Multiple Outlet Plates for TV

Bill Wright

from *Television*, July 1999

With the increasing complexity of many domestic TV installations, there is a need for a neat and tidy multi-pole coaxial wall plate with good electrical performance. This article also discusses problems of signal crossover between connectors.

Most houses built in the last twenty-five years have an aerial cable built into the wall. This length of coax usually runs from an outlet plate in one corner of the living room up to the loft. What seemed a fine and futuristic innovation in 1974 is woefully inadequate in 1999. Just as the two single 13A mains outlets fitted in opposite corners of the living room are no longer adequate for all the appliances in use today, so the single coaxial cable and outlet plate has no chance of meeting present-day needs.

The need for a screened multiple co-axial wallplate

There is often an unholy mess behind the present-day TV set, with the builder's original wallplate in use, plus various other cables coming through the wall, along the floor, or even through the corner of the nearest window-frame. In-line splitters, game switches, and suchlike complete the picture (fig 1). Quite often the customer asks, in a hopeless sort of way, if anything can be done to tidy things up. That's her perception of the problem. Your perception is that a jumble of cheap flyleads and loose-fitting unscreened outlets can seriously affect reception quality. Let's assume that you rip out all this rubbish and bring new cables in, nice and neatly through the rear of the original backbox. You need a tidy way to terminate this unruly hank of cables or the result will still be a rat's nest. Tidy up the mess in the corner of the living room, and the improvement will count for as much with some people as any amount of aerial-rigging expertise on the roof. What's needed is a five- or six- way coaxial socket, built onto a standard domestic wallplate.

Full screening is essential, both to prevent crosstalk between the different co-axial circuits that pass through the wallplate, and to prevent leakage to and from the outside world. In Part Two I'll go into this in some detail, because it's becoming more and more important.

As far as I know there isn't a suitable outlet plate on the market. The problem arose repeatedly, and finally I had to find some sort of DIY solution. But before I get onto that, let's assess the size of the problem, both now and in the future. Just how many coax cables could be needed?

Cable count-up

Take a very common domestic set-up. The TV set, video recorder, and satellite receiver sit in the corner of the living room. The video and satellite outputs are fed to various other rooms, as well as to the main TV set. Assuming that the satellite and VCR outputs are added to the off-air UHF signals in the proper way using channel-pass filters (rather than simply daisy-chained), the cable tally is likely to be as follows:

1. Aerial for the TV set.
2. Aerial for the VCR (carries all UHF signals except the VCR output).
3. Satellite dish cable.
4. VCR output to the distribution system.
5. Satellite receiver output to the distribution system.

Other possible cables, either now or just round the corner, are:

1. A second dish cable, usually Eutelsat 13˚E.
3. A third dish cable, usually for a specific group of ethnic channels.
2. An unfiltered feed from a wideband aerial for the ONdigital box.
4. The ONdigital output to the distribution system.
5. A Sky digital dish cable. This will often be an addition, because many people are going to retain their old analogue satellite equipment, despite Sky's efforts to the contrary.
6. A VHF-FM radio aerial downlead.
7. A Digital Audio Broadcasting aerial downlead.
8. A surveillance camera cable.

Fig. 1

Practicalities

For years I simply drilled holes in a blank plate, one for each cable. This was technically satisfactory, but there were obvious aesthetic and other disadvantages, so eventually I started fitting up to eight 'f' type line couplers onto each plate. The result was a nice, tidy, multiway outlet, with no possibility of crosstalk, impedance mismatch, or excessive through-loss. Rear connections are via ordinary 'f' plugs.

At first, I made these plates up as they were needed, usually at the last minute. This was a bit of a chore, so I was pleased when my son Paul turned to mass production! The worst part of the job was the marking out, but he now has a simple device which makes this unnecessary, and allows four plates to be drilled at a time, with great accuracy (fig 2). He makes about thirty plates in a session, usually when it's raining! We keep two-way, four-way, and six-way plates in stock (fig 3). The plates can easily mark each other in transit, so it's a good idea to re-use the original packaging.

