highly visible locations, and this is applauded by the residents. Victorian apartment blocks glory in their hideous external plumbing and paint it in a contrasting colour to show it off.
Why then does the harmless satellite dish arouse such ire? Of course this isn't about aesthetics, it is about cultural associations and straightforward old-fashioned British snobbery. In the early days of Sky an image of the typical satellite viewer formed in the minds of many people. This is best explained by the joke 'What do you call the thing a satellite dish is fixed to? A council house'. The problem many people have with satellite dishes is not what they look like but what they are and what they represent to a certain mindset. It's certainly true that in the early days social groups D and E took to Sky with greater enthusiasm than the rest of us, but nowadays satellite TV has broader appeal. A single dish, sensitively positioned, is now as natural and inevitable a fixture on a block of flats as the gas flues.
Despite my rather cynical attitude to the anti-dish brigade, I am strongly in favour of installing dishes as unobtrusively as possible. It is certainly worthwhile spending some time in contemplation before actually commencing the installation. This is called 'giving the job a good coat of looking at' and it usually pays off. The only technical constraints are that the fixing must be secure, the dish must have clear line of sight to the satellite, and there must be a cable route to the head end. This leaves great scope for ingenuity, and it is surprising how often a good tidy solution can be found. Ideally the dish should be invisible or almost so. This isn't always possible of course, but even when the building faces south-east it is usually possible to find a location other than on the front wall. Beware though, of fixing to a side wall with the dish at right angles to the masonry. This can look worse than fixing to the front wall because the dish can be silhouetted against the sky, and the installation will be vulnerable to the strong gusts that blow between buildings. Fixing to a north-facing wall with the dish on a mast looking over the roof is usually a bad idea. After all, the appearance of even the back of the building must count for something, and such an installation can look really terrible.
It's always best to discuss the proposed dish location with all concerned before actually installing it. A digital camera is a useful tool. Get a shot of the building and simulate the proposed dish using a photo-editing program.
Special rules apply to listed buildings and conservation areas. If residents have already installed their own dishes, it's worth making the point that these will be removed, and one 75cm dish looks better than a dozen 55cm ones.
Although we've become used to hiding the dish as best we can, in recent years a curious counter-culture has arisen that can make this unnecessary or even undesirable. To Mr Modern and his partner looking for an apartment property, certain appurtenances on the front of the building suggest coolness and high technology. First amongst these are CCTV cameras in ugly housings, followed by complicated door entry systems and of course a rather large dish. Apparently it's really cool these days to live in a building rigged up like the Russian Embassy.

Cable

Judging from the emails I received following the publication of *Coaxial Cable Quality* (Television, January 2004) it seems that a lot of people have found out the hard way that the use of the wrong cables can cause serious problems. Satellite IF signals extend up to 2050MHz, and at those frequencies poor quality cable can be very 'lossy' indeed. Table 2 lists suitable cable types.

Cable type	Dielectric	Manufacturer/distributor
CT100	Semi-air spaced polyethylene	Raydex
CTF100	Foam	Raydex
HYC100	Semi-air spaced polyethylene	Commtech
HYCF100	Foam	Commtech
QC100	Semi-air spaced polyethylene	Cavel/Ace
QF100	Foam	Cavel/Ace
WF100	Foam	Webro
H109F	Semi-air spaced polyethylene	Webro

Table 2. Suitable cables for downleads. All these cables have a copper inner, copper braid, and a copper foil wrap. These are just a few examples of the many makes available.

It is essential that good quality cable is used. Raydex CT100 or any *direct* equivalent is fine. Beware of the cables sold as 'CT100-type'. These usually have the cheap aluminium (rather than copper) foil wrap. There are cables on the market with the words 'satellite' and 'digital' printed all the way along them. This proves nothing. This confusion (deliberately caused by the sellers of inferior cable) means that you should personally inspect any cable that the electricians are going to install on your behalf. I have had large buildings wired for me in poor quality cable that has been labelled 'CT100'. This is pretty disastrous because it can be impossible to make the system work properly if the cable runs are long.
All the cable throughout the system should be CT100 or equivalent. The only exceptions are the use of the next size up, CT125, for any very long downleads, or CT167 for tap-off lines and trunks (of which more later). If possible the dish should be close to the head end, but if it is more than about 20 metres away it is worth using CT125 for the four cables. Long downleads to the master outlets should be avoided if possible, but often the building layout dictates that one or two downleads are 30 metres or more in length. An example might be a sheltered housing scheme where the warden's house adjoins the main building. In this case use CT125 for the long downleads. Because it is difficult to connect CT125 into the outlet there should be a change to CT100 close to the outlet, possibly in the roofspace. Connect the two cables together with two 'f' plugs and an 'f' line connector. If in doubt about the dryness of the location wrap the joint with self-amalgamating tape.
Do not use the CT63 cables now available for domestic Sky installations.
Treat the cable carefully. If it is kinked or squashed or forced into a sharp bend the signal will be affected. The ends of cables installed during the 'first fix' must be sealed because wet plaster will subsequently be applied to the walls near the backboxes. Cable ends left hanging down external walls ready for the dish should also be sealed.
Cables that run underground, even in ducts, must have a totally waterproof outer sheath. These are usually distinguished by their green colour.

Earth bonding
For many years it has been the practice to use isolating outlet plates for communal TV systems. These have high voltage capacitors in series with both conductors and provide safety isolation. Systems that use voltage and tone switching are obviously incompatible with these outlets, so as an alternative these systems rely on earth bonding. To protect the dwellings every downlead is earth bonded at its point of exit from the head end or repeater. The theory, or hope, is that even if all active components were to be removed the earth bonding would remain intact. The earth conductor must have 4mm cross sectional area. Resistance between any outlet and ground must be negligible. The relevant BS number is EN 50083. The usual type of earthing rail has a row of 'f' line connectors through which each downlead is routed, as shown in fig 17.

