Fig. 3. A wideband yagi has a greater spread of element lengths than the grouped equivalent, because it has to handle a greater range of frequencies. The reflector is long enough for the lowest channels, whilst the directors are short and close-spaced, so that they can function on the higher channels. The folded dipole is usually a compromise length.

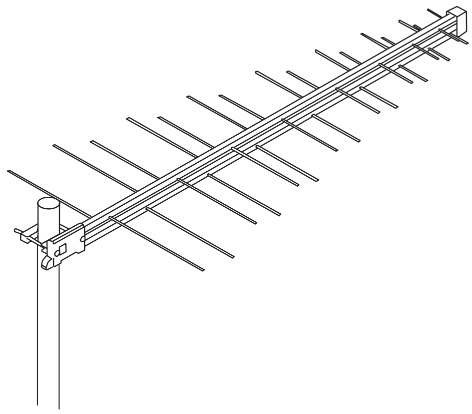

Fig. 4. An end-mounted, horizontally-polarized, log-periodic aerial. The feed point is at the high frequency end, with the feeder running inside the boom. The boom also functions as a transmission line.

trouble to optimise and impedance-match their wideband yagis, but some of the contract quality wideband efforts are an absolute joke, with no useful gain or directional characteristics on some channels.

The log-periodic

Virtually every other television aerial ever made can trace its ancestry back to Professor Yagi's eponymous invention, but not the log-periodic. Unlike yagi-based designs, every dipole of a log-periodic is driven – that is, it is connected to the feeder (figs 4 and 5). I'm not going to go too far into the theoretical aspects of the design, but the basic idea is that the dipole length and spacing follows a regular geometrical progression. This ensures a smooth transfer of resonance from one dipole to the next as frequency varies. The range of frequencies covered can be tailored exactly, because it depends simply on the resonant frequencies of the shortest and longest dipoles. The boom also functions as a live transmission line, with the dipoles mounted along its length in alternating phase. The feeder is connected across the high-frequency end of the boom. The gain is more-or-less constant across the design

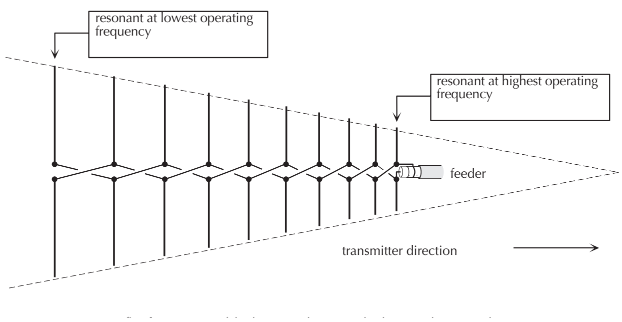

Fig. 5. Diagram of the log-periodic principle showing the cross-phasing and the geometric progression of the element length and spacing.

bandwidth, and the array is highly directional. Sounds too good to be true? Well, the downside is the forward gain, which for practical designs covering the UHF TV band is only about 9dBd (*dBd = 'dB referred to a half wave dipole'*). If you replace a grouped yagi with a log-periodic expect to lose 3 to 6dB of gain. This might be where you reach for a wideband, low gain, masthead amplifier, as discussed below.

The stacked dipole

Colloquially known as the 'panel aerial', 'billboard', 'fireguard', or 'grid', this array consists of four dipoles (nominally full-wave) with a large reflector (fig 5). The dipoles are stacked one above the other (when mounted for horizontal polarisation), and linked by crossed transmission lines to a central feed point. The spacing of the dipoles and the crossed transmission lines mean that the output from an on-axis signal will be in phase at the feedpoint. This gives the aerial much of its gain and directivity. The double arms of the dipoles make a 'V' shape and form the equivalent of a broad 'butterfly' dipole, so they have much broader resonance than a straight dipole. Thus the aerial is wideband.

These aerials are available from various manufacturers, and since the basic design allows considerable modification, the performance varies significantly from one make to another. In general, however, the gain can be as low as 8dBd on channel 21, peaking at about 13dBd somewhere around channel 55 or 60. Gain tends to decrease above that point, which is a pity, because otherwise the response would be well suited to the familiar wideband situation where the highest channels need the most gain. These aerials could be useful for Group K reception (Bilsdale, Craigkelly, Storeton, and Caradon Hill), where all channels are in the range 21 to 49.

Some installers swear by the 'fireguard' as an anti-ghosting aerial, and this suggests that it could be useful for dealing with digital co-channel interference. I would dispute this for horizontal polarisation, but when the aerial is used for vertical polarisation the four dipoles are stacked horizontally, giving considerable rejection of off-beam signals due to the phasing of the array.

