Reprinted from 'Hi-Fi News', November, 1967.

equipment review

MANUFACTURER'S SPECIFICATION.
Custom-built four-element aerial for outdoor erection intended specifically for FM stereo reception. **Tuning:** Optimised on the stereo transmission frequency of each area. **Gain:** Forward, at peaked frequency, better than 7 dB. **Features:** Supplied complete with universal mast clamp. **Price:** £4 7s. (Type PM3 phasing and matching harness for stacking two aerials £1 10s.) **Manufacturer: J-Beam Engineering Ltd., Rothersthorpe Crescent, Northampton.**

THERE was a four-element FM aerial in the J-Beam catalogue some years ago, but limited demand led to its withdrawal. Why then introduce the *FM4S*? The answer is to be found already in the published literature relating to the problems that are experienced in receiving FM stereo radio programmes. To recapitulate, these are

(a) There is a reduction in the effective signal-to-noise ratio which will be perceptible to the listener if the signal voltage reaching the receiver is not unduly strong. The likelihood of degraded stereo reception increases markedly with decreasing voltages below 200 microvolts.

(b) Unpleasant audible distortion is caused when there is reception of one or more time-delayed (indirect) signals in addition to the direct signal. Multi-path reception is more apparent in stereo than mono and very noticeable in the reproduction of piano music.

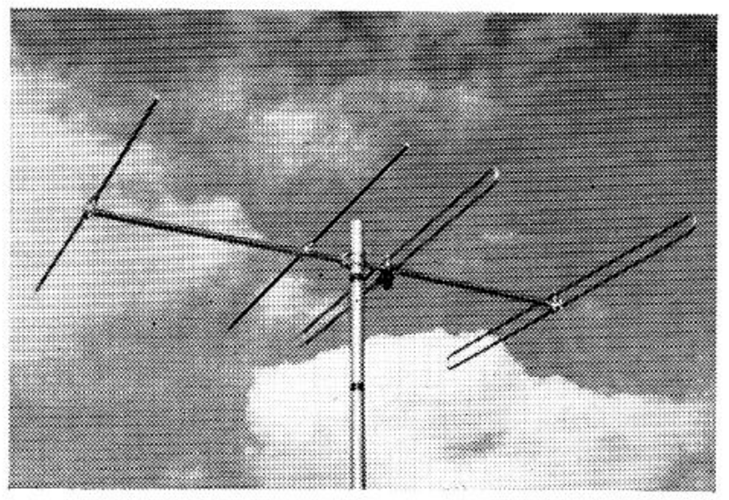
(c) Unwanted noise and audio beat components arise due to reception of interfering stations operating at or within about 100 kHz of the wanted stereo station frequency.

At the present stage of FM stereo broadcasting in the UK, problems (a) and (b) assume the greatest importance but improvements to overcome both are in the hands of the *listener*. Take problem (a) where the signal voltage reaching the receiver is not unduly strong, and inquire "Why?" The most probable answer is that the location is several tens of miles distant from the transmitter. But equally well one can be within ten miles of it—yet in a valley or almost at river level in central London encircled by tall buildings with much the same effect. The location may differ but the end results are similar and often aggravated by poor aerial siting. In issuing their maps of station coverage and the grades of reception to be expected for 50% of locations 45 feet from a busy road, the BBC use a height of 30 feet above ground as the standard reference level for the receiving aerial. Often, the listener's aerial is at best about 25 ft.—usually in the loft, and sometimes it is only 6 ft. on the wall of a ground floor room.

A rough 'rule of thumb' applies here:—namely, raising the height of the aerial above ground level increases the signal voltage at the receiver and *doubling* the height virtually *doubles* the signal. Expressing this another way, the signal strength available from the ground floor room aerial may be about only *one quarter* of that attainable from the loft aerial. To prove the point, we connected a dipole and short length of feeder cable to a receiver having a calibrated meter and set it to the *Wrotham* 91·3 MHz transmission exactly 60 miles distant. The results are set out in **fig. 1.** A multi-element aerial would certainly yield a further improvement, if required, in overcoming problem (a) but it is essential for tackling problem (b) that of multi-path reception. This phenomenon has been investigated by Spencer and Philips[1] and by Hurck, Stumpers and Weeda[2]. Distortion due to multi-path reception can arise in almost any hilly area with greater effects for path differences of less than five miles; for example, with piano music and a two mile path difference, the reflected amplitude in stereo must be about half that of a mono transmission for just perceptible distortion. Distortion has been experienced quite close to *Wrotham* where the delayed signal from a neighbouring hill slope arrived at the receiving aerial only a few degrees from the direct signal bearing. So far as we are aware, a multi-element aerial did clear the trouble.