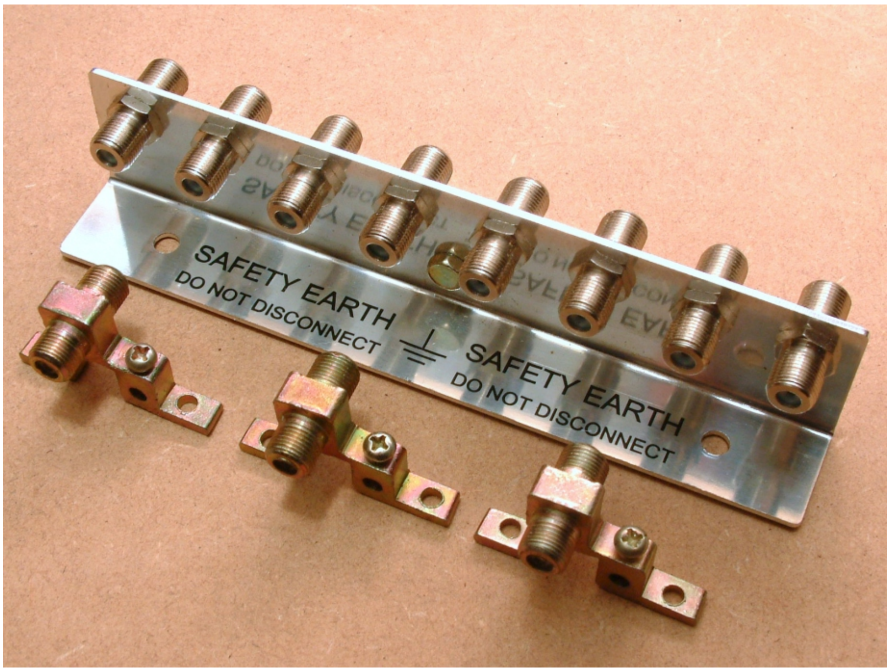


Fig 17. At the rear an eight way earth bonding strip, and in the foreground three one-way earth tags.

Sky+
Sky+ needs two independent dish feeds. On a distribution system this means two downleads and two multiswitch ports. This adds considerably to the cost, and at the moment many clients are balking at it. One solution for new build projects is to install the extra downlead only, terminating in a single backbox next to the master socket. A blank plate is fitted, and residents asking for Sky+ can have the outlet and multiswitch fitted at a price.

Signal levels
Forget all you know about UHF system planning! Satellite IF distribution is quite different. All the signals originate from the

LNB, which is analogous to a very high gain UHF masthead amplifier receiving an adequate signal. By 'adequate' I mean 'not good'. That means that the c/n ratio set by the LNB represents the best possible figure throughout the system you can worsen it further down the system but you can't improve it. The c/n ratio will probably be only 10dB above threshold. Compare this with a UHF system. The signals originate from an aerial of course, and if field strength is good the c/n ratio at the aerial terminals will be very high indeed probably higher than you can measure. Assuming that there are no catastrophic errors in the head-end (such as the signal levels being reduced to pathetic levels and then re-amplified) the only significant source of noise will be the tuners of the TV sets, VCRs, and DVDRs. So as long as the system delivers adequate signal levels to each outlet everything should be fine. But a satellite IF system has the noise sitting there probably only 20dB below the carriers. It is essential that the c/n ratio is kept as high as possible throughout the system. Signals must enter amplifiers within the window where the balance of amplifier thermal noise and cross-modulation is optimal. Table 3 summarises the differences between UHF and satellite IF signal level planning.

	UHF system	Satellite IF system
c/n at source	Normally very good (aerial)	Effort needed to ensure that c/n is adequate (LNB)
Most significant system c/n factor	The masthead amplifier (if used) or the distribution amplifier front end	The LNB/dish performance
Signal level at source	Varies but is often similar to outlet plate level	Always much higher than is necessary at outlet plates
Typical download loss	1.7dB per 10 metres for Group B	2dB per 10 metres at the bottom of the band 3dB per 10 metres at the top of the band
Equalisation ratio	1:1.1 across ten channels (negligible) 1:1.4 if full band used	1:1.5 always needed
Adjustment of individual channel levels	Where required this can normally be done easily	Not possible within a normal budget
Cross modulation	It can be necessary to run the main amplifier only 6dB below the cross-mod threshold due to analogue signal levels	Not normally a problem with digital-only systems

Table 3. Comparison of the satellite IF and UHF aspects of a typical distribution system.

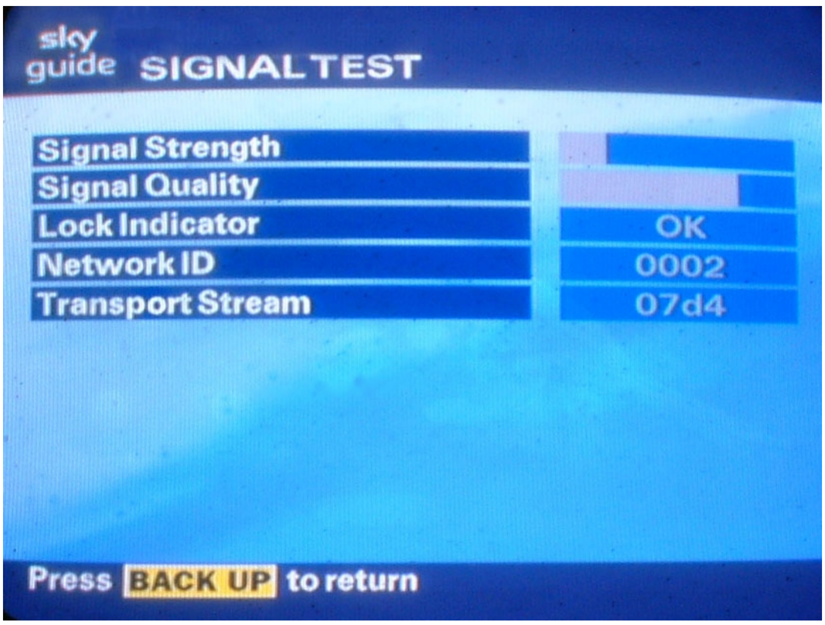


Fig 18. The Signal Test display of a Sky receiver. Some residents will query the low signal strength indication, but it has no real significance.

