Aerials for h.f communications

IN ADDITION to a wide range of well established designs of aerials for short, medium and long distance communications, the Marconi Company can now supply a range of newly developed log-periodic aerials for applications where it is an advantage to be able to cover the whole h.f band with one aerial. The range available, given in Table I, includes three interesting designs of receiving aerial which give polarization diversity for telegraph reception; in each case only two masts are used to mount one vertically polarized and one horizontally polarized aerial. Another noteworthy design is a compact aerial which uses two masts, only 125 ft (37·5 m) high.

For some applications rhombic aerials have unique advantages and the range of designs available is shown in Table II.

Other aerials such as folded dipoles, quadrant aerials, and horizontal arrays of dipoles can also be supplied. In all cases The Marconi Company offers an expert design service, backed by the specialized knowledge and experience of the Company's propagation research engineers, who will assess the operating frequencies and angles of elevation required for the most efficient use of the various ionospheric layers for point-to-point h.f circuits in any part of the world.

Log-periodic Aerials

The log-periodic aerial is an end fire array with a beam width of approximately 60° between 3 dB points. Its main characteristic is that the shape of the beam remains constant over a very wide bandwidth and the input impedance is also substantially constant over the same bandwidth. It is therefore applicable to h.f circuits where a large bandwidth is required.

In h.f propagation using the ionosphere for short-length and medium-length routes, radiation at a given angle above the horizon is required, the angle depending on the route length and the predominant ionospheric layer used. To obtain the required radiation pattern in the presence of the ground, the low-frequency end of the aerial is supported at a height which gives the appropriate angle of fire and the projected apex of the aerial is placed at ground level. The radiation centre, which varies with frequency, is then at a constant height in wavelengths above ground and the angle of fire is therefore constant.

In some cases, particularly for long-distance communication, the required angle of fire decreases as the frequency is increased. To achieve this the low-frequency end of the aerial is put at the appropriate height for low-frequency operation and the high-frequency end is put at the appropriate height for high-frequency operation.

While log-periodic aerials can readily be made to give free-space gains of the order of 11 dB with respect to an isotropic source, the full increase of 6 dB which is normally obtained when an aerial is placed above ground cannot be realized. This is because, to obtain the required radiation pattern, the aerial must be mounted with its axis sloping into the ground so that the radiation at the angle of fire comes from the side of the primary beam. The presence of ground then increases the gain by about 4 dB, giving a total gain of approximately 15 dB with respect to an isotropic source.

It is evident that the angle which the aerial axis makes with the ground should be kept as small as possible so that, for a given mast height, the aerial should be fairly long. Furthermore, because the useful radiation comes from the side of the primary lobe, it does not pay to make the primary gain (i.e. the gain in free space) too high as this would result in a primary lobe which is too narrow.

These remarks apply to horizontally polarized aerials, which are generally preferred because ground wires are unnecessary. However, where an extremely compact aerial without a very high gain is needed a vertically polarized log-periodic aerial is a good solution.

Log-periodic aerials can be designed to have an impedance characteristic giving a voltage standing-wave ratio of 1·5:1 or better over the entire h.f band. The value of the impedance is usually less than 350 Ω, depending on the form of the dipole used in the array and the method of feeding it, so that a tapered line transformer is required to transform it to 600 Ω. Alternatively, for coaxial feeders, a ferrite-cored transformer can be used to convert the impedance to 50 Ω.

In general the front/back ratio of a log-periodic aerial is better than 20 dB, an important advantage for reception.

TABLE I Log-periodic Aerials

Service	Range (miles)	Elevation angle	Frequency range (Mc/s)	Polar-ization	Gain of aerial mounted above perfect earth (ref. isotropic source) (dB)	Power handling capacity p.e.p	Number of masts	Height of masts (ft)	Approx. length of aerial excluding mast stays (ft)
T or R	200–600	45°	2–24	H	12	10 kW	2	125	250
T	570–1250	20°	4–28	H	14	30 kW	2	200	450
R	570–1250	20°	4–28	H	14	Receive	2	200	450
Diversity R	570–1250	20°	4–28	V & H	14	Receive	2	200	450
T	>1000	15°	4–28	H	15	30 kW	2	250	450
R	>1000	15°	4–28	H	15	Receive	2	250	450
Diversity R	>1000	15°	4–28	V & H	15	Receive	2	250	450
T	>1000	17°	6–28	H	15	30 kW	2	150	450
R	>1000	17°	6–28	H	15	Receive	2	150	450
T	>2000	10°	6–28	H	15	85 kW	2	250	450
R	>2000	10°	6–28	H	15	Receive	2	250	450
Diversity R	>2000	10°	6–28	V & H	15	Receive	2	250	450
Tx	>1000	15°	4–28	V	12	30 kW	1	150	150
R	>1000	15°	4–28	V	12	Receive	1	150	150
T or R	200–800	Omni-directional	2–20	V	3	15 kW	2	100	180

T=Transmitting R=Receiving
V=Vertical H=Horizontal

Rhombic Aerials

In cases where a very high gain is required, rhombic transmitting and receiving aerials can be supplied. The range of standard designs available is given in Table II.

In each case the frequency range is approximately ±40% about the designed mid-frequency. Three-wire rhombics supported on four masts, usually of lattice steel, are used for transmitting. The aerials are capable of handling up to 30 kW p.e.p from the transmitters. Twin wire feeders, generally of 600 ohm impedance, are used and terminating resistors form part of the aerials.

For receiving stations, single-wire rhombic aerials are generally used with transformer coupling to 75 Ω coaxial feeder cable.

For economy in materials and erection costs, double rhombic aerial systems can be supplied. They consist of an inner and an outer rhombic aerial supported by the same masts and capable of covering a frequency range of about 5:1.

TABLE II Rhombic Aerials

Elevation angle	Frequency range (Mc/s)	Gain (ref. isotropic source) (dB)	Height of masts (ft)	Length of major axis (ft)
33°–15°	3·5–8·0	13–19	120	1065
26°–10°	3·5–8·0	15–22	150	1218
32°–15°	5·0–12	14–20	80	790
25°–9°	5·0–12	15–20	120	642
23°–8°	5·0–12	16–23	140	1090
15°–8°	5·0–12	18–24	170	1910
35°–15°	8·0–16	12–17	70	372
25°–12°	8·0–16	15–20	80	582
27°–10°	12–28	15–22	50	384
15°–8°	12–28	20–23	80	592
15°–5°	12–28	19–26	80	954
18°–8°	12–28	17–24	80	635

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