Pre-Echo

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Pre-echo is often mistaken for ghosting, but the cause and the remedy are quite different. This article takes as examples two housing developments to show how pre-echo can arise in different circumstances.

Picture the scene: a pleasant modern development of forty bungalows for the elderly. Well-spaced semis, nice community centre, good class of tenant, friendly atmosphere. Everything, or almost everything, is just fine at Sunset Gardens. But there's one little problem. A problem which, during the three years since the place was built, has gradually soured the relationship between the tenants and the housing association until finally—well, let's eavesdrop on the warden, talking on the phone to Head Office.

'Look, the fact is, Mrs Rabblerouser is organising a rent strike…yes, I know, but they can't watch television properly, Mr Watchpenny. They're so fed up I think they might just do it this time…Well, can't you send a different firm to look at it? These you've been sending are absolutely useless…'

The communal TV system is simple and straightforward. There is an aerial, an amplifier, and an arrangement of trunk cables, tap-off units, downleads, and outlet plates. The amplifier output is sufficient for every dwelling to receive a normal signal level. It's an area of excellent off-air reception—the transmitter is a high powered one about ten miles away, and because the ground slopes gently in that direction the mast can be seen clearly through most of the living room windows.

Direct signal pick-up

It's the strong signal that's the cause of the trouble. In areas of high field strength, the TV set, and other components, can pick up signal directly off air. This direct signal can be strong enough to compete with that from the aerial system. This is pre-echo: surprisingly common and the cause of a variety of strange faults. The most obvious symptom is a ghost image. In the case of normal ghosting the interfering signal arrives after the main signal, so the shadow is to the right of the main image. But where the interfering signal is received directly at the TV set it arrives before the aerial signal (hence the expression pre-echo), so the shadow is to the left. The shadow can be very strong, resulting in a double picture, which may pull sideways. Teletext and Nicam may be garbled. Moving the TV set or its leads even slightly will have a great effect on reception, because this affects the strength of the signal which they pick up, and its phase relationship with the main signal.

If the two signals arrive in phase, the secondary image will be positive; if they arrive out of phase it will be negative. Strong antiphase signals may cause sync disturbances. Intermediate phase relationships will produce a weaker secondary image, but often with strongly delineated edges. This is reminiscent of ordinary ghosting; not surprisingly, because pre-echo and ghosting are both forms of multi-path reception.

The delay affecting the main signal has two components. The first stems from the difference between (a) the transmitter to receiving aerial distance, and (b) the distance from the transmitter to the point where the unwanted signal enters the system. The latter is usually located at, or very near to, the TV set. This factor can either add to or subtract from the total delay, because either the receive aerial or the TV set might be the nearest to the transmitter. The second component is the delay within the system itself. This can only add to the total delay, of course, and moreover it will always exceed the value of the first component. This is because the velocity factor of cable is less than unity. In other words, signal travels slower in co-ax than it does in space. A typical velocity factor for co-ax is 0.80. In addition, cables rarely take an absolutely direct path from A to B. So, if you imagine a system where the aerial is at the very end of the site nearest to the transmitter, with a

trunk cable running more or less directly back to a straight line of dwellings, there will still be a signal delay, even though the distance over the ground from transmitter to TV set is virtually equal along both paths. What this all boils down to is: of the two images on the screen, the one on the left is always the direct signal, since the direct signal always gets there first; and the one on the right is always the signal which has passed through the system. Either of them can be the strongest, and appear on the screen as the 'main' signal, with the other as the 'ghost', but it must be said that if the signal from the system is weaker than the direct signal, then something is seriously wrong.

At Sunset Gardens the aerial is in the middle of the site. At the bungalows nearest to the transmitter the pre-echo is quite unmistakable. The total delay affecting the main signal is considerable, since its path is extended across to the aerial and back again. On a 55cm screen the shadow is about 6mm to the left of the main image, and quite clearly defined. Towards the other side of the site, just a few bungalows away from the aerial, things aren't so clear-cut. Here the pre-echo is hardly visible in its own right, because the time delay is so small. The two images are virtually superimposed. There is a lack of definition, garbled teletext, weak colour, and other symptoms. The effect looks something like the results of a severe impedance mismatch or cable termination fault.

