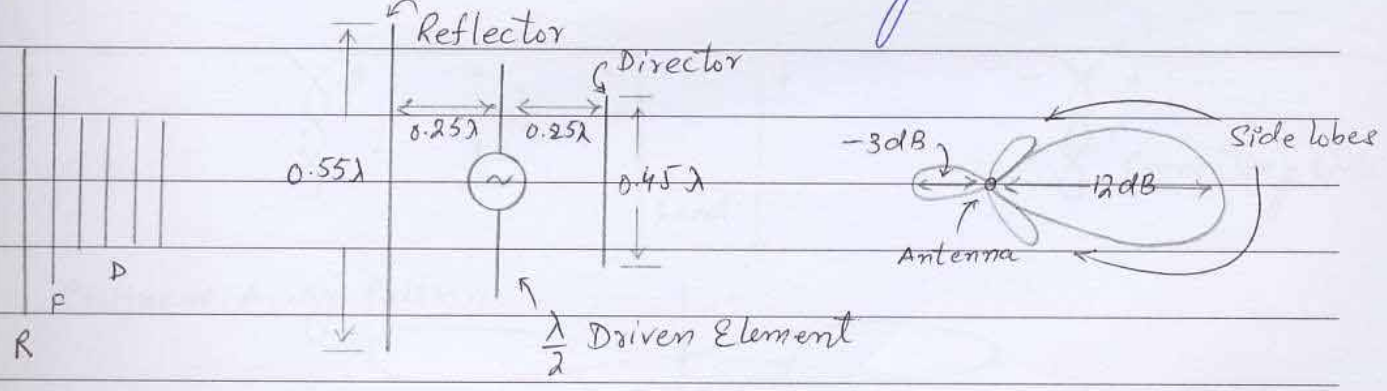
Date: 06 NOV 2008
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YAGI - UDA

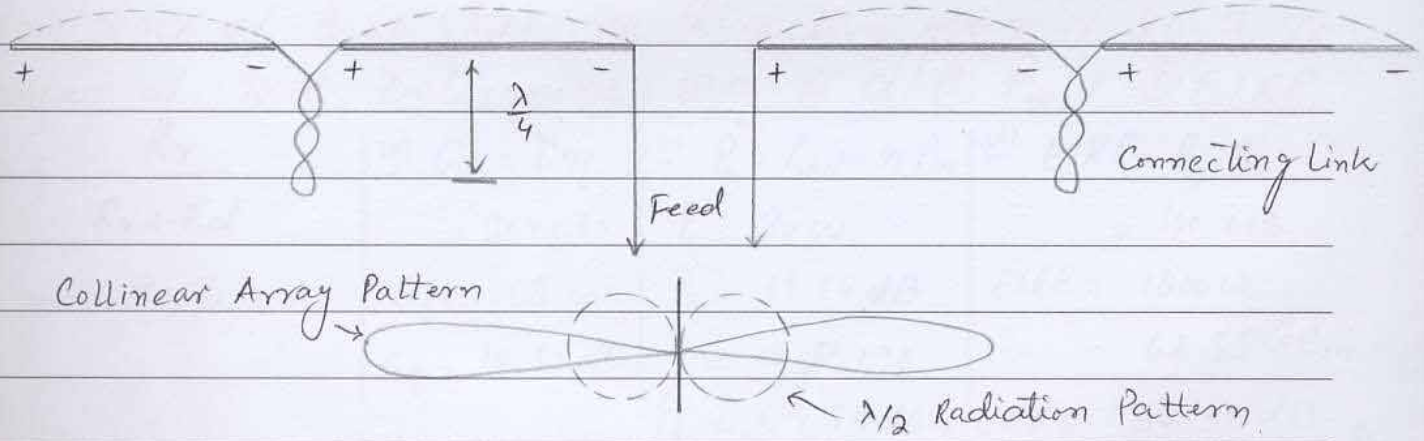
* Named after Japanese Scientists, Yagi & Uda.
* It consist of a driven element and two or more parasitic elements; one may be reflector and others may be directors.
* A director results in focusing desired Em energy in required direction generally results in 2 side lobes w/c are undesired.
* Driven element is $\frac{\lambda}{2}$ dipole or folded dipole. The reflector is sligthly longer than $\frac{\lambda}{2}$ may be 0.55λ and directors are slightly < $\frac{\lambda}{2}$ may 0.45λ and spaces b/w elements varies but is typically about $0.2 - 0.25\lambda$; this is result of Experimental research rather than theoratical calculations.
* The gain of ata varies from 10 dBi to 16 dBi depending upon no. of directors.
* The Yagi-Uda is often used as HF txing ata & as VHF/UHF TV-recieving ata.



