VHF Superturnstile Antennas

The term 'Turnstile' is applied to a class of antennas comprising pole mounted 'crossed' radiating elements fed in phase quadrature.

The horizontally polarized Superturnstile employs the familiar "Batwing" radiators and is pictured in Fig 1.

Fig. 1 Horizontally polarized Superturnstile array

Features of the designs are:

- Suitable for top mounting on existing towers
- Simple and economical installation
- Wide bandwidth
- Radome protection available for severe weather conditions
- Inherent lightning protection
- Wide range of gains available
- Available for single or double main transmission line
- Multi channel options available

The Superturnstile

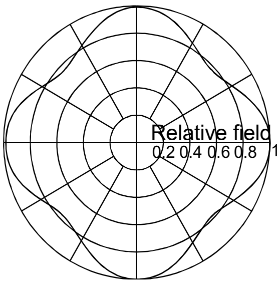


Fig. 2 Omnidirectional HRP

The Superturnstile is generally employed as an omnidirectional (Fig 2), or occasionally a figure eight, horizontally polarized transmitting antenna and provides excellent and reliable service in the Low, Mid and High Bands. Most frequently used as a medium power single channel antenna we also offer custom designs for two or even three channel operation. The antenna is equally suited to both analogue and digital transmissions.

Design

Each bay of the antenna consists of four galvanized radiating elements of the familiar Batwing shape. The radiators are mounted at 90 degrees with respect to one another around the tubular steel supporting pole. The top and bottom of each radiator are both solidly connected to the pole, thereby forming a very strong and robust mechanical assembly. The direct connections also give a very low impedance path to ground and afford excellent protection against lightning discharges.

Available Apertures

The required total antenna gain is achieved by stacking the appropriate number of bay assemblies one upon the other, spaced approximately one wavelength apart. Available apertures with their corresponding gains are shown in Fig 3.

Three standard sizes of Batwing radiator assemblies build up the complete range of Superturnstiles covering the Low, Mid and High Band VHF broadcast channels. Custom radiator designs are required in some instances for dual channel working.

Available Apertures Cont.

The maximum number of bays generally considered to be both mechanically and economically feasible for each band is:

Low Band TV 41 - 68 MHz 6 Bays

Mid Band TV 68 - 88 MHz 8 Bays

High Band TV 174 - 216 MHz 16 Bays

These maximum arrays occupy approximately 30m of vertical aperture for the Low and Mid Bands and approximately 25m for the High Band. Composite arrays for antennas operating in different bands may be mounted on the same pole. The maximum number of bays for each channel is restricted by the same mechanical and economic considerations, so that the total aperture does not exceed approximately 30m. In exceptional circumstances larger apertures may be made feasible by guying the antenna pole. This approach may sometimes provide a more economic solution for the overall tower/antenna package even for smaller apertures.

Distribution Harness

To provide an omnidirectional azimuth pattern the four batwings in each bay are fed with equal amplitude currents in phase quadrature, 0°, 90°, 180°, and 270° via 75ohm cables. The four or eight way power dividers feeding individual bays or pairs of bays are connected together by air spaced semi flexible cables to main input power dividers. Appropriate cable sizes and input networks are provided for the power rating required and depending on whether the antenna is to be used with a single or dual main transmission line. Input power ratings for standard antennas are given in Fig 3.

To ensure that the inside of the coaxial distribution harness remains dry and clean it is designed to be pressurized up to the output of the bay power dividers. Pressurization is normally carried out via the main transmission line.

Fig 3. Power Ratings, E.R.P.'s and Apertures of standard omnidirectional Superturnstile antennas

Typical Power Ratings, E.R.P's and Apertures

	Number of bays	Aperture (nominal) ft	(m)	*Mean Effective Gain	**Input Power Rating	Mean ERP for Max Rated Input Power	Input Flange for Max Power Rating
Low Band (Ch. 2 and 3)	2	37	(11.3)	3.3 dB	20 kW	43 kW	1 5/8 EIA
Mean frequency	4	74	(22.6)	6.0 dB	40 kW	159 kW	3 1/8 EIA
53 MHz.	6	111	(33.8)	7.5 dB	60 kW	341 kW	3 1/8 EIA
Mid Band	2	26	(7.9)	3.4 dB	18 kW	39 kW	1 5/8 EIA
(Ch. 4 thru 6)	4	52	(15.8)	6.1 dB	36 kW	145 kW	3 1/8 EIA
Mean frequency	6	78	(23.8)	7.6 dB	54 kW	311 kW	3 1/8 EIA
77 MHz.	8	104	(31.7)	8.7 dB	72 kW	534 kW	6 1/8 EIA
High Band	2	10	(3.0)	3.4 dB	9 kW	20 kW	1 5/8 EIA
(Ch. 7 thru 13)	4	20	(6.1)	6.1 dB	18 kW	73 kW	3 1/8 EIA
Mean frequency	6	30	(9.1)	7.7 dB	27 kW	158 kW	3 1/8 EIA
194 MHz.	8	40	(12.2)	8.7 dB	36 kW	269 kW	3 1/8 EIA
	10	50	(15.2)	9.7 dB	45 kW	422 kW	3 1/8 EIA
	12	60	(18.3)	10.5 dB	54 kW	600 kW	6 1/8 EIA
	16	80	(24.4)	11.4 dB	72 kW	985 kW	6 1/8 EIA

*Including allowance for null fill. **Ambient Temperature: 95°F

The power rating refers to analog transmission peak sync power and assumes a visual to aural ratio of 5 to 1.
Clearly for single channel working the mean ERP capability considerably exceeds FCC licensed values in many cases.
Andrew will be pleased to advise on the rating for digital and for multi-channel systems.