Satellite IF signal levels at the outlets can be very low indeed compared to the LNB output before receiver noise becomes a bigger factor than LNB noise. In other words, the LNB output signal levels are much higher than the receiver actually needs. The signal levels of the different transponders and LNB gain both vary quite a bit, but a typical level from the LNB would be 10 to 15dBmV. Receiver threshold also varies, but 20dBmV is typical. It is therefore possible to attenuate the output from an LNB by as much as 25 or 30dB before receiver noise becomes a serious factor and receiver BER starts to fall. So it is not necessary to provide each outlet with signal levels equivalent to those coming from the LNB. This might seem odd at first, but think of a UHF system where the aerial signals are very strong perhaps 25dBmV or more. There would be no need to supply that strength of signal to the outlets. This means that our little twelve-outlet system might need no satellite IF amplification other than that inside the multiswitch. (This amplification merely compensates for the switch's internal loss). The total cable run from the LNB to the outlets (via the multiswitch) might be thirty metres, which equates to 9dB loss in CT100 at 2,050MHz. Even so, the signal levels presented to the receivers will still be well above receiver threshold. Fig 18 shows the signal test display of a Sky receiver. As you can see the signal strength reading is low, and this might cause protests from residents who regard themselves as 'clued up', especially if they had a dish with a short downlead at their previous

address. In fact all multiplexes were entering this receiver at about 50dBV, which is perfectly adequate. After the photograph was taken I attenuated the dish feed by a further 10dB with no effect on reception, although this dropped the signal strength bar to zero! You have to make the point to residents that it's the 'quality' reading that matters.
Despite the ability of digital satellite receivers to operate satisfactorily on low signal levels, it is not wise to plan a system so that the receivers have signal levels not much above threshold. There are a number of reasons for this.
A good allowance must be made for 'rain fade'. This is the attenuation of the microwave signals caused by moisture in the atmosphere. The LNB is a straightforward frequency shifter and amplifier: it does not have AGC, so variations in the off-air 11,000MHz signals will be exactly mirrored in the satellite IF signal levels. Levels can drop 6dB or more during heavy rain.
It is reasonable to plan the system so that every outlet has about 0dBmV, or 60dBuV. This is over 10dB below the LNB output but still a long way above receiver threshold. The great advantage of the latter point is that you will avoid many of the call-backs that are caused by things beyond your control. No matter how careful you are there will be response dips, or 'suck outs' as the Americans call them, at some outlets. These are due to peculiarities of the multiswitches, connectors, cable, and wall plates. If the signal levels are generally rather high these dips probably won't have any effect, since they are rarely more than 10dB deep.
Having polished off the compact block of twelve flats, let's turn to a slightly more difficult installation. This time there are 15 rather nice large flats, and the building is essentially a long thin two-story affair, with eight flats upstairs and seven downstairs. Alas this isn't new build: it is a 1970s upmarket development, very neat and tidy with low tolerance of visible cables and dishes (not to mention ladders in flower beds!). Instead of an eighth downstairs flat there is a communal utility area at one end of the building. The Residents' Association rather assumed that we would put our new head-end in there, but this wouldn't be a good idea because the downleads would then vary in length from 7 metres up to 90 metres. A trunk cable and tap-off design is ruled out because all the cables have to run along the front wall, and five CT167 cables with housings at intervals containing tap-off units and multiswitches would look hideous. A much better solution is to position the head-end near the middle of the building, giving a maximum downlead length of about 45 metres. As luck would have it there is a convenient 'under-the-stairs' location in the middle entrance hall, with a landlord's mains supply available. Even 45 metres is a very long downleadtoo long reallybut sometimes the constraints of the job force a technical solution that is less than ideal.
Unfortunately the dish location presents a problem. The dish can't go on the front wall; that goes without saying, but the front wall is the only wall facing south-east. The ingenious installer finds a solution, which is finally accepted after several long committee meetings. The dish is to go on the wall of the garage block, to the rear of the main building. The location is 30 metres from the main building, so the satellite signals have line-of-sight over the roof. An easy cable route exists to the head-end, but it totals 40 metres. The four cables from LNB to head-end will be CT125, as will the longest downleads to the flats. We have to think, therefore, about the signal losses in 85 metres of CT125. These will be 21dB at the top of the IF band and 14dB at the bottom. What would be the result if we simply installed the system as described so far? Well basically, life would be hell the first time there was a bit of bad weather. The signal levels presented to the receivers in the end flats would be just about adequate on a nice sunny day. But come a few low clouds and spots of rain and the installer's phone would start to ring. You don't need me to describe the effects of inadequate digital signal levels, or the subsequent sound of a middle class lady Residents Association Treasurer who suspects that she has been ripped off. To avoid receiving this tongue lashing the installer must compensate adequately and accurately for the cable losses.