This is not a high-gain aerial, despite often being used as such, and with quite high wind resistance needs secure mountings when atop a long mast. I've never been a great fan of the 'fireguard', feeling that they are rather unwieldy for their performance, but I have found them useful when it has been necessary to fit an aerial half way up a wall. When the transmitter direction is roughly at right angles to the wall the installation is very neat, protruding only about 300mm.

Tree trouble

When the signal path passes through trees, strange things can happen. Familiar analogue reception conditions include a simple reduction of signal strength across all channels, a severe reduction on one or more channels whilst the others remain relatively unscathed, and deep signal fading for short or long periods. These faults can occur singly or in combination. Because foliage tends to affect higher frequencies the most—a wild generalisation but let's stick with it—multiplexes on higher channels are likely to be a problem. Good reception of Group A analogue tells you nothing about likely Group C/D digital reception if there is even the slightest tree screening.

During the initial installation the digital receiver might find fewer channels than expected. The spectrum analyser will show that some multiplexes are much weaker than the others. This can be treated in the same way as the equivalent analogue problem. Employ all the usual techniques, but in particular try to find a location for the aerial where there is less tree screening. This is often a lot of trouble, but it will give a more reliable result than simply using big aerials and amplifiers. Attempts to amplify very weak multiplexes will most likely result in cross-modulation, since they could be 50dB below the analogue channels. Get all multiplexes as strong and as even as possible at the aerial terminals before considering amplification.

The really annoying tree-screening fault is the 'occasional deep fade'. The signal level on one or more multiplexes suddenly takes a dive, dropping by ten or twenty dB. This will typically last between one and ten seconds. It might happen once a week, once a night, or once every few minutes. With analogue reception, the customer might not be too concerned, because often all that happens is that the picture becomes snowy for a short while. With digital, the picture freezes or disappears, and this is subjectively much worse. The customer will probably claim that it always happens during 'the exciting bits'. You might have to take their word for it, because the fault might not manifest itself whilst you are there. The chances are, the signal levels will not be too good even when they are at their best, so a better aerial location and a low gain masthead amp might help. Make the customer understand that this might not be a complete cure, because at times the fluctuating signal might still fall below threshold.

Masthead amplifiers

The danger with masthead amplifiers is that the analogue channels will cause cross-modulation. The temptation to use a masthead amp will arise when one or more multiplexes are on or below the noise threshold. Why are these multiplexes so weak? It might be that they are transmitted 30dB or more below the analogue channels, instead of the more common 20dB, or it could be because of a null in the transmitter's radiation pattern. It could be as the result of frequency-selective screening along the signal path. When these factors combine there can be massive differences in signal level between the weakest multiplexes and the strongest analogue channels, making the use of a masthead amplifier problematic. It is possible that digital signals weak enough to need a masthead amplifier can be accompanied by analogue signals strong enough to overload the amplifier. The digital signals will normally be about 20dB below the analogue, of course, but even when this factor is discounted the dynamic range entering the amplifier can be rather alarming. The problem is exacerbated because cross-mod that would have little visible effect across analogue channels all of roughly the same strength can seriously affect accompanying weak digital signals.

To find the input signal level that drives an amplifier into cross-modulation, subtract the gain from the maximum output. So the vital message is, 'Keep the gain down!' The masthead amplifier's gain should normally be enough to compensate for downlead losses, plus no more than 10dB. High gain masthead amplifiers should only be used when all incoming signals are very low. They can make matters worse if used indiscriminately.

The choice of amplifier should take into account noise figures and maximum output capabilities, as well as gain. I nearly always use a Labgear PUM110. This is a wideband amplifier built into a sturdy diecast housing, with a gain figure of 12dB, and a noise figure of 2.5dB. This item has a high maximum output figure, but even so might be in difficulties when digital signals are 40dB or more below the analogue ones.

Where conditions are less extreme, with all signals just slightly low, masthead amplifiers can often be very useful. When a grouped aerial is replaced by a wideband one, signal levels from the aerial will inevitably be lower. If a masthead amp wasn't in use before, suggesting that analogue signal levels from the grouped aerial were –3dB/mV or better, fitting one in conjunction with a wideband array can work well. This is especially true if the downlead is on the long side.

But when analogue signals from the grouped aerial are in the range –20 to –10dB/mV, it's a different story. It's likely that a high gain, grouped, masthead amplifier will already be in use, and if so, tread very carefully. The signal to noise ratio is largely set at the input to the masthead amp., and if the output from the aerial is reduced the s/n ratio will inevitably be worsened. If you do fit a wideband aerial, a high gain wideband masthead amp would be appropriate, but the results could be disappointing.