In a high-rise block pre-echo is only likely to be a problem on the side of the building facing the transmitter. The system delay is usually short. The outlets are more or less directly below the receive aerial, so the only delay is in the trunk cable. There is normally a number of trunks, each dropping straight down via a vertical stack of outlets. On a ten storey building each trunk will only be about 40 metres long, with pre-echo less likely in any case to be visible towards the ends of the trunks, near ground level. Padded outlets with integral tap-off units are commonly used, so there is no downlead delay. On the higher floors pre-echo in high-rise buildings can be savage, with very strong direct signals and the sort of very short delay factor which wipes out teletext and horizontal definition. On the top floor the delay may be so small that the phase relationship results in simple additive or subtractive effects on signal strength. It is sometimes possible to take the TV set from a good picture to almost nothing and back again simply by rolling it half a metre across the carpet, changing the phase relationship of the two incoming signals. This effect can result in some very unlikely sounding calls, such as the the recent, 'It's a good picture with the TV facing my husband, but not with it facing me!'

In the normal domestic setting where one aerial feeds one TV set via one length of coax, pre-echo will not show up because the aerial signal will always be much stronger—unless the downlead is damaged. In areas of moderate field strength the fault would, of course, show up as snowy pictures, but in 'swamp' areas the main symptom of a faulty downlead might be picture flutter when a bus goes past the living room window. There is no secondary image visible on the screen because the delay is so small, but reflections from the body of a large moving vehicle may cause rapid phase variations at the TV set. The same effect can occur on small domestic distribution systems, if the signal level from an outlet is much below that which would be obtained direct from an aerial. If this sounds odd, remember that in strong signal areas a signal at the TV set 20dB below the aerial output may give noise-free reception.

Back at the Ranch

Wyatt and Roy are two good-natured blokes who rig aerials when the ice cream round isn't busy. Roy's the boss, because it's his van. He lives two streets away from Sunset Gardens. Him and Wyatt have been on hard times just lately, and they couldn't believe their luck when the girl at Head Office found their name in Yellow Pages. Since then the light blue and cream Transit bearing their handpainted and mis-spelled boast, 'Earp and Rogers—Ariel Experts', has been a frequent visitor to the Gardens. The Tranny is probably the only aerial rigger's van in Britain to have musical chimes. Wyatt and Roy haven't done a thing to improve reception at the bungalows. On each visit they have tinkered ineffectually; they have then submitted their account, which the dozy fools at Head Office have always paid without question.

During one of the first visits Roy was behind a TV set fiddling about with the aerial flylead. He was intrigued to find that simply moving the lead affected reception. With the lead in one position the annoying shadow almost disappeared from BBC-1, but when he tried the other channels it was worse. After a period of experimentation which was fruitless both in practical results and in any growth of his understanding of the phenomenon, he accidentally unplugged the flylead from the wall plate.

'Oh that's better!' chorused Gerry and Mavis. Gerry put his other glasses on, squinted at the

screen, and pronounced with all the quavering gravitas of his 83 years, 'That's the best picture we've ever had, young man!' 'Well no, Dad, I don't think its as good as it was when we lived on Acacia Avenue' said Mavis. 'Of course not, woman,' snorted Gerry. 'I mean it's the best we've ever had here.' After a moment's reflection he added, stating the apparently obvious, 'We'll never get it as good here as it was on the Avenue'.

The picture was now snowy, but the awful double vision effect had gone. Disconnected from the delayed signal output of the aerial system, the TV set was now in receipt only of the weak signal picked up by the cheap white flylead. Had Roy thought about it, he could have touched a screwdriver to the end of the flylead, and standing as he was near the window in full view of a half-megawatt transmitter, shown Mr and Mrs Attrick a fairly good picture.

But he didn't think of it. Muttering something about a 'faulty booster' he left the flylead unplugged, and made his escape. A few days latter the Attricks' son gave them a set top aerial. This was a great improvement on anything which had gone before, but the picture fluttered when traffic passed the bungalow, which was almost all the time.