Pre-amplifiers
Multiswitches with gain are available, but for flexibility I prefer to use four line amplifiers fitted at the multiswitch inputs. Don't over-do it though. Choose amplifiers with just enough gain. The Labgear CM5220/00 lifts 950MHz signals by 13dB and 2,050MHz signals by 18dB. The extra gain at higher frequencies is called 'equalisation', 'slope', or 'tilt', but whatever name you call it by it is very useful. There are lots of line amplifiers available with various gain and equalisation levels. The Labgear one mentioned compensates very nicely for the cable losses in our hypothetical system. The outcome would be that the flats farthest from the head-end would have signal levels of about +2dBmV and those nearest the head-end would receive about 16dBmV. These figures allow for outlet plate and flylead losses, and assume 0dB switch loss. That spread of signal levels might seem a bit wide for those accustomed to the carefully-

planned UHF system, but it is quite normal for a satellite IF system.
If you feel uncomfortable about final signal levels exceeding a typical LNB output level, it is quite acceptable to use low value attenuators at the switch outputs on the shortest cables. The attenuators must be intended for use up to 2050MHz, with 'f' connections and line power pass. The attenuation will of course also affect the terrestrial signals. You would only use 3dB or 6dB attenuators for this purpose, not higher values. You shouldn't really allow final signal levels to exceed typical LNB outputs (10 to 15dBmV) because many receivers will start to show decreased 'signal quality' readouts above that level. It can be instructive to fit a variable attenuator on the IF input of a Sky digibox. Some boxes are happier with levels 12dB below the LNB output!
Just going back to the line amplifiers a moment, they are of course powered by the DC on the dish feed. This originates in the multiswitch, so check that the switch is capable of powering four line amplifiers as well as the LNB. Don't fit the line amplifiers at the LNB. They are happier with the lower signal levels at the head-end.
You might be asked to fix a system where some or all of the downleads are losing horrendous amounts of signal. Maybe someone has used very poor quality cable, or maybe the system was originally designed for UHF (in 1970?) and someone has added satellite with no regard for cable losses. Maybe some of the downleads are absurdly long. Whatever the reason, think hard before you add line amplifiers on the downleads either at the switch outputs or half way down the cable. Most line amplifiers don't pass UHF, and no line amplifier passes UHF if it isn't powered, so residents without a satellite receiver would have no terrestrial reception either. If the cable is 'lossy' because of age or damp the losses will gradually worsen until you are unable to compensate for them with amplification. Losses will be most severe at higher frequencies, and it is possible to have the low end at almost normal signal levels and the top end below the receiver noise in other words, undetectable! This sort of problem should be fixed by better cables and if necessary by the re-planning of the system, not by adding more and more amplification. Don't get drawn into providing a 'cheap fix'.

Cross modulation
Is it possible to overload the polarity switches or satellite receivers with signal? Most readers will be familiar with the effects of cross modulation on analogue television. A faint image of one channel drifting across another, that kind of thing. The effect of cross modulation on a digital system is simply a reduction in c/n, with the consequent deleterious effect on BER. Cross modulation occurs when, somewhere along the line, an amplifier is over-driven. In brief, there are upper and lower limits to the levels of signals that an amplifier is happy with. These are not sudden rigid boundaries, but at the lower extremes the weaker the signals are, the worse the carrier/noise ratio becomes (because the amplifier noise is fixed) and at the higher extremes, as the signal levels approach the nominal maximum, the amplifier starts to become overloaded. On a system carrying more than one channel or carrier the latter condition causes cross modulation, where one channel interferes with another. The more channels or carriers there are the lower the cross modulation ceiling becomes, as shown in fig 19. The more amplifiers there are in the chain (the gross gain of the whole system) the lower the cross modulation ceiling becomes, as shown in fig 20, and

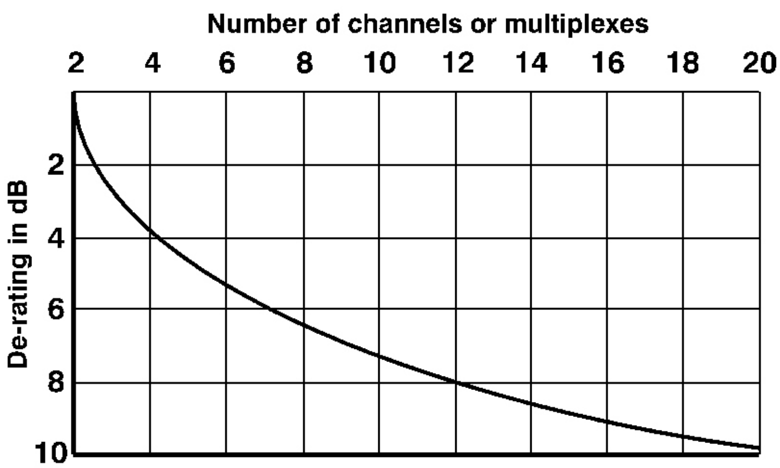


Fig 19. Assuming that all channels have the same strength, there is a simple relationship between the number of channels and an amplifier's maximum output.

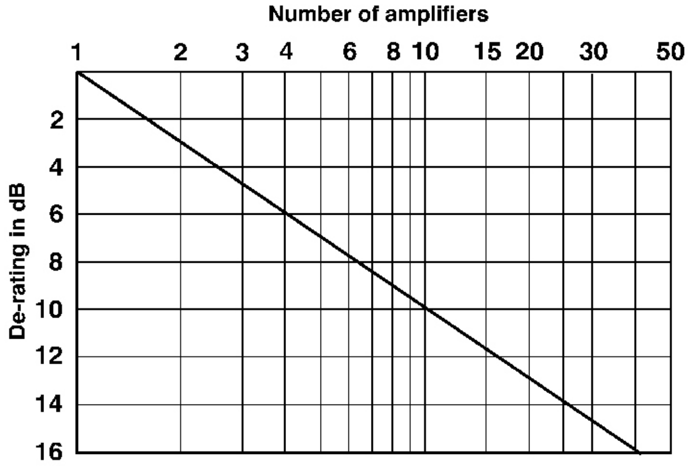


Fig 20. If you have four amplifiers in cascade you must de-rate them all by 6dB. This is why the 'end-to-end' amplification on a system should always be kept to a minimum.

the higher the noise floor becomes. The operational window gets smaller and smaller. Think of a large system carrying a lot of channels, with repeater after repeater in a long chain. Travelling from the head end to the last repeater is a bit like working your way through a cave system, where the height of each cavern is always less than the last, until you are reduced to wriggling on your belly in the mud. Just as you might encounter a nasty troglodyte at the end of the cave, you can be sure that the very last outlet on the system will be in the living room of some old grumpy guts who just lives for the Residents' Association meetings.