Weather Protection

The impedance of each individual radiator is around 75 ohms and is readily matched with standard coaxial feed lines. Because the impedance is low, ordinary icing has a negligible effect on performance. Radome protection may be supplied for conditions of severe icing. We recommend this form of de-icing in preference to electrical heating, which can be both unreliable and costly to operate. An additional advantage offered by radomes is the ability to pigment the fiberglass sections to customer requirements. Bays may be coloured differently in order to comply with aviation warning regulations, thereby eliminating the need for continual repainting.

Wind Loading

The pole itself, like the batwing elements, is galvanized steel. The diameter of each section depends on the number of bays and the design wind speed required. Standard antennas are designed for a wind speed of 110 mph without ice. With 1 inch of radial ice the design wind speed is reduced to 80 mph. Figs 5 & 6 give mechanical data, including aerodynamic areas for the various antennas.

Fig. 4 Physical dimensions for standard Superturnstiles

Physical Dimensions

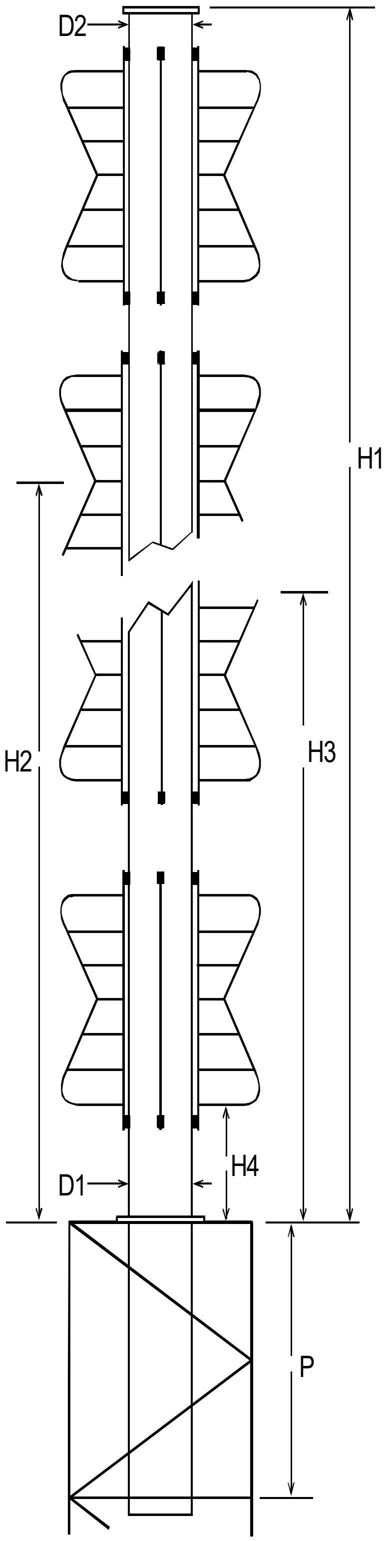
	No. of Bays	H1 ft	H1 (m)	H2 ft	H2 (m)	H3 ft	H3 (m)	H4 ft	H4 (m)	p ft	p (m)	D1 ins	D1 (m)	D2 ins	D2
Low Band	2	36	(11.0)	19	(5.8)	18.0	(5.5)	4.5	(1.4)	6.6	(2)	10.75	(0.27)	10.75	(0.27)
Channel 2	4	70	(21.4)	36	(11.0)	34.0	(10.4)	4.5	(1.4)	9.8	(3)	16.0	(0.41)	10.75	(0.27)
	6	104	(31.8)	53	(16.2)	40.0	(14.8)	4.5	(1.4)	13.1	(4)	24.0	(0.61)	10.75	(0.27)
Channel 3	2	33	(10.2)	18	(5.4)	17.0	(5.1)	4.3	(1.3)	6.6	(2)	10.75	(0.27)	10.75	(0.27)
	4	65	(19.8)	33	(10.2)	31.0	(9.6)	4.3	(1.3)	9.8	(3)	12.75	(0.34)	10.75	(0.27)
	6	96	(29.4)	49	(15.0)	45.0	(13.6)	4.3	(1.3)	13.1	(4)	24.0	(0.61)	10.75	(0.27)
Mid Band	2	31	(9.4)	16	(5.0)	15.0	(4.7)	4.0	(1.2)	6.6	(2)	10.75	(0.27)	10.75	(0.27)
Channel 4	4	60	(18.2)	31	(9.4)	30.0	(9.1)	4.0	(1.2)	9.8	(3)	12.75	(0.34)	10.75	(0.27)
	6	88	(27.0)	45	(13.8)	43.0	(13.0)	4.0	(1.2)	13.1	(4)	16.0	(0.41)	10.75	(0.27)
Channel 5	2	27	(8.2)	14	(4.4)	13.0	(4.1)	4.0	(1.2)	6.6	(2)	8.63	(0.22)	8.63	(0.22)
	4	52	(15.8)	27	(8.2)	26.0	(7.9)	4.0	(1.2)	9.8	(3)	10.75	(0.27)	8.63	(0.22)
	6	77	(23.4)	39	(12.0)	37.0	(11.3)	4.0	(1.2)	13.1	(4)	16.0	(0.41)	8.63	(0.22)
	8	101	(31.0)	52	(15.8)	49.0	(15.1)	4.0	(1.2)	13.1	(4)	16.0	(0.41)	8.63	(0.22)
Channel 6	2	25	(7.6)	13	(4.1)	12.0	(3.8)	3.6	(1.1)	6.6	(2)	8.63	(0.22)	8.63	(0.22)
	4	48	(14.6)	25	(7.6)	23.0	(7.0)	3.6	(1.1)	9.8	(3)	10.75	(0.27)	8.63	(0.22)
	6	71	(21.6)	36	(11.1)	34.0	(10.4)	3.6	(1.1)	13.1	(4)	16.0	(0.41)	8.63	(0.22)
	8	93	(28.6)	48	(14.6)	45.0	(13.9)	3.6	(1.1)	13.1	(4)	16.0	(0.41)	8.63	(0.22)
High Band	2	11	(3.4)	6	(1.8)	6.0	(1.8)	2.75	(0.8)	3.3	(1)	5.5	(0.14)	5.5	(0.14)
Mean frequency	4	21	(6.4)	11	(3.4)	11.0	(3.4)	2.75	(0.8)	6.6	(2)	5.5	(0.14)	5.5	(0.14)
194 MHz.	6	31	(9.4)	16	(4.9)	15.5	(4.7)	2.75	(0.8)	6.6	(2)	8.63	(8.63)	5.5	(0.14)
	8	41	(12.5)	21	(6.4)	20.5	(6.7)	2.75	(0.8)	6.6	(2)	8.63	(8.63)	5.5	(0.14)
	10	51	(16.5)	26	(7.9)	25.0	(7.6)	2.75	(0.8)	6.6	(2)	10.75	(10.75)	5.5	(0.14)
	12	61	(18.6)	31	(9.4)	30.0	(9.1)	2.75	(0.8)	9.8	(3)	10.75	(10.75)	5.5	(0.14)
	16	81	(24.7)	41	(12.5)	40.0	(12.2)	2.75	(0.8)	13.1	(4)	14.0	(14.0)	5.5	(0.14)