Signal to Noise Ratio

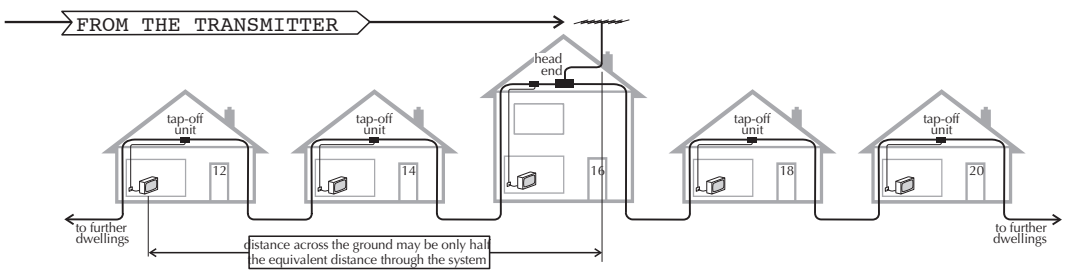
Like a lot of other things in this game, pre-echo comes down in the end to the relative strength of two competing RF voltages or fields. The only significant difference between them in this case is their exact time of arrival. Nevertheless we can think in terms of the traditional signal to noise ratio, just as we can with conventional ghosting. We strive to increase the S/N ratio in two ways. Firstly we cultivate the signal assiduously, giving it every encouragement to grow big and strong. Secondly we pour weedkiller on the 'noise', and let the dog bury his bones amongst its roots, in the hope that it will wither and die.

Increasing the Signal from the System

The first aim is the normal requirement of every system: that signal levels at each outlet are adequate; but where pre-echo is a possibility this requirement is writ very large. Here, 'adequate' does not mean the usual 0 to +6dB/mV. The likely strength of the direct signal must be taken into account. The degree of pre-echo will vary from outlet to outlet, because screening from the transmitter will vary, but there is a useful rule of thumb. It applies in cases where some or all of the TV sets are screened from the transmitter only by a few brick walls, or the equivalent, and it assumes that the flylead, etc., is up to standard, as discussed later. Measure the signal from a good 18 element aerial mounted with clear line of sight to the transmitter. If the signal is above 35dB/mV, pre-echo is probably going to be unavoidable unless channel changers are used, as described later in this article. Below 35dB/mV you're in with a chance, so proceed as follows:

Subtract 15dB from the reading. This gives the minimum level which should be available at each outlet, as long as it is above +6dB/mV. As an example the line-of-sight aerial signal from Emley Moor, 15 miles from the transmitter in the direction of maximum ERP, is about +27dB/mV. Each outlet, therefore, needs at least +12dB/mV. This is a lot of signal, but is typical of the levels needed to overcome pre-echo. On a system of moderate size it can usually be achieved without too much expense.

System planning is outside the scope of this article, but a brief word is in order. If the system is new the planning should take these final output requirements into account, so if you go



The system serving the bungalows. The signal path within the system, from aerial to TV set, can be surprisingly long: much longer than the across-the-ground distance might suggest. Where detached or semi-detached dwellings are linked by underground cables the lengths which rise up the wall cavities can often double the total run. This has two consequences for pre-echo: the inter-image spacing is greater, making the fault more noticeable; and signal losses are worse than might be expected, making the secondary image stronger. At No 12 Sunset Gardens the secondary image is some distance from the main image, because the main signal travels to the aerial and then back to the TV set. The two delay periods add together. At No 20 the two images are quite close, because the delay is merely the difference between the delay.