Let me digress slightly (as if I haven't already!) and tell you about the most unsatisfactory period in my career. This was when we were attempting to install analogue satellite distribution systems, in the days of Sky from 19E. Each polarity and band was absolutely stuffed full of channels, all at different levels. There was no way to adjust the channel levels individually, so the difference between the strongest and weakest simply had to be subtracted from the height of the operational window. It was hard to find amplifiers that could produce enough output once they were de-rated to allow for the number of channels. The c/n ratio needed was significantly more than it is for digital, so near the bottom end of a big system the operational window was sometimes reduced to a narrow slit! Receivers varied widely in their ability to cope with high or low signal levels (who remembers the Pace Prima?), and to be honest it was almost impossible to make these systems work properly. I was heartily relieved when the digital revolution came.

The problems I encountered in the analogue days can happen with digital reception, but they are much less likely. There is not so much variation in carrier levels, and the fact that digital signal levels are lower than analogue ones makes things so much easier. To say that digital signal levels are lower than analogue ones is just another way of saying that the c/n ratio can be less, of course. Take the output of a normal LNB, lift it 15dB with a line amplifier, and you are still a very long way from driving a multiswitch into cross modulation. This is really only a potential problem with large systems, where you might be driving a big head-end amplifier rather hard. I'll deal with that later.

Adding terrestrial reception

Acquiring good clean terrestrial signals can often present more problems than any other part of the job, but this isn't the place to deal with them. Let's assume that the aerial has been installed and is working properly, otherwise this article will go on forever!

Don't allow the terrestrial part of the job to become a poor relation. Remember that many residents will not have satellite TV. The terrestrial part of the installation should be carried out to the same high standards as the satellite part, so cheap aerials and cable should not be used, and every effort should be made to provide first class reception quality at every outlet. To this end it is almost always necessary to pass the incoming terrestrial signals through channel filters.

Terrestrial channel filters

This isn't the place for a full-scale discussion of terrestrial reception and distribution techniques, but the crowding of the UHF band in recent years has made some sort of input filter a must on virtually every system. For that reason I think it's necessary for me to cover terrestrial input filters here, if only in brief.

There are two reasons for using channelpass filters at the terrestrial input. The first is to facilitate the adjustment of the relative levels of each analogue channel and digital multiplex. The second is to exclude unwanted signals and interference.

In some circumstances there is no need to use filters. If the UHF aerial is receiving very strong signals and if they are all at the correct relative levels then filters might be unnecessary. By 'very strong' I mean that the analogue channels should be no less than 25dBmV and the digital multiplexes should be no less than 5dBmV. Under these circumstances it is unlikely that signals from the aerial on any other frequencies will be strong enough to cause problems but have a good look at the analyser screen to make sure. You don't want anything coming from the aerial that's within 10dB of the wanted signals. The other essential criterion for possibly omitting the filters is that all the channels are received at the correct relative strengths. This can be the case with some transmitters, where all the analogue channels and digital multiplexes are within the same channel group and the muxes are 17 to 20dB below the analogue channels. If everything is within one channel group there will be no need to equalise the signals for cable losses further down the system. Having said all this, I would only omit input filters on a small simple system with no repeaters. A system with no input filters is wide open to any local idiot with an illegal CB or unlicensed amateur radio transmitter.

In the majority of cases input filters will be essential. The filters are available in units containing one, two, four or six channel paths. Each channel path has a tuned stage, a variable attenuator, and then two more tuned stages. Any configuration of inputs is possible, from one input per channel to one input for all channels, but the output is always common to all channels. Through loss is about 4dB. Fig 21 shows a five-channel filter unit with the rear cover removed. The filter units are built to order incidentally. Our supplier is Taylor Bros of Oldham.