These figures are for standard antennas, special circumstances may require the use of non-standard support pole material.

See diagram on following page for key

Fig. 4b Key diagram for dimensions given in Fig. 4 for standard Superturnstiles

Key Diagram



*H1	Height of pole above tower top	
H2	Height of centre of radiation above tower top	
H3	Height of wind pressure center above tower top	
H4	Clearance of lowest radiator above tower top	
P	Pole penetration into tower top	
D1	Diameter of largest pole section	
D2	Diameter of smallest pole section	

*Excluding lightning conductor 3.5ft.

Fig 5. Weights and aerodynamic areas of standard Superturnstile antennas

Weights and Aerodynamic area

	No. of bays	WEIGHT Without radome Kg	WEIGHT With radome Kg	TOTAL AERODYNAMIC AREA Without ice with or without radome ft^2	TOTAL AERODYNAMIC AREA 1inch radial Ice ft^2
Low Band Channel 2	2	1207	1253	65	96
	4	3301	3399	138	197
	6	6455	6626	227	320
Channel 3	2	1080	1244	57	84
	4	3530	3623	123	175
	6	6387	6543	204	288
Mid Band Channel 4	2	1045	1083	52	76
	4	2595	2677	109	155
	6	5188	5319	174	242
Channel 5	2	782	810	40	58
	4	1846	1905	84	120
	6	3387	3488	135	188
	8	5522	5681	189	266
Channel 6	2	740	766	36	53
	4	1540	1596	80	114
	6	3043	3137	127	176
	8	5120	5224	177	249
FM Band	2	575	599	30	47
	4	1169	1221	64	96
	6	2181	2265	103	155
	8	3420	3540	145	218
	10	5350	5506	186	276
High Band Ch. 7 thru 13	2	148	153	14	23
	4	297	307	29	48
	6	620	646	46	77
	8	1045	1087	63	102
	10	1448	1510	83	135
	12	2156	2234	102	165
	16	3632	3753	153	244

Note:

The above figures are for standard antennas, special circumstances may require the use of non standard support pole material which could modify both weights and areas. The aerodynamic wind area is that to which appropriate force coefficients have already been applied. To calculate shear force and overturn moments it is necessary to apply the appropriate dynamic wind pressure (and the height of the pressure centre above the tower top (Fig 4).