out to price up a new job, consider the possibility of pre-echo. If you have to allow for pre-echo, virtually every component will be affected: the tap-offs, grades of cable, repeater positioning, and head-end output. On an existing system where the original installer has not allowed for the pre-echo problem (a very common occurrence), the best approach is to consider how signal levels can be increased sufficiently at minimum cost. The head-end output levels should be set to a safe maximum (don't be tempted to overdo it), although it is unlikely that this will be sufficient by itself. Wholesale re-planning and re-building is likely to be expensive, as is the replacement of every tap-off unit. It is almost inevitable that some tap-off units will have to be changed, but the careful use of repeater or line-extender amplifiers can often keep this to a minimum. It is quite likely that the system planning will be 'optimistic', meaning that signal levels will be low throughout, and especially low at outlets near the ends of tap-off lines. In such cases the solution may be to install line-powered repeater amplifiers somewhere along each tap-off line. It should then be unnecessary to alter the tap-off values following the repeater. The tap-offs between the head-end and the repeater—there are likely to be only four or five—can be exchanged for ones of lower tap value where necessary. The reduction in signal levels which this will cause further down the line can be compensated for at the repeater. Repeater gain will normally be 10 or 20dB. The practical approach is to proceed down the line from the head-end, checking levels at each tap-off and fitting new units of lower value where necessary. When the point is reached where levels on the tap-off line are appropriate, fit a repeater. Typically, a repeater with 10dB gain would be fitted at a point where its input would be 25—30dB/mV. Repeaters can be cascaded along the tap-off line, within limits.

All the above assumes that the system is in reasonable condition. If it is hopelessly outdated, or badly installed, then pre-echo is likely to be just one of many reception faults. The steps necessary to bring the system up to scratch generally might well cure the pre-echo without any special consideration of that problem, although it is always as well to bear pre-echo in mind when selecting components and planning signal levels.

Decreasing the Direct Signal

The other factor in the S/N ratio is the amount of signal which finds its way, by whatever route, into the TV set's tuner without passing all the way through the aerial system. This must be reduced as much as possible. Because the amplifier output and trunk cable are carrying high signal levels, any direct signal pick-up will normally have no effect. The potential for harmful direct pick-up starts in the tap-off unit at its downlead terminals. I will deal with each possible 'point of entry' in turn.

Tap-off unit

Because tap-off units are likely to be situated where there is relatively high field strength—in the loft or high up on an outside wall—they are likely to receive direct signals. If you suspect the tap-off, move the TV set and the flylead about a bit. If this has no effect on the phase or intensity of the secondary image, the tap is probably guilty. The screening of the tap is all-important. The worst offenders are the plastic cased ones popular about 20 years ago. The metal cased ones with skimpy push-on lids are also suspect. Those in diecast housings, with a cover which screws on firmly, are best for outdoor use. An example is the Teleste CM9000 series. For indoor use the small f-connector taps are excellent, being 100% screened, although some types do not have power throughpass, which is essential if line-powered repeaters are in use.

If the outer conductor of either the trunk or the downlead is not making good contact at the tap-off unit, pre-echo will be one likely symptom. If the lid or cover of the tap-off unit is missing, pre-echo may occur.

Downlead

On a new system a good quality copper foil wrapped cable such as Raydex CT100 or Ace QC100 should be used as a matter of course, pre-echo or not. If a cheap 'low-loss' type has been used on an existing system, it might be worth replacing one or two downleads with CT100 as an experiment. A downlead cable commonly installed in the sixties (and often found in use today) had a foam dielectric and two discrete copper screens separated by insulation. This sounds good, but unfortunately this cable is very lossy at UHF. Changing it for CT100 can give as much as a 6dB increase in signal at the outlet, with proportional easing of any pre-echo problem.

Outlet plate

Check that the braid is properly connected to the outlet. If not, pre-echo and other unwanted signal pick-up is likely. Unless the system carries