Masthead amplifiers often amplify out-of-band signals that we would otherwise know nothing about. The classic is the UHF communications base station on 450 to 470MHz of the 'BD to Z Victor One' variety. This frequency is well within the passband of most masthead amps, and a nearby transmitter can easily cause cross-modulation. At the level where the analogue pictures might show only faint patterning, digital reception can be badly affected. A clue might be the intermittent nature of the fault, due to the interfering carrier only being on when in use—although some carriers are on continuously. The cure is a notch filter, fitted in-line before the masthead amplifier. A suitable item is the Taylor TBF4, but this is an indoor unit so some sort of housing is required. A spectrum analyser is necessary to identify the offending signal, and to tune the filter.

Distribution amplifiers

Some cheap domestic distribution amplifiers will be disturbed by strong signals on frequencies as low as 27MHz. Now that CB radio has been largely displaced by the internet as a means of broadcasting teenage angst, the main culprit seems to be taxi base stations and suchlike on about 175MHz, and VHF-FM pirate stations. Fit a 300MHz high pass filter (Antiference TVI/U). See also 'Interference from VHF Transmissions' (*Television*, November 2000).

There are some really bad distribution amplifiers on the market. One common fault is a severe fall-off of gain above channel 60. Another is very limited maximum output, which can mean that the amplifier produces cross-modulation even with quite modest input levels. This sort of thing just won't do when the digital signals are carried 20dB below the analogue ones.

The distribution of digital and analogue signals together on communal television systems is a large subject, fraught with difficulty. It's beyond the scope of this article, but I hope to cover it in a later contribution.

Separate processing of digital signals
When digital and analogue signals are on adjacent channels, diplexers or channel-pass filters cannot separate them. This means that they must be processed together, and their relative levels cannot be adjusted. But when digital and analogue signals are not adjacent, a range of possibilities opens up.
The most satisfactory method is to use separate channelpass filters throughout. Each channel passes through an individual series of one-channel filters and a variable attenuator. The only disadvantage is the cost, which would be about £150 for the five analogue and six digital channels. But it can be worthwhile in some circumstances, such as:

- Building a head-end for a medium or large distribution system.
- Where some multiplexes are on permanent low power.
- At difficult receiving sites where propagation effects weaken some channels much more than others
- Where long cable runs need equalisation because of excessive loss at higher frequencies.
- Where it is necessary to use more than one aerial to receive all the required channels.
- Where other signals, such as set-top box RF outputs, will be added, but no clear channel exists for them.

Less costly solutions might include the use of notch filters, bandpass filters, and grouped aerials to attenuate the analogue signals, thus allowing amplification of the digital multiplexes without cross-modulation. Notch filters are usually tunable, and stop one channel. Bandpass filters pass one channel group but attenuate another. A good quality diplexer can be used as a bandpass filter, by connecting one input only and terminating the other with 75Ω.

Co-channel interference

The very full use of the UHF TV band in the UK has led to frequency allocations where co-channel interference is a distinct possibility. In some locations co-channel interference can be the main factor limiting coverage. Co-channel interference can be digital on analogue, analogue on digital, or digital on digital. It can also, of course, be analogue on analogue, but that's an old story that doesn't concern us here—and won't, I suppose, concern us at all before long.

Co-channel on digital, whatever the source, reduces the s/n ratio, and if it reduces it enough will cause the familiar stop-start effect, or even complete loss of reception. Digital on analogue co-channel interference gives a snowy picture, just as if the signal is weak.

I'm sure the network planners know what they're doing, but some of the digital channel allocations do seem a bit perverse. In this part of the world, for instance, Emley Moor and Chesterfield, which have a considerable service area overlap, both use channels 40, 43, 46, and 50. Although the polarisation differs, this causes severe problems in some districts.

In the battle against digital co-channel problems, we must employ the familiar weapons used against analogue co-channel interference and ghosting. I mention ghosting, because the problem is fundamentally the same—the presence of an unwanted off-axis signal. Highly directional arrays and very careful aerial positioning are needed. If the aerial has to be wideband, things are that bit more difficult. The use of buildings and topography as a screen against the unwanted signal can work very well. Stacked and phased arrays can be helpful—see my optimistically titled piece 'Eliminating Ghosts' (*Television* Nov 1978).