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Driven Collinear Array

* It is a combination of $\frac{\lambda}{2}$ elements in w/c all elements are excited by connecting $\frac{\lambda}{2}$ length of Tx-line (a $\frac{\lambda}{4}$ twisted pair) at ends, placed in such a way so as to form a straight line by taking (locating) end to end (End fire).
* Each element is excited so that their field is in phase (additive) for points ⊥ to array while using of twisted pair Tx-line connection will cancel effect of each other generated field to minimize losses. It is an ideal ata for repeater.
* Reinforcement of energy radiation propogate away from ata's ⊥ direction with smaller beam-width creats a flattened doughnut shape.
* Increased directivity & gain are obtained by adding more collinear driven elements Its F/B ratio is 1.

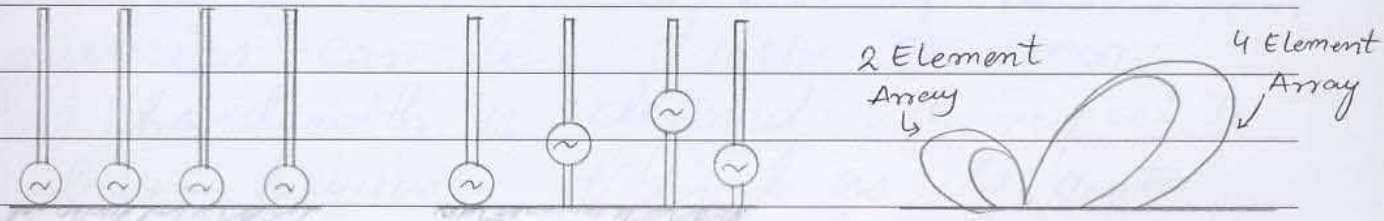


Date: 12 Nov 2008

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Marconi Phased Array

* There or more vertical antennas lined up in a row with equal spacing between them with properly controlling ϕ and power level into each of ~~its~~ tower, this arrangement is called a phased array or vertical.
* The control of ϕ & power of signal applied at each ata resulting in a wide variety of change in its pattern at sunrise & sunset b/c inc^t sky wave have effects of climate.
* The patterns generated by each ata are simply vector sum of instantaneous field strength.



Q For tx-ata with a R_r of 72Ω, an lumped effective resistance of 8Ω (R_d), a directive gain of 20 & i/p power of 100W, Determine: (a) η (b) G_t (c) P_{rad} (d) EIRP.

(a) $\eta = \frac{R_r}{R_r + R_d}$

$\eta = 90\%$

(b) $G_t = D\eta$

$= 20 \times 0.90$

$G_t = 18$ (or)

$G_t = 12.55$ dB

(c) $P_t = P_{rad} = \eta P_{in}$

$P_t = 90$ W

$P_t = 19.54$ dB

$= 19.54 + 30$

$P_t = 49.54$ dBm

(d) $EIRP = P_t G_t$

$= 160 \times 18$

$EIRP = 1800$ W

$= 62.55$ dBm

$EIRP = 32.55$ dB

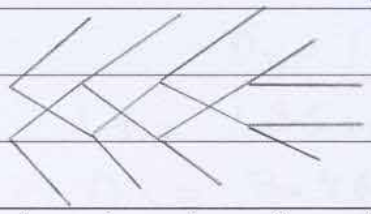
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Log Periodic Array

(Wide-band, Broad-band)

* Also known as log Periodic dipole Array (LPDA).
* It is a special case of driven broadside array; derives its name from fact that feed point Z is a periodic fns. of operating frequency first developed in 1957.
* Its good gain over wide range of frequencies made it useful for multiband transreciever operation and as a TV recieving unit to cover entire VHF & UHF bands. Its gain is about 8 dB.
* The elements are dipole with longest one at least $\frac{\lambda}{2}$ of length at lowest operating frequency & shortest one less than $\frac{\lambda}{2}$.
* The ratio between highest & lowest frequencies can be 10:1 or more. Its bandwidth is defined with respect to its design frequency termed as its center frequency.
* Only about three of elements are carrying much current while other elements are inactive. As frequency inc^{n} active elements more towards front of array.