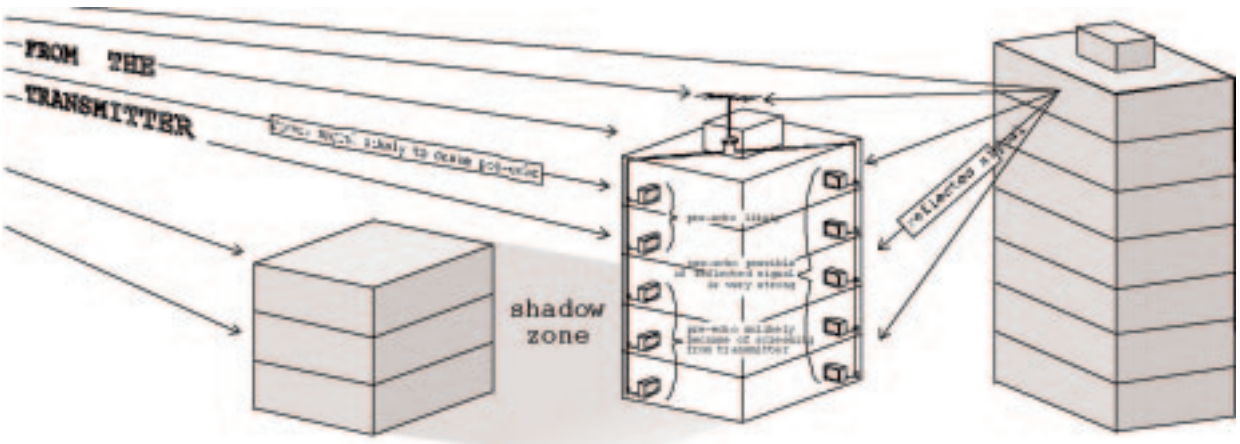
satellite IF as well as UHF, the wall plate should be an isolating type. Examination of different makes of isolating outlet will show that some are better than others, both in terms of direct signal pick-up and through loss. Both criteria are relevant to pre-echo avoidance. Avoid outlets with large, untidy, unscreened, connectors and capacitors. In particular, there is one import from the Far East which is popping up all over. Although it is supposed to be a simple straightforward isolated outlet, the PCB is obviously a multi-purpose design, with a large printed inductor and various short lengths of track, all connected to the co-axial inner. The other end of the inductor is not connected to anything. I'm surprised this item isn't sold as 'The outlet which doesn't need an aerial', because in strong reception areas I think they'd get away with it. To make matters worse the through loss is awful—4 to 10dB, varying with frequency. The connection to the outlet should be made as neatly as possible, with the minimum of coaxial inner bared. Some electricians seem to think that they should separate the braid from the inner, twist the former into a pigtail, and leave about three inches of unscreened inner coiled up inside the backbox.

I was once called out to a system in a large new private house, which had line of site to the nearby relay transmitter. The electricians had fitted the outlets, backboxes, and downleads. The local rigger had installed (or rather slung) a cheap aerial and an amplifier in the loft. Reception was most peculiar, and it turned out that the electricians had fitted a make of outlet which has a long inner terminal which protrudes backwards. In every case this had contacted the shallow steel backbox, which was receiving quite a good signal. The signal from the aerial and amplifier wasn't up to much. As there was virtually no delay on the signal from the aerial, the effect was pure phase cancellation: at its worst it was like a stacked pair of aerials with a null looking at the transmitter.

Flyleads

The short leads which link the wallplate, the video, the satellite receiver, and the TV set, are a prime cause of pre-echo. Quite often, this is because the braid isn't connected inside the plugs. If pre-echo occurs at an outlet where it isn't expected, and where there isn't such an obvious cause, the first thing is to unplug the aerial lead at the wallplate. Chances are, there will then be a snowy picture on the screen, or at least some evidence of a transmission. You can plug the lead back in and mess about with it, making the pre-echo come and go, but why bother? You'll never get it right. Make up new flyleads using CT100 cable, all-metal plugs, and all-metal line connectors. Ensure that all plugs and sockets are a tight fit. With everything re-assembled, but with the flylead still not connected to the wallplate, there should be nothing but snow on the screen.