There are blank plates available at 25p each, but they shatter under the drill. We have settled on the Contactum 1017 one-gang moulded plate. These are not cheap, but they are very strong and good looking.

If you want to make outlets in this way, you can use a normal HSS drill, but don't put on too much pressure. It should take about15 seconds at 900 r.p.m. to drill each hole. Any quicker and you might splinter the face. A ⅜" drill is slightly too big, but will serve. A 9.3mm drill (RS 513-483) or a 23/64" drill (RS 202 8432) is perfect. A drill stand makes the job a lot easier.

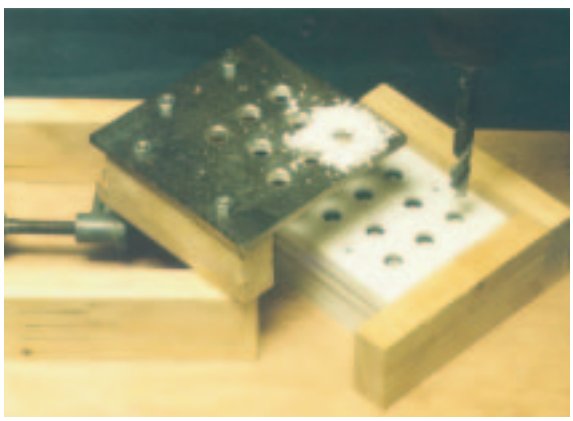

Fig. 2.

When the connectors are fitted the nuts should be really tight. Don't worry, the plate won't crack (unless you have a gorilla on the payroll!). A nut-spinner and ring spanner, used in opposition, seem to provide the easiest method. I don't know the technically-correct size, but 7/16AF or 11mm both fit.
Once installed the plates look quite impressive (fig 4), and I have no difficulty in itemising them on the invoice at a price that well rewards our time and trouble! Now that we've got our act together and can make the things without too much trouble, they have become an absolute boon. I use about five a week, and I wonder how I ever managed without them!

Fig. 3.

Posh people with brass mains fittings will naturally require a matching brass TV outlet. Matching brass blanks are usually available. Find out what make and pattern they are by looking at the back of a mains socket or light switch. The same applies to brushed stainless fittings. Both of these scratch very easily, so protect the surface with masking tape when drilling. These items are, of course, a one-off, so the posh customer will understand that they are very, very, expensive…

F type connectors

The choice of connector was dictated by the need for full screening and by constraints of space. Our old friend the Belling Lee is, of course, the UK standard for all aerial connections, but try to fit six fully-screened Belling sockets onto a single blank plate and you'll see why I settled on 'f' types. The latter also have the great advantage that the plug

Fig. 4.

screws firmly onto the socket instead of just pushing into it. The 'f' type originated as a CCTV connector in the USA, and I remember how sceptical we all were when we first saw it. The use of the cable inner as the centre pin caused raised eyebrows, but the expected problems don't seem to have materialised. Flyleads with moulded 'f' plugs are readily available, although I usually make up my own using CT100 cable.

When buying the 'f' type line couplers (also called line connectors, through connectors, plug-to-plug connectors, female-to-female adapters, etc) make sure that they are supplied with the nut and washer. Some are, but most are not. The CPC item SECON2 is suitable, and cheap, at 19p.

Cable routes

It's usually easy enough to get the cables into the room from their various origins. The 'TV corner' of most living rooms has at least one external wall, so it's no problem to remove the existing single outlet from the wall, bash out one of the knock-outs from the rear of the backbox (the steel box set into the wall), and drill straight through the wall to the outside. Be careful not to shell off the face of a brick on the front of the house, and use plenty of silicone sealant to weatherproof the hole after the cables have been fitted. If possible, find a reasonably camouflaged cable route up to the loft. It's often convenient to hide the cables behind a fallpipe. By the way, using individual cable clips on an outside wall for several parallel cables looks awful. Use push-in cable-tie holders and secure everything in one neat bunch.

Even when the 'TV corner' is not on an outside wall, a bit of scrabbling about under the floor will usually get the cables through. Nowadays I find it worthwhile to use a slender and athletic youth for this sort of job!