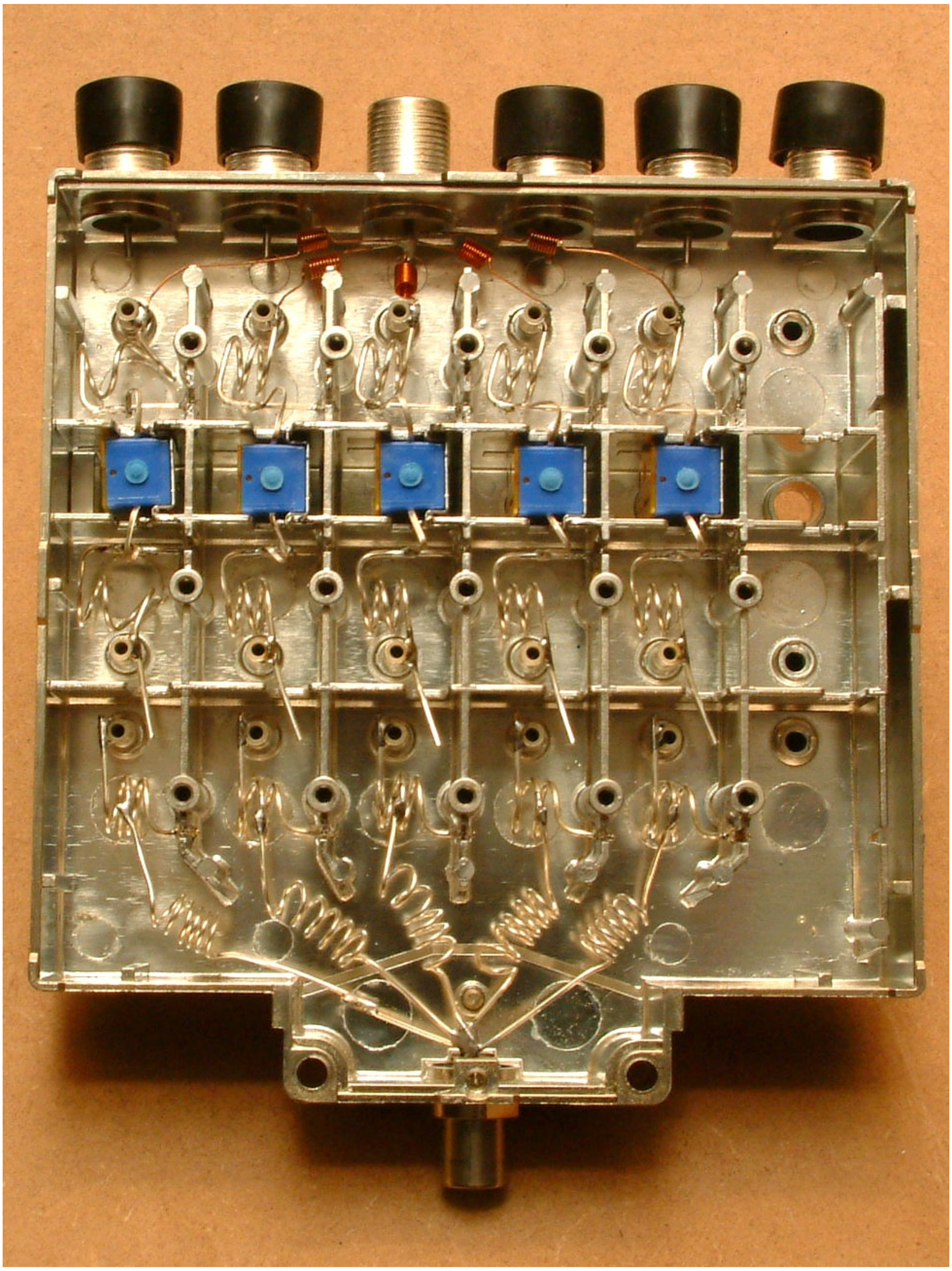
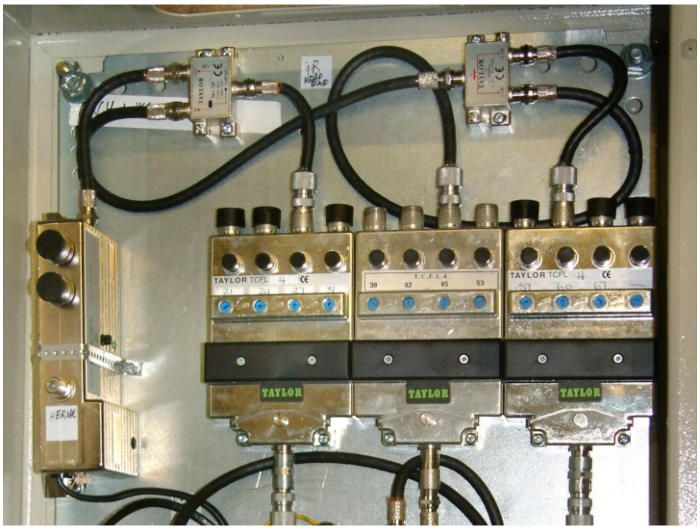


Fig 21. A five-channel filter unit with the rear cover removed. In this example all five channels share one input. From top to bottom each channel has a tuned stage, a variable attenuator (blue) and two more tuned stages.

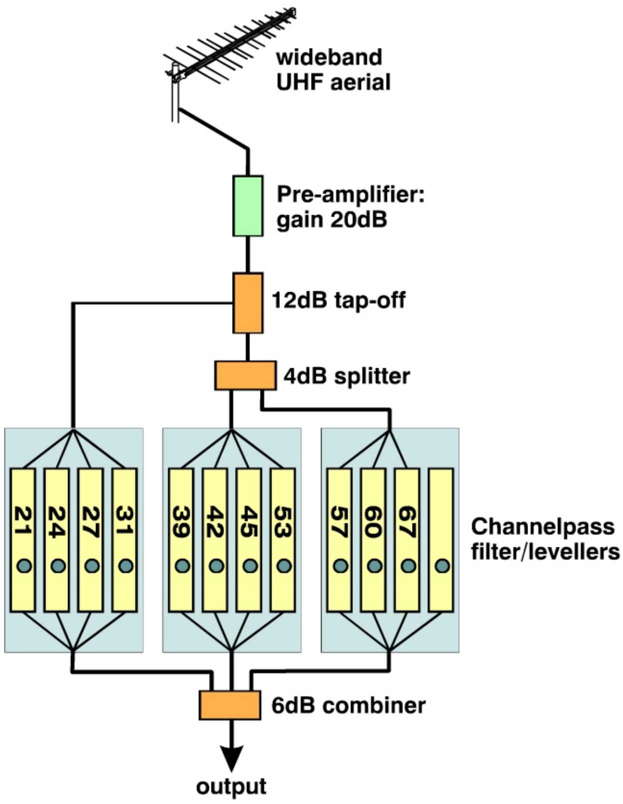
Suppose the signals from the aerial are as follows