If you find one of those cheap ready-made flyleads with moulded plugs, throw it away without hesitation. As we all now know, these are responsible for a lot of the channel group A patterning problems associated with satellite receivers. They are also quite remarkably bad for pre-echo. I have carried out a few simple tests. Standing in my backyard, where Emley Moor transmitter is visible 20 miles away, a 2 metre flylead produced around 0dB/mV. This is only about 15dB less than a reference half-wave dipole! The signal from a CT100 flylead was about -25dB/mV. These figures can only be approximate, because the signal level jumps about all over the place as the flylead is moved, but a difference of 25dB is unmistakable! The figures are the maximum which could be obtained from each flylead. It made little difference whether the other ends of the leads



The system serving the flats. Pre-echo at a high rise development. Nearby buildings can greatly affect the likelihood of pre-echo at any particular flat. If a flat is screened from the transmitter by another building, pre-echo is highly unlikely. Strong reflections from nearby buildings can cause a sort of post-pre-echo! The reflected signal shown entering the aerial would, of course, give rise to conventional ghosting.

were terminated or unterminated. Why these cheap leads pick up so much signal is a mystery. The way the braid is connected to the plugs tends to be a bit hit and miss, but replacing the plugs with properly fitted metal ones seems to reduce the pick-up only slightly. On the leads I've experimented with, the cable used is of quite reasonable quality. It has a very thin aluminium foil wrap under the braid. This is 100% screening, so theoretically there should be minimal pick-up. I wonder if anyone can suggest how cable of this construction can perform so badly.

Sometimes an architect's idea of the best position for a TV set does not agree with that of the occupier. Long coax cables are the result, going along two sides of the living room. Take nothing which disappears under a carpet for granted. These cables often have joints made with a blunt table knife, and wrapped with sellotape. The cable might have been extended with 50Ω CB coax, connected into a beer-sodden 30A joint box. Do you think I'm kidding? Believe me, I've found things under carpets which would make your hair curl. Before you do anything else, bypass the sub-carpet enigma with a length of CT100.

When approaching a system with the stated aim of curing the pre-echo, budget for new CT100 flyleads at every dwelling. Replace all the flyleads, even at dwellings where pre-echo is not visible at the moment when you call.

The occupier's equipment

A TV set with nothing connected to the aerial socket should not receive RF. If, as a TV distribution system repairer on the track of pre-echo, you find a set that shows a picture with no aerial connected, then the problem passes to the occupier's TV dealer (sorry, lads!). The communal aerial repairer's only course of action is use another TV set to test reception at that outlet. This is a nuisance, but the occupier will need a bit of convincing, and this is a good way to do it. These situations often arise when someone moves from their own house to sheltered accommodation. Their TV set will have performed perfectly until the move. 'Now we've got double vision and this impudent scallywag from the council says it's our telly that's faulty!'

VCRs and satellite receivers don't seem to cause pre-echo. Game switches and plastic splitters do. Where the occupier has fitted a cheap plug-in splitter at the wallplate, everything which follows is about 6dB worse off in the pre-echo stakes. In addition, the splitter itself could be receiving direct signals. In houses with several bedrooms you might well find a splitter feeding more splitters, with the signal to the living room TV set 12dB down. The only thing you can do is to demonstrate the improvement in reception when the TV set is connected directly to the wallplate, and advise the occupier accordingly. I usually suggest that they replace the splitters with a screened distribution amplifier.

Silly causes of pre-echo

Occasionally I've found pre-echo in areas of relatively low field strength, where it just shouldn't be a problem. In one case an occupier had fitted a Labgear indoor aerial and amplifier in the loft, to receive an alternative ITV. In order to get the signal down to his living room he had connected the output to the trunk terminals in the tap-off unit, which was also in the loft. The house was only six back from the end of the trunk, so the signal level on the trunk was not high at that point. The alternative ITV came in a treat, and the silly person wasn't bothered by the faint outline on the four normal channels. The neighbours were, though. To make matters worse, our man had wired his amp into his immersion heater circuit, which was only switched on during the evenings. The neighbours had to video the fault before I would believe them, and even then it took several visits before the cause of the fault could be pinpointed. I am not normally malicious, but I made sure that the cause of the problem was clearly stated on the invoice, in the hope that the tamperer would have the cost added to his rent.