Behind the wallplate

Each line coupler has an 'f' plug screwed to its rear, so a reasonable amount of clearance is necessary. A standard backbox allows about 30mm of depth, and this is just enough for a four-way plate. The cables should be just long enough to allow the fitting of the plugs or they won't push back easily into the box. Try not to kink them. Where a shallow backbox has been fitted it might be possible to use right-angle crimp-type 'f' plugs, but often the only answer is to replace the box with a standard one. With care this can be done without disturbing the plaster or wall finish. Use a drill, then a cold chisel, to deepen the hole.

If the wall is faced with plasterboard, with a space behind it, the backbox will be a 'dry liner' type. These fix into the plasterboard using side lugs and can have part of their rear wall removed, if necessary, to accommodate cables and plugs.

If there is no suitable backbox, it will be necessary to fit a patress. This white plastic box screws onto the surface of the wall. The outlet plate fits on the patress. This is undoubtedly the easiest way to fit a multiple TV wallplate. The only disadvantage is that it isn't as neat as a flush fitting, but the finished job is still usually a great deal better than what went before. The very deep patresses made for cooker switches (Contactum 1055) are ideal. I wouldn't advocate fitting one of these in the middle of the living room wall, but in the corner behind the TV set they are usually acceptable. Various mounting boxes are shown in fig 5.

Fig. 5.

The local electrical wholesaler is the place to buy blank plates, patresses, backboxes, and so forth. Don't go to the Do-it-Yourself megastore for these items, unless you want to pay three times the proper price.

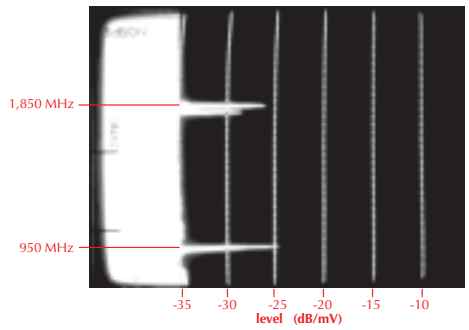

Fig. 6. Spectrum analyser display showing cellphone transmissions in the satellite IF band. The signal levels shown here are low, but in the vicinity of a cellphone mast they can be much higher.

Labels

The electronic labelling machines now available make this part of the job a doddle. Nice neat plastic labels at the press of a button! When I first got mine, I was so pleased with it that I used it to write to our Carolyn at university. The letter was eleven feet long!

When the lady of the house decides to re-arrange the living room furniture (probably on Christmas Eve at 5pm), she will blithely unplug all the cables behind the TV set. This can lead to annoying phone calls, just when you thought you could relax. If you have labelled every socket, there is some chance that the problem can be rectified over the phone. If not, and you have to make a visit, you can put things right very easily. Because all the sockets are labelled and any child could have reconnected everything correctly, the customer will be too embarrassed to balk at the cost of the call-out. You might even get a mince pie, but I doubt it.

It's worthwhile to include on the labels the output channels of VCRs, satellite receivers, and other set-top boxes which feed into the distribution system. These signals will normally pass through channelpass filters before being added to the off-air signals, so when the customer attempts to install his new VCR or whatever, it is unlikely that he will succeed. A call-out will result, and the channel number on the label in the living room will save a trip up to the loft to look at the label on the filter.

Higher installation standards

Nowadays, the aerial and satellite installation trade needs to work to higher standards than ever before, although in the world of large scale contract rigging this is often outside the control of the actual installer. Technical standards are often the last consideration, and those readers who install aerials and satellite dishes on a contract basis will no doubt be reading this article with a wry smile. When you're obliged to complete ten or fifteen installs each day there isn't even time to drink the infrequently proffered cup of tea, never mind fit fancy outlet plates! Don't worry, I know all about it—I spent twenty years working like that. Incidentally, as well as earning a lot of money I developed knee, elbow, and back problems that are proving much more long-lasting than the cash. For those of you trapped on that particular treadmill I have the greatest sympathy, and I can understand how irrelevant this article must seem.