Digital reception brings its own special problem: it is often not possible to assess the result of any work to reduce co-channel interference by simply looking at the TV screen. The work might take the signal from just above threshold to well above threshold – well worthwhile in view of possible propagation fluctuations. The unwanted signal, after all, is likely to have a fairly distant origin, so might vary considerably. But at the time of the alterations to the aerial no improvement will be seen. The job will probably have been undertaken because of a complaint of occasional loss of digital signal. It is, of course, necessary for the s/n noise ratio to comfortably exceed the 'threshold' figure, and this applies whether the 'noise' is thermal noise or an unwanted signal on the same channel. But the 6dB attenuator test will prove nothing in the case of co-channel interference, because it will reduce the wanted and unwanted signals equally. The fact is, we are going to need sophisticated (read expensive) test equipment, and a lot of (priceless) intuition, as the digital revolution rolls out.

Impulse interference

We are all familiar with the interference caused to analogue reception by next door's lawnmower or faulty central heating thermostat. Impulse interference consists of one or more very short duration 'spikes'. The 'spikes' are broadband, with an energy distribution that usually falls off above the VHF band. Nevertheless, the amplitude of a 'spike' at UHF can be surprisingly great, with only its very short duration preventing it from completely swamping the signal. A whacking great burst of noise, even if it lasts only a few milliseconds, has the potential to play havoc with digital reception. In areas of very low field strength, where impulse interference is often visible on analogue reception, be prepared for digital pictures to 'freeze' periodically. Occasionally the receiver might 'lock-up', necessitating a press of the 'reset' button. The peak amplitude of the spike, if we could measure it accurately, would probably be many dBs above the signal. Although re-siting the aerial, and so forth, could improve the s/n ratio by as much as 15dB, the effects of the interference might not be eliminated. The 'spike' could still be 15dB or more above the signal. The only effective action is to stop the interference at source. This might be possible with a faulty thermostat (if it can be found), but not with traffic interference.

The finishing touches

Many aerial contractors feel that their responsibility ends when they connect good signals into the set-top box. This is unlikely to satisfy the customer, since 'bad reception' is 'bad reception', whether the cause is on the roof or in the living room. To complete the installation, scrounge a cup of tea and give some time to those little tasks in the living room that can make all the difference.

Set-top box installation

If the set-top box or IDTV (Integrated Digital TV) is brand new, it is usually only necessary to follow the on-screen menus. All available programme services will be found and stored. If the unit has been installed before, on a different transmitter, select 'store channels' rather than 'add channels'. Some boxes require you to input the four digit parental code at this point. If this happens and you don't know the code, remove the card and try again. For some strange reason this usually works.

When re-installing a box remove the card first, because its presence seems to cause some boxes to display 'no channels found', even though the signal strengths of all channels may be shown as 'good'.

In areas of very high field strength, cross-modulation in the receiver can reduce the number of channels found. Fit an attenuator and try again. The on-screen signal strength display is useful, but cannot tell you when to fit an attenuator because a full-scale reading equates to only about12dB above threshold. Half scale is roughly 3dB above threshold, 'satisfactory' is only 1 to 2dB above threshold, and 'poor' is just on the threshold.

What happens if a box receives signals from more than one transmitter? A 'channel list' is compiled taking signals from both transmitters, but the channel order seems to be haphazard, necessitating extensive use of the 'change channel numbers' facility. I recently re-installed a receiver (using 'store channels') that had previously been used on the Emley Moor transmitter. At the new location all the Bilsdale multiplexes but one were at good strength, whilst all the Emley Moor signals were poor. The receiver stored BBC-1, BBC-2, ITV, and Ch4 from Emley Moor on positions 1 to 4, with terrible stop-start reception. Good reception of these channels from Bilsdale appeared on positions 8, 16, 34 and 35. Other channels were from either transmitter, apparently at random. An auto-update didn't help. To save a lot of time shuffling channels, temporarily attenuate the incoming signals so that the receiver only 'sees' the strongest transmitter, and operate 'save channels' again.

Peculiarities of IDTVs

When dealing with an unfamiliar Integrated Digital TV set you might find the RF connections confusing. Three Belling (aerial) connectors will be found on the rear, not necessarily near to each other. These are (a) the aerial input to the digital tuner, (b) the RF output from the digital section, carrying the aerial signals and the digital section's modulator output, and (c) the input to the analogue tuner. In other words, (a) and (b) are the 'in' and 'out' RF connections to the digital box, and (c) is the analogue TV set's aerial input. Normally, the aerial will connect to (a), with the VCR connected between (b) and (c). It is not always obvious which connector is which, though. Some IDTVs have both (a) and (c) marked with an identical aerial symbol ( ), whilst the RF output could be a male or female Belling, probably with no identification. Having figured out which connector is which (if all else fails, read the instructions), the IDTV can, for RF purposes, be treated as two separate items in one box. The unfamiliar remote should open up the more familiar digibox menu pages, to allow the setting of the RF output channel and so forth.