Of the readers writing to us over the years about indifferent (mono) FM reception, some 85% of their troubles can be traced to poorly sited aerials (too low) or use of the wrong type (e.g. the TV aerial!). The remainder fall into such miscellaneous categories as receiver faults, wrong type of feeder cable, water seeping along aerial terminals and feeder, new building block immediately in front of basement aerial(!) and signal fluctuations caused by prevailing propagation conditions. Enough said, and on with the review at last!

First impressions on unpacking the *FM4S* from the sturdy transit carton are of the 'clean' design and finish. The 73 in. cross boom is of 1 in. aluminium tube to which the *Mazak* die-cast element clamps are secured by centre fixing bolts of aluminium alloy. Elements are of ½ in. alloy tubing, the ends being sealed by plastic bungs to prevent whistling. The folded elements have internal damping. A universal mast clamp is supplied and this is suitable for masts of 1 to 2 in. diameter.



J-BEAM TYPE FM 4S AERIAL ARRAY

The aerial is shipped partly assembled and completion of this job follows the usual pattern—the cross boom is laid vertical and the element wing nuts slackened off almost to the limit of bolt threads. It is also necessary to slacken the centre-fixing nuts which bear on to the die-cast clamps that secure the ends of the folded elements. Having swung the individual elements up to their horizontal position, wing and clamp nuts are tightened.

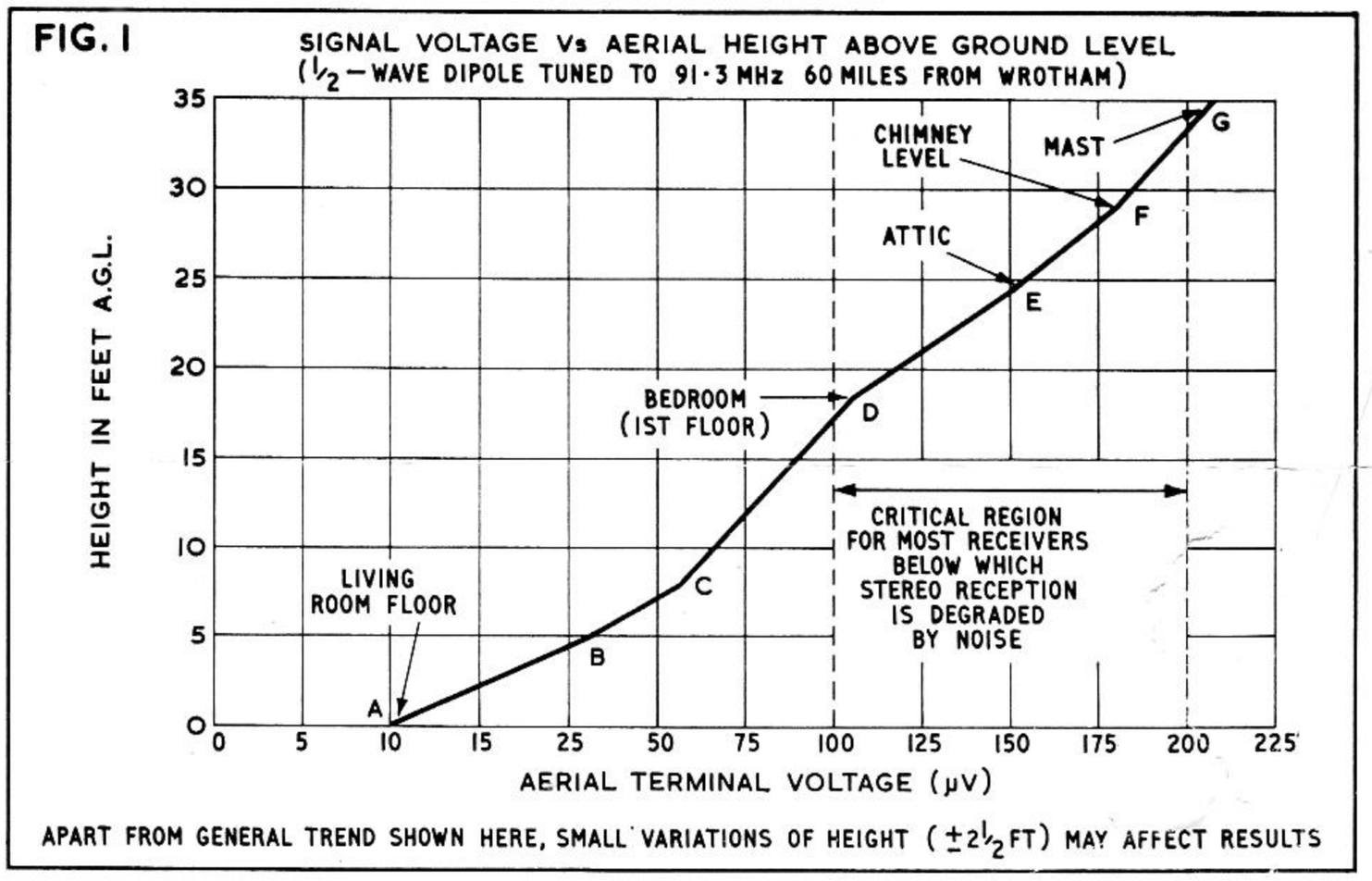
The cable connector box is covered by a waterproof gland. Breathing down the gland moulding provides sufficient lubrication for the cable to be passed through, and this must not be enlarged with a tool if the box is to be kept waterproof and low-loss conditions maintained! A cleat secures the cable and having connected up to the terminals, the gland is 'push-twisted' over the box.