I am now able to work at my own pace, and it is very gratifying to find that a significant number of customers appreciate the finer points of the job, and are prepared to pay accordingly. As the volume of domestic aerial work decreases year by year, it seems to me that a survival route for the competent self-employed contractor is to cultivate the top end of the market. Go for the big jobs. If someone else has made an almighty mess, so much the better. Keep to the highest possible installation standards, explain exactly what you're doing and why, don't smoke in the house, and look forward to the recommendations.

Outlet plates: the importance of screening

As domestic installations grow in complexity, good screening of all co-axial feeds is becoming more important. I'm concerned here with the screening properties of outlet plates, but most of what follows also applies to masthead amplifiers, downlead cables, splitters, and flyleads.

The traditional wallplate is fitted with one, or at best two, coaxial sockets. There is no screening, but the better designs minimise the amount of unscreened inner conductor, and if the cables are prepared with due regard for good RF practice they work perfectly well almost all of the time. Unwanted signal pick-up from outside sources does occur occasionally, however, and crosstalk between the two circuits is always a danger.

Inferior outlet plates

Badly designed wallplates cause all sorts of problems, and there are some truly awful ones on the market. Some manufacturers either don't know or don't care about good RF practice. One particular double outlet plate has a printed

circuit (including a printed inductance, but with the other components not fitted), connected to one of the inner conductors. The circuit appears to be intended for a diplexer, or something similar. Because of the large area of unscreened copper track connected to the coaxial inner, this item radiates and receives signal very efficiently, to the great detriment of the outlet's proper function. UHF through-loss is between 6 and 15dB! The amount of crosstalk between the two sockets is similarly disastrous. Outlets like this will cause impedance mismatch, leading to standing wave effects. I have cured many a strange reception fault merely by removing one of these beastly things and fitting a decent outlet. Other culprits include an outlet in which the soldered screen connection breaks easily but invisibly, and one where the centre pin pushes back and contacts the rear of the steel back-box.

Pre-echo

In strong reception areas, enough signal can be picked up direct by a poor quality outlet plate (and flylead) to compete with the signal from the aerial. This effect is called 'pre-echo', and is a particular problem on communal aerial systems (in *Television*, March 1996, available from Wright's Aerials web site).

Interference from satellite receivers

Some satellite receivers radiate UHF noise alarmingly, particularly on channel 25. A few years ago this became a very common problem, and we were all advised to fit 'double screened' coax leads. You might think that if the aerial feed is looped through the satellite receiver in the usual way, any signal pick-up in the outlet plate would be insignificant, but this is not the case. Interference can even come from next door's satellite receiver—and other equipment. In the semi-detached situation, the outlet plate is likely to be back-to-back with the neighbour's, and not much further from their satellite receiver, games machine, or computer. In blocks of flats, the TV set and associated equipment on each floor is likely to have similar equipment only 3m above and below it.

Interference to satellite IF

The LNB output frequencies (commonly called 'satellite IF') coincide with various transmissions. If these signals find their way into the feed from the LNB to the receiver they can cause interference. Cellphone masts have become a particular problem, with transmissions centred on 950MHz and 1850MHz (fig 6).

Cellphone transmission	Satellite frequency which may suffer interference:		
	9.75GHz LNB	10GHz LNB	10.6GHz LNB
950MHz	10,700MHz	10,950MHz	11,550MHz
1850MHz	11,600MHz	11,850MHz	12,450MHz

The output of an LNB is at a very high level, with carriers as much as 35dB above the minimum receiver input, and this provides good immunity from interference. But sometimes these levels are greatly attenuated by the time they reach the outlet, flylead, and receiver. This can happen if the satellite downlead is very long, or if it is of an inferior type of cable. Satellite IF distribution systems are normally designed to deliver a signal level to each outlet which is only 12dB or so above the receiver's minimum input. Because of varying carrier levels this can occasionally fall to a much lower level. In these instances there is vulnerability to interference that enters at the outlet plate and flylead. Nowadays it seems that virtually every high rise building has a cellphone transmitter on the roof. Although cellphone transmissions are not high powered, they can, in my experience, cause problems within the building itself and at sites up to a quarter of a mile away.