I once had to visit a most unpleasant and aggressive young man, who was threatening hell and high-water if the council didn't get rid of the 'ghosting' on his living room TV set. He met me on the street as I got out of the van, shouting about 'My solicitor' and 'My rights'. Like many of his sort he was well versed in his rights, but not his responsibilities. There were three very young children in the flat with their mother, a gormless girl of about 20. The place was filthy and stunk to high heaven. The children were bawling and screaming, and their father kept shouting at their mother, 'Can't you make them bloody shut up?' I felt like taking him on one side and explaining what had caused them in the first place, but instead I turned my attention to the TV reception. The VCR supplied signal to TV sets in the living room and the bedroom, via a taped joint. For reasons which escape me, the bedroom TV had this feed, plus its loop aerial, connected into it via a resistive splitter. The loop was producing enough signal to cause pre-echo on both TV sets. Choking for breath, I headed

for the door, avoiding the used disposable nappies scattered across the hall floor.

At a block of eight flats occupied by elderly people the pre-echo was horrendous. The two signals were of roughly the same strength. This was in an area where pre-echo is a major problem. For years I had been responding to complaints from the surrounding blocks, and one by one new systems had been installed. But no-one from this block had ever complained, and the original system, installed primarily for 405 line reception, was still intact. If the pre-echo was this bad, and it had to be with this antique system, why had no-one ever complained before? It turned out that the door entry system repairers had been at work. Their intercom and electric door locking system is connected to the 'landlord's' electricity supply, as is the TV system. They had turned off the supply when they started work, and turned it on again when they finished. But when turning it back on they had also turned on a switch labelled 'TV system—do not switch off'. This had, in fact, been switched off for years, with the tenants happily watching TV on a system with no mains supply! With the supply off, reception was snowy, but with it on it was unwatchable because of the pre-echo. It's my guess that someone had discovered many years previously that reception was better with the system off than on. I bet he got paid, as well.

Use of a different transmitter

Faced with pre-echo, you might be tempted to redirect the system's aerial towards a different transmitter, and distribute those signals. This might seem like a good idea, but actually it isn't, and I think I can justifiably say, 'Don't do it'. The implication is that very strong local signals would not be used, and less strong, less local signals would take their place. This will cause problems.

It is unlikely that the signals from the remote transmitter will be as reliable as those from the nearby station. Even where the second-choice transmitter provides good quality reception—unlikely in an area swamped with signal by the first transmitter—there are drawbacks. Occupiers will persist in tuning-in the weak signals from the nearby transmitter, which will still, inevitably, be present at the outlets.

Frequency shifting: the ultimate answer

There is an absolutely cast-iron cure for pre-echo. If each incoming signal is frequency shifted before it is distributed, it won't matter how much direct signal gets into the TV set. In locations of exceptionally high field strength there may be no alternative. Frequency shifting is quite a large topic, so I will only deal with it here only in the context of pre-echo.

The main disadvantage of frequency shifting is cost. Adding channel convertors to an existing system will cost a minimum of £750, including labour, for four channels. This figure would pay for simple direct convertors. One notch up the scale of cost and quality is double conversion, in which the incoming signals are converted to an IF of 38.9MHz, and then to the final output frequency. An even more expensive option is to demodulate and then remodulate each channel. If good quality equipment is used, the cost could be £3,000 for four channels. These costs would be of little consequence under some circumstances. For instance, if pre-echo has been a major problem on a system serving 600 dwellings, a cost of £5 per dwelling will not raise eyebrows, particularly if the purchasing authority can be given some sort of understanding of the technicalities. A more typical set of circumstances, however, would be as follows:

The installer is quoting on a competitive tender basis for the installation of a system to serve 40 bungalows. He is quoting to an electrical firm, who have the TV system included in their work. They in turn are putting a tender together for the main contractor, who is himself in competition with other builders. No-one wants to know about some weird problem called 'pre-echo'. If the installer allows for the cost of channel changers, one thing is certain: he will not get the job.

When finances allow the use of channel changers, the technical problems must be addressed. The first question concerns the channels to be used. Because signal attenuation on cable is less at lower frequencies, use of the lower channels is always an advantage. Channels carrying other signals of significant strength in the area should not be used. Where possible a standard set of four channels should be used. These sets are n, n+3, n+6, n+10, and n, n+4, n+7, n+10. Channels 34 to 38 should not be used.