Analogue channels 21, 24, 27, and 31: 28dBmV ± 3dB
Digital multiplexes 39, 42, 45: 7dBmV ± 3dB
Digital multiplexes 53, 57, 60: 3dBmV ± 3dB
Analogue channel 67: 11dBmV

These signal levels (typical of line-of-sight reception in Sheffield city centre) must be balanced at the head-end. If the output was at these relative levels either the Group A analogue channels would be too strong at the outlets or the Group C/D muxes and analogue channel would be too weak. You really couldn't provide channel 67 at a level 17dB lower than the other analogue channels! As well as the need to correct the unequal signal levels from the aerial, when there is a wide spread of channels like this it is necessary to launch the higher channels with a few extra dB to compensate for the greater cable losses on higher frequencies. With the off-aerial signal levels given above it might be just possible on a very small system to get away with a 10dB equaliser in front of the amplifier. For a larger system, especially where there are repeaters, individual control of each channel is necessary. Figs 22 and 23 show a photograph and schematic of a filtering arrangement that will correct these signal levels. The adjustment range of the variable attenuators on each channel path is 18dB. To increase the effective adjustment range and bring each channel more comfortably into the middle of the range a 12dB tap-off unit has been used to feed the filter unit for the strong analogue channels. This makes the input to that unit 7dB lower than that to the other two units.



Figs 22 (above) and 23 (right). An arrangement of channel filter/levellers designed to carry five analogue channels and six digital multiplexes. A pre-amplifier compensates for combiner and filter losses. A 12dB tap-off unit helps to equalise the channels. The final 6dB combiner is not visible on the photograph.



Even with very high signal levels from the aerial, a pre-amplifier will be necessary, and it needs to have low noise and be capable of quite high output. The filters are passive, so they can only attenuate the stronger channels until they match the weakest one. This means that the c/n ratio of the weakest channel will determine the c/n ratio of all the other channels, all other things being equal. If the weakest channel is in fact at quite a good level, as in the example above, no harm is done. A pre-amplifier is necessary though, because of the through loss on the whole assembly. On a channel with minimum attenuation applied the through loss will be about 15dB. In the example above the channel 67 signals would emerge from the assembly at 4dBmV if there wasn't a pre-amplifier, an inadequate level at which to enter the next amplifier. The c/n ratio would be effectively set by the ratio between the 4dBmV signal and the noise figure of that amplifier, and no amount of later amplification would be able to improve it. Not only would the ch67 signal be noisy throughout the system, so would all the others, because of course the filters would have to reduce all the other channels to that level.

A more awkward situation arises where the weakest channels are only available at a level where the c/n will inevitably be compromised. It is vital not to use the filters to reduce all the other channels to the same

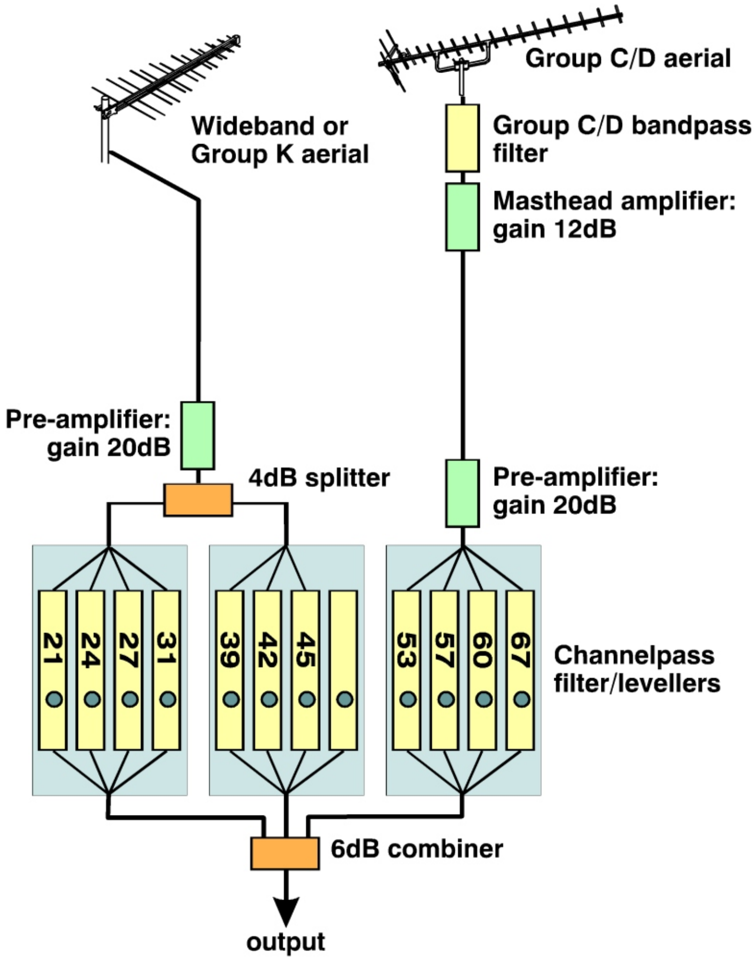


Fig 24. An input configuration designed to deal with a mixture of adequate and weak aerial signals.

inadequate level. To reiterate: if that is done all channels will have a poor c/n ratio at every outlet. The answer is to pre-amplify the weakest signals separately. This will not necessarily help their own c/n ratio but it will save all the other channels from being afflicted. Fig 24 shows an example of an input configuration that will solve this problem. The muxes on channels 53, 57, and 60 are only a few dB above threshold, and analogue channel 67 is a few dB below it, at about 5dBmV. A masthead amplifier is used to maximise the c/n ratio of these channels, and lift them by12dB. A bandpass filter prevents the strong Group A signals from overloading the masthead amplifier. Where field strength is really poor, it is better to use grouped rather than wideband aerials. Note that the channelpass filters are configured differently to those shown in figs 22 and 23.