How can the outlet plate receive enough cellphone signal to cause interference? A quarter-wave dipole (perhaps the most efficient aerial of all) is only 38mm long for 1,850MHz, and the length of unscreened inner conductor behind the outlet can be a significant fraction of this length.

Crosstalk in double outlets

Double outlets often allow crosstalk between the two circuits. This is quite a common problem, even where good quality outlets are used. The amount of crosstalk depends to some extent on the way the connections have been made at the back of the plate. If an unnecessary amount of inner conductor is left unscreened, the outlet can allow UHF signals to pass from one port to the other with as little as 20dB attenuation. Fig 7 shows a typical attempt by a site electrician — who, to be fair, can't be expected to know about the peculiarities of RF—to wire a double outlet. The outlet plate is a good quality one, and the manufacturer has positioned each saddle clamp and terminal screw close to each other to minimise the necessary amount of unscreened inner. Alas, this was in vain, and this particular example was the sole cause of severely degraded reception.

Interference from satellite IF

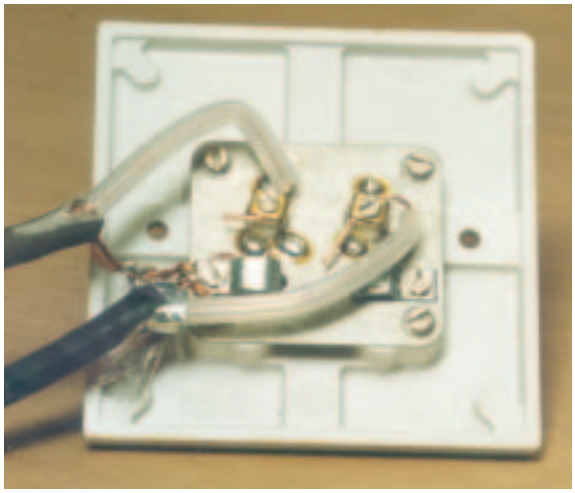

Fig. 7.

Satellite IF feeds and unscreened double outlets form a very unhealthy combination. An LNB is, from this point of view, no more than a noise source followed by about 50dB of amplification. The noise output of most LNBs extends down well into the UHF TV band. If this noise gets into the UHF aerial feed the signal-to-noise ratio will be reduced, and the picture will become 'snowy', just as if the UHF signal was too weak. Cheap flyleads can be the culprit here, as well as dodgy outlets. LNBs with a local oscillator frequency of 9.75GHz aren't too bad in this respect (fig 8) but the older 10GHz types will down-convert the lower satellite channels to frequencies within UHF Group C/D, with obvious interference-causing potential. The 10.6GHz types, intended for reception of the higher satellite frequencies, appear to be even worse in this respect. When the LO frequency is switchable between 9.75 and 10.6GHz, the LNB is known as a 'universal' type. These LNBs are often used for reception of Eutelsat 13˚East, so I measured the UHF output of a 0.8dB universal LNB, set to 10.6GHz and aligned on 13˚East with a 1m dish. The results (fig 9) show that significant leakage of the LNB signal into the UHF feed will cause severe reception faults. The

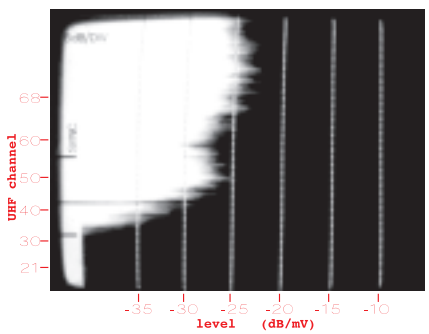

Fig. 8.The UHF output of a 9.75GHz LNB. If this noise finds its way into a UHF aerial feeder the picture will be 'snowy', as if the UHF signal is weak. In this example the satellite downlead loss was 10dB. Note that there is 20dB less input attenuation than in Fig. 9.