Where channel changers have been installed on a system, the original, unchanged signals will still be present at each outlet where pre-echo was previously a problem. Anyone arriving with a TV set to install will assume, not unreasonably, that he should tune it to the local transmitter. A

glance at the aerial will seem to confirm this. The tuning may even have been done in advance at the shop. We are often called out shortly afterwards, to find the TV set carefully tuned to these weak signals, with the strong, translated signals ignored. We maintain one system where this has become a serious problem. Explanatory labels have been stuck to every outlet plate, with little or no effect. At present I am considering the extreme measure of adding a 'spoiler' signal at the head-end, which will make it impossible to tune-in the untranslated channels. Another answer to this problem is for the system to carry both translated and untranslated channels. The theory is that those who are offended by the pre-echo can re-tune to the translated channels, and those who aren't needn't bother. The main disadvantage is that the system must carry eight, rather than four, channels, which implies extra cost if the head-end is channelised, or a reduction of output levels if it is broadband. In any case, it simply isn't worth the trouble, because call-outs still arise. Those with pre-echo usually don't think to re-tune, even where an explanatory leaflet has been distributed.

Despite all these drawbacks, channel changers are sometimes the only answer. Typical of installations where frequency shifting had to be used was a high rise hospital building just half a mile from a 5kW transmitter. Some wards had floor-to-ceiling glass on the side facing the transmitter, with the TV set standing just in front of it. There was nothing wrong with the TVs, the flyleads, or anything else, but pre-echo was an annoying niggle on an otherwise excellent system, and eventually something had to be done. Why, you might reasonably ask, should anything be done? If there's so much signal, why not just fit out the whole place with set-top aerials? In fact, the hospital technicians had fitted set-top aerials in some of the wards which faced the transmitter, but this meant that the satellite channels, which were distributed at UHF, were lost. It isn't acceptable to have patients and staff fiddling about behind the TV set changing aerials all the time. A more serious disadvantage of set-top aerials arose in the wards which faced away from the transmitter. Here the field strength was less, but still enough to cause direct signal pick-up. Most of the direct signal was not, in fact, so direct, having arrived via a bounce off a nearby tower block. Consequently set-top aerials were useless because of ghosting. Where responsibility for all the TV sets on a site rests in one place, incorrect tuning (to the untranslated channels) is less likely. Patients and nursing staff are less likely to tamper than people in their own homes.

In conclusion

Pre-echo is often the unexpected problem which spoils an otherwise well planned and well executed communal TV system. Even when the installer is aware of the possibility, the constraints of cost and competitive tendering may lead him to take a chance. Assessing the possibility of pre-echo is very difficult under these circumstances. I hope this article will help contractors estimate the likelihood of pre-echo problems accurately, and thus tender more competitively.

Maths

To calculate the distance signal travels in the time taken to scan one line:

$c = 3 \times 10^8$; line period + 64µs

(a) in free space

$(3.0 \times 10^8) \times (6.4 \times 10^{-5})$

$= 19.2 \times 10^3$

=19,200 metres (about 12 miles) per scan

(b) in co-ax with a velocity factor of 0.80

19,200 x 0.80

= 15,360 metres of cable per scan

If the distance on the screen between the two images is measured, it is possible to calculate the total delay time. Although it is not possible to distinguish between the free space and cable components of the delay by this method, an approximation of the overall extra path can be made.

To calculate the signal delay, and hence path extension, for a given screen image displacement

Delay factor = $D_1 \div D_2$

where D_1 = distance between screen images

D_2 = total scan width

(a) signal path extension

(where all of extension is in free space)

E = delay factor x distance

$E_{space} = (D_1 \div D_2) \times 19{,}200$ metres

(b) signal path extension

(when all of extension is in cable)

$E_{cable} = (D_1 \div D_2) \times 15{,}360$ metres of cable

For example, the long delay screenshots show pre-echo images 3mm to the left of the main image. The line scan, including sync and overscan, is about 190mm, estimated from the screen width. The aerial and TV set are about the same distance from the transmitter, so all of the delay is within the system.

$(3 \div 190) \times 15{,}360 = 242$ metres