The assembled aerial comprises two parasitic directors, a folded dipole and a folded reflector. Spacing between first and second directors is 0·25λ, second director and dipole 0·1λ, and

[1]J. G. Spencer and G. J. Philips, 'Stereophonic Broadcasting and Reception'. *Radio and Electronic Engineer*, Vol. 27, No. 6. June 1964 pp. 412–413.

[2]N. van Hurck, F. L. H. M. Stumpers and M. Weeda, 'Stereophonic Radio Broadcasting'—(II). *Philips Technical Review*, Vol. 27, 1966 pp. 65–66.

FIG. 1



APART FROM GENERAL TREND SHOWN HERE, SMALL VARIATIONS OF HEIGHT (±2½ FT) MAY AFFECT RESULTS

dipole and reflector 0·22λ. Tuned for 92·3 MHz, overall element lengths are 56, 60·5, 61 and 67 in. respectively.

The two conductors forming the folded reflector both carry equal currents, their total aperture approximating a sheet of metal 0·5 × 0·75λ. This allows a good front-to-back ratio to be attained without requiring the short director chain to be off-tuned from optimum, the designer's objective being a clean polar diagram without side lobes, as in **fig. 2.**

The *FM4S* is normally supplied tuned for optimum gain on the *Third Programme* frequency of each area, although as a custom-built aerial it can be supplied tuned to any desired frequency within Band II. Most BBC stations broadcasting three programmes are allocated frequencies having 2·2 MHz spacing between them, with the *Third* (all right then, Radio 3!) on the centre channel, so the aerial performance should not deviate appreciably over a 4·4 MHz bandwidth.

Fig. 3 is the forward gain frequency curve (relative to a half-wave dipole) of the *FM4S* tuned to 90·3 MHz. The desired conditions are nicely met with the gain falling less than 2 dB (to 6 dB) LF and 3 dB HF of the peaked frequency; thereafter, the response falls sharply HF and more slowly LF. The curve by the way slides up and down the Band relative to the peaked frequency, so the reader may redraw this for any other frequency of interest to assess the overall effect. Here then, is the difference between the *FM4S* and a conventional four-element aerial which would probably realise marginally less gain though with a broader bandwidth centred around 94 MHz. This type of aerial (or the *J-Beam FM6S*) would need to be used for a station like *Wenvoe* (should it ever 'go stereo') owing to the exceptional frequency allocations.