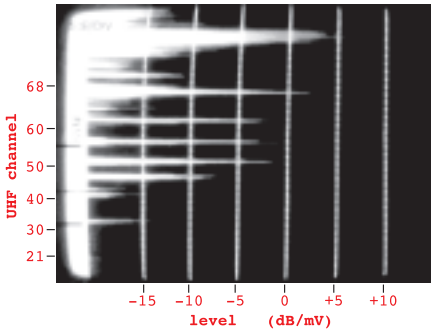

Fig. 9. The UHF output of a 10.6GHz LNB. Even after 10dB downlead loss the satellite carriers can touch +5dB/mV. If a satellite carrier happens to coincide with an occupied UHF channel there is severe interference potential. Despite differing transmission standards satellite signals may even produce identifiable pictures on a UHF TV set.

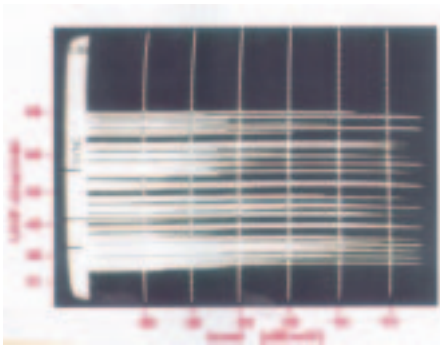

Fig. 10. The output of a multi-channel UHF distribution system. In this shot and in Fig. 11 the signal levels have been temporarily reduced by 6dB.

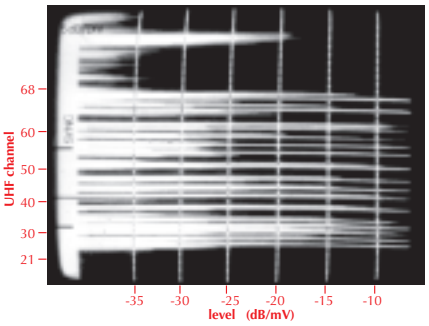

Fig. 11. The UHF spectrum shown in Fig. 10, but with interference from a 10.6GHz LNB. The latter was introduced via a badly wired double outlet which caused crosstalk measured at –26dB. As well as the obvious spikes above channel 68, lesser signals and noise are visible almost to the bottom of the band.

Fig. 12.

satellite carriers leave the LNB at +10dB/mV or more. Allowing for satellite downlead loss of 10dB, a double outlet crosstalk figure of –30dB could result in a signal to noise ratio of, say, 35dB. This will severely degrade analogue UHF reception. Figs 10 and 11 show the effect of crosstalk, as shown on the spectrum analyser. On the TV screen the result tends to be a strange mixture of 'snow' and cross-modulation, as shown in fig 12. Even if the UHF channel in use is affected by LNB noise only, without a satellite carrier, the result is, as you might expect, a very noisy picture.

The point is, when the dish feed passes through the same double outlet plate as the UHF aerial, screening within the outlet is vital. There are double outlets on the market with one Belling and one 'f' type socket. Although expressly sold for dual IF/UHF use, the two circuits are not screened from each other. Beware!

Sky digital

Reception from 28.2˚East requires a universal LNB. At the time of writing, all the transmissions are near the top of the band, with little or nothing lower down. When digital transmissions start on lower frequencies, they will be converted by a 10.6GHz LNB onto the UHF band. I expect this will cause no end of trouble.

Satellite IF crosstalk

Crosstalk can occur between two satellite IF feeds, if both LNBs are continuously powered. If both feeds pass through the same outlet plate crosstalk is almost inevitable, because the length of unscreened inner will be a significant fraction of a wavelength. The effects may be subtle, but they are best avoided.

In conclusion

I hope this article has gone some way to explain some of the odd little peculiarities that we all encounter from time to time. Sometimes there's just a minor fault: a little bit of patterning or a slightly grainy picture. It's tempting to simply shrug your shoulders and hope the customer doesn't notice, especially if you have no idea what the cause might be. Unfortunately, a minor fault can turn into a major one as soon as your back is turned. How much better to put it right in the first place! It's usually fairly simple to diagnose this sort of thing, for instance by disconnecting each possible source of interference in turn. As the satellite and aerial installation business gets ever more complicated, competent installers have a chance to distance themselves from the cowboys. The way to do this is by working to high standards. Don't ask yourself if the customer has noticed. Ask yourself if you have noticed.