Some IDTVs will not allow RGB operation, which I think is ridiculous. Setting the digital section's output to RGB has no effect. You might or might not find a SCART socket carrying the output from the digital section. If not, digital channels can only be recorded via the aerial lead, with the consequent inferior picture quality and mono sound. It seems to me that the manufacturers of some 'budget' IDTVs have not really taken the word 'integrated' seriously, and have simply shoved two pieces of kit into the same case without much thought for the interconnections that the user might require.

Set top box SCART connections

Turning from IDTVs to the as yet much more common set-top box, an RGB SCART lead should be used to link the box and the TV set. If the TV set is RGB-capable set the digital box to RGB output. If the TV set is pulled onto the SCART input when the set-top box is on, and this is not convenient, cut the wire to pin 8 in the SCART plug. This is necessary because there is no 'SCART control', as found on a Sky digibox. Fit a SCART lead between the set-top box and the VCR.

Demonstrate to the customer how to select the correct RGB AV input on the TV, and how to record programmes via the VCR's AV input. If the set top box's RF output is not to be used, 'park' it on an unused channel.

RF interconnections

As far as possible, use SCART connections between the set-top box and the main TV set and VCR. RF links can't always be avoided, though. The same aerial will normally provide both the analogue and the digital signals, and the customary loop-through arrangement will be used, with the digital box first in the chain. Apart from the fact that the digital box's RF output should pass to the VCR and the TV set, it is better if the digital box has a clean aerial feed.

If RF loop-through is used, it is vital that clear channels are found for the output of each modulator. This can be surprisingly difficult in some parts of the country. It's worthwhile making a chart showing channel usage in your area. Include all local analogue and digital transmissions, and also those from any other transmitters that put a significant signal into the area. In many areas this exercise will show that only half a dozen channels are clear. Some of these cannot be used for modulator outputs because they are adjacent to broadcast analogue. The channel relationships n+5 and n+9 are best avoided, especially where an old TV set is in use. Older VCRs often have a modulator restricted to channels 30 to 40 or thereabouts, of course. When the customer wants you to 'daisy chain' the digital box, a satellite receiver, and a VCR, things can get very tight if you are in an area where virtually every channel is occupied by broadcasts.

When the first item in the chain is a masthead amplifier things can be worse—much worse—since all the unwanted transmissions and interference picked up by the aerial enter the system at a much higher level.

A distribution amplifier is often an additional item at the end of the daisy chain. This method of feeding all the TV sets in the house with the off-air and modulator channels is almost universal, and it is almost universally unsatisfactory. It is not possible to adjust the relative signal levels of the off-air and the modulator channels, and the noise and spurious signals from each item are cumulative.

Since the early days of VCRs, loop-through has been the time-honoured way, but times have changed. I will not set up any but the most simple and innocuous daisy chains without warning the customer of the likely problems, since I can't take the blame for the patterning and noise that might appear as soon as my back is turned. If they want to feed the outputs of the digital box and the VCR all round the house, offer them a proper system with channelpass filters. If they balk at the cost and subsequently suffer poor reception, they can't blame you!

Will DTT bring in work?

Retailers who offer DTT set-top boxes are equipped with a booklet that tries to predict whether or not reception will be possible at a potential customer's address, based on the postcode. Individual postcodes can also be checked on www.ondigital.co.uk. Anyone who knows the first thing about UHF propagation will find the concept of predicting coverage at a particular address by use of the postcode highly amusing. The system can only provide wide (or wild?) generalisations, and cannot take into account the small-scale local variations in reception conditions that can make all the difference. Although lots of customers with good DTT signals are turned away, which is a pity, the converse is that aerial contractors can expect calls from those who, armed with a 'correct' postcode, have obtained a set-top box only to find that reception is poor or non-existent. The OnDigital subsidised aerial scheme seems to leave a percentage of discontented customers in its wake, who then turn to a local contractor to get the thing sorted out properly.

So DTT brings in work, and as the changeover from analogue to digital progresses, this will undoubtedly increase. When IDTVs are the norm, lots of people are going to bring them home from the shops, plug them into their knackered old aerial, and then hastily contact their friendly local aerial rigger.

As I said at the start, your customers might well be happy with a snowy analogue picture, but not with the digital equivalent — either stop-start pictures or no reception at all. What's more, successful DTT aerial installations in difficult reception areas need installers with good equipment and knowledge, so DTT should separate the sheep from the goats rather more than has been the case with analogue.