Initial tests were made at an open site in Berkshire where we had the interesting experience of being able to swing the *FM4S* through 10° and listen to either BBC *Peterborough* or RTB *Houdeng* (Belgium) both at 92·3 MHz with 12–15 μV inputs. The more gradual fall in response at the lower end of the band covered also had the effect of bringing the Hilversum stations around 88 MHz out of noise to an extent not found with other multi-element aerials. Later tests using an assortment of receivers left a favourable impression of performance and, as these were proceeding, Harry Leeming at Blackburn wrote to say that the aerial outperformed a certain six-element American type that he had been trying out!

During the review period, attempts to simulate multipath conditions were not very successful (perhaps a summer holiday in the Teutoburger Wald area would have been the answer?); however, open site tests using 92·7 MHz (*Sutton Coldfield*) showed nothing amiss in the polar response. This would of course be markedly modified if the aerial were used indoors—fortunately it will not fit into many lofts!

ONE ABOVE THE OTHER

For stacking one aerial above the other, a type PM3 matching and phasing harness is required. This comprises a quarter-wave transformer using 53 ohm feeder between the junction of the aerial feeders and main feeder, so avoiding the added hardware often required with other stacked aerials. Vertical stacking distance is 70 in. Improvement in gain and vertical discrimination was marginal and for most localities within the local stereo transmitter service area, a single *FM4S* mounted in a clear outdoor position will yield satisfactory results. Where degradation due to weak signal is still apparent, it will be worth trying out a mast-head pre-amp, of the sort described in the September 1966 edition of *Hi-Fi News*, on page 319.

The *FM4S* is considered to be good value for money—hard to fault in performance or workmanship and offering a useful improvement in gain and directional properties for listeners not satisfied with *local stereo* reception with an existing dipole or horizontal 'H'. It is less easy to give a fair assessment between this and other four-element arrays although *marginally better* results are probable at the *optimised frequency*.

To conclude, some thoughts on maintenance and installation. The aerial itself is constructed of chosen alloys which form an oxide film in the air and is partly a protective coating in itself; however, some form of paint protection is well worthwhile particularly when sited in coastal regions. One of the resin-based paints such as polyurethane varnish would be very suitable and make dismantling and re-assembly of the aerial easier if this proves necessary. *J-Beam* have suggested *Gipral* made by *British Paints Ltd.* When using resin-based paints it is a good idea to avoid skin contact by wearing gloves and work in an area that is well ventilated. The insulator terminals must not be painted of course. If the waterproof gland has been correctly fitted little change of air can occur and corrosion is unlikely. The plated steel parts, that is the main mast bracket and bolts, should be protected using either a normal red leaded paint or a high resistivity grease.

Very few radio/TV dealers want to be bothered with aerial rigging nowadays, a situation that gets increasingly worse; those that will carry out this work are certainly not properly trained to understand or care about particular site problems.

FIG. 2 FM4S POLAR RESPONSE AT 90·3MHz (MANUFACTURER'S FIGURES)