Cluster filters

Some UK main transmitters have the DTT and analogue signals on adjacent channels. Passive filters will not allow you to adjust the levels of adjacent channels independently. The response simply isn't sharp enough. Fortunately most of these transmitters have the muxes at quite reasonable levels relative to the analogue signals, so 'cluster' filters can be used successfully. These have a filter path for each cluster of channels. For instance, the filter paths for Emley Moor are 37, 40–41, 43–44, 4647, and 49–52. Where three or four channels are handled by one filter path the through-loss will be about 7dB.

Some manufacturers have introduced amplifier packages that attempt to process adjacent analogue and digital channels separately, by the use of passive filters. This is a tall order, and so far I haven't been impressed.

Final terrestrial signal levels

The output of the filter assembly will go eventually to the terrestrial input of each multiswitch, probably via further amplification. The adjustment of the signal levels at the filter attenuators should be carried out with reference to the output levels of a multiswitch. This allows for any unevenness of response in the switch. Channels near the top of the band should be set slightly high to compensate for their greater losses on cable. This adjustment will always be a compromise between the longest and shortest runs. There is no need to keep digital signal levels 20dB below analogue ones. Even if they are only 10dB below analogue levels they will not add significantly to amplifier de-rating. I usually set the digital channels about 14dB below the analogue ones. This does no harm at all to analogue reception and makes DTT reception that bit more solid. Table 4 gives the signal levels that I recommend at the outlets. The minima are higher than many would advocate but they will give good protection against interference from within the dwellings, and some compensation for losses after the outlet plate, such as VCR loopthrough and 'iffy' flyleads. Amplification is cheap: use it!

Transmission type	Minimum, dBmV	Maximum, dBmV
Analogue TV	6	20
DTT	–10	10
VHF FM	–10	10
VHF DAB	–20	10

Table 4. Signal levels at the outlets

Larger systems

The systems we've looked at so far have every downlead running back to one point. The maximum permissible downlead length sets the practical limit for this design. In a 'new build' project where it is easier to implement a technically ideal solution that it is in an old, occupied, building, I suggest that no downlead should be longer than 30 metres. This means that for buildings above a certain size there needs to be two or more locations where groups of downleads come together. These locations might contain nothing more than passive tap-off units and multiswitches, or they might include repeater amplifiers.

Planning larger systems

Every large system presents its own challenges. Often several appropriate system designs will come to mind, all radically different and each with its advantages and disadvantages. If you understand the principles of RF distribution and have the use of good test equipment you can usually find an effective and economic customised solution. If you don't have these assets you might well find yourself asking a manufacturer or distributor for help. This will get the system planned for you, possibly free of charge, but with the drawback that the planner will, of course, be restricted to items that he sells. This might be fine, but I have to say that I have seen many systems that have been installed using inappropriate and over-elaborate methods. Equipment dealers make their money from selling equipment, and I'm afraid that leads a minority to recommend unnecessarily expensive solutions. The favourite is the use of eleven channelised UHF amplifiers for the five analogue and six digital channels, where one broadband amplifier would be perfectly adequate.

There is no need to fall for this sort of thing. If you understand the basic principles you can read the specifications of the various items available and plan your own system. Mix and match components, drawing on whichever brands fit the bill. This is one of the few modern industries where customised solutions are the norm.

Tap-off line systems

Terrestrial-only systems wereand areoften designed around tap-off lines. The basic layout has a long cable, usually CT167, with tap-off units at intervals along its length. Typically the CT167 might run through the lofts of a terraced row, with a double tap-off serving every two dwellings. Another common layout has the CT167 running externally just below gutter height along a block of low-rise flats or terraced dwellings. The tap-off values gradually decrease along the line to compensate for the losses on the CT167, so all the outlets receive the correct signal levels. A tap-off line system for satellite and terrestrial reception needs five parallel tap-off lines on each run. Each tap-off location needs five tap-off units and a multiswitch. To minimise the component count and the complexity of the system it makes sense to have the maximum number of outlets per tap-off location, as long as the downlead lengths don't become excessive. Various manufacturers produce kit for this sort of system. The five tap-offs are built into one unit, and this plugs directly into the multiswitch. Some products are passive but some amplify the signal on the tap-off line, and given the very high signal losses on cable at 2050MHz this is the only way a long tap-off line can be done. Obviously there is a limit to the amount of repeated re-amplification that can be used, although I have seen systems where the installers have not understood this. The result is adequate (or even high) signal levels and very poor c/n and BER. In one case cheap satellite downlead cable had been used for the tap-off lines, each of which was 120 metres from end to end. The result was a complete lack of the higher frequency signals at the last few dwellings on the system.

Sometimes it is only possible to feed a few outlets per tap-off location in order to keep the downleads to a reasonable length, but this can become messy unless the system is very small. An extreme example would be a row of detached holiday chalets, with the tap-off line cables running underground between them. Multiswitches are much more complicated than simple tap-off units and thus more likely to go wrong, so every unit needs to be in an accessible location. Accurate planning of signal levels and equalisation can be difficult where there is a long series of tap-off locations. Each tap-off location has to be earth bonded, and this can be quite an expense where each location feeds only a small number of dwellings.

The Vision V5 range of amplifiers, tap-off units and multiswitches goes some way towards solving installers' tap-off line problems. Fig 25 (overleaf) shows a typical system layout using this equipment, but don't interpret the diagram too literally because it gives no details of cable losses. The whole system is powered from the amplifier by 18VDC carried on the two horizontally polarised satellite feeds. This has the great advantage that mains supplies are not needed at each tap-off location, but I hope the sort of problems we used to have years ago with DC line powered UHF systems don't affect this equipment. DC