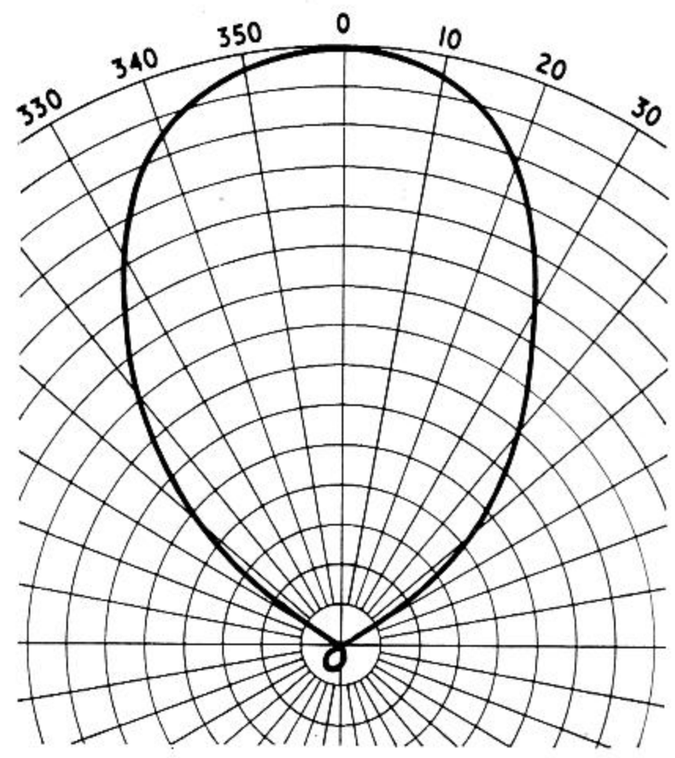
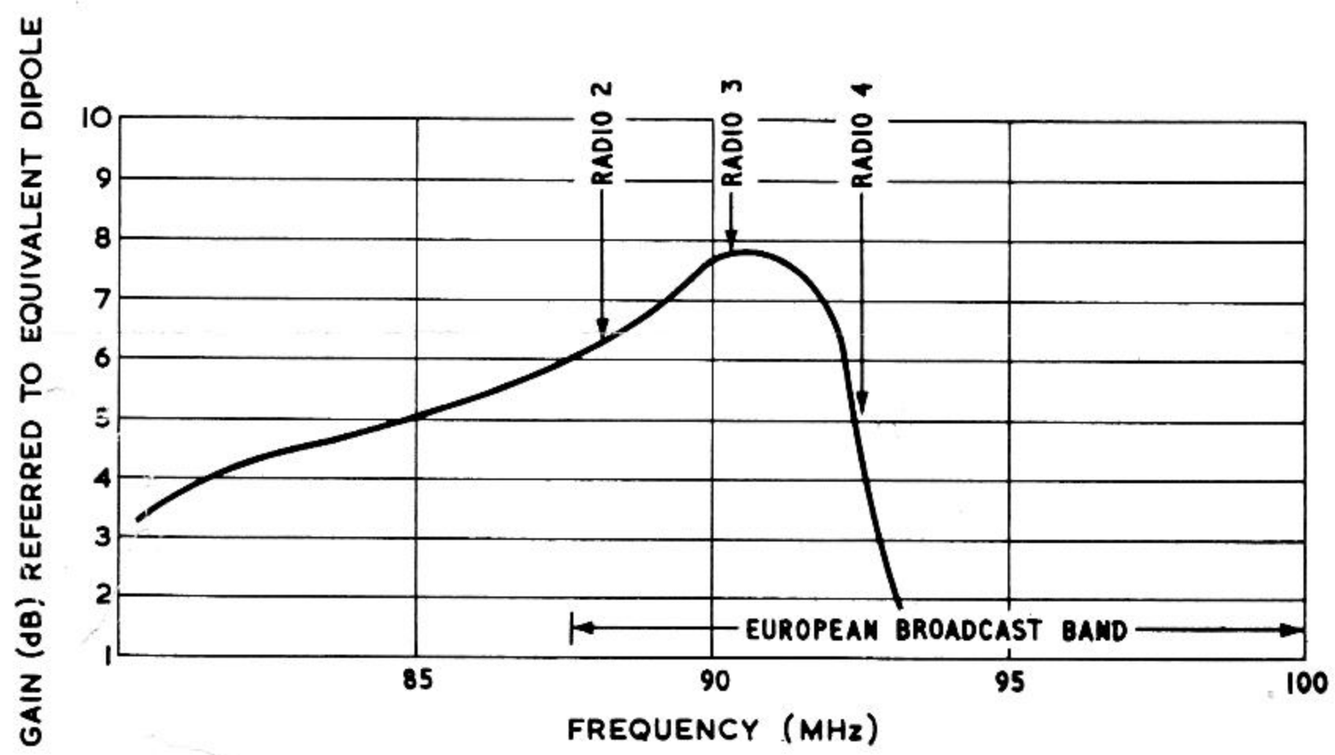


FIG. 3 FM4S GAIN Vs FREQUENCY (NOTED FREQUENCIES REFER TO WROTHAM)



AN ODD JOB MAN

If you are prepared to spend time site probing with the aerial, but are put off the roof work or getting a garden mast up, it is worth enlisting help from an odd-job/handyman (sometimes the 'small-ads' in the local press). Alternatively, members of the nearest amateur radio group might assist.

Our advertisers, *Audio Workshops*, specialise in aerial installation work but only within reasonable distances of their premises.

If you have to resort to a local dealer, we strongly recommend for you to arrange to be present personally during installation. At a straightforward location, it ought to be possible to get the aerial within 2° of the true transmitter bearing. Receivers fitted with a meter type tuning indicator are useful in the absence of a proper signal measuring device.

A. H. Uden