VEE Type LPDA



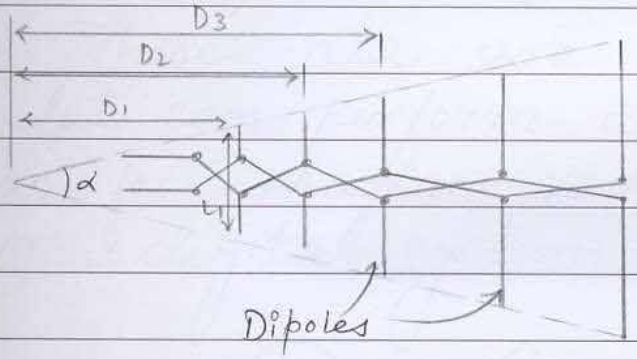
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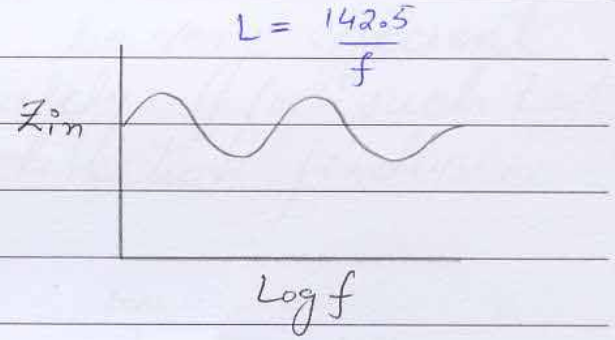
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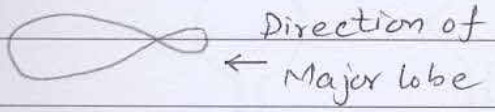
* The no. of dipoles of different lengths and spacing are related by a parameter known as Design ratio (τ) with a typical value b/w 0.7 to 0.9.

$$\tau = \frac{D_1}{D_2} = \frac{D_2}{D_3} = \cdots \qquad \tau = \frac{L_1}{L_2} = \frac{L_2}{L_3} = \frac{L_3}{L_4} \cdots$$

← Beam Direction







* The angle is usually designated α & is typically about 30° & can be calculated by

$$\tan\frac{\alpha}{2} = \frac{L_1}{2D_1} \qquad L_n \geq L_{max} \qquad L_n = \frac{L_{n-1}}{\tau}$$

$$L_{min} = \frac{142.5}{f_{max}}, \quad L_{max} = \frac{142.5}{f_{min}}$$

Q Design a log-periodic for range of 100 - 300 MHz Use $\tau = 0.7$ & $\alpha = 30°$.

Sol

$$L_1 = \frac{142.5}{f_{max}} = \frac{142.5}{90} = 0.445m, \quad L_2 = 0.636m, \quad L_3 = 0.909m$$

$D_1 = 0.830m$ $D_2 = 1.19m$ $D_3 = 1.69m$

$L_4 = 1.30m$ $L_5 = 1.85m$

$D_4 = 2.42m$ $D_5 = 3.46m$

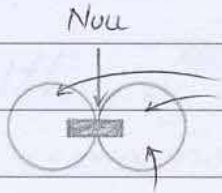
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Air Wound Loop Antenna

(or Ferrite Loop Antenna)

* A loop anta is a turn of wire whose dimensions are normally such smaller than 0.1λ & is effective even an extreme wide range of frequencies is selected - w/c its diameter is about $\lambda/16$ or less.
* These ata are not be very efficient but can perform adequately for such test as for Marine radio direction finders or in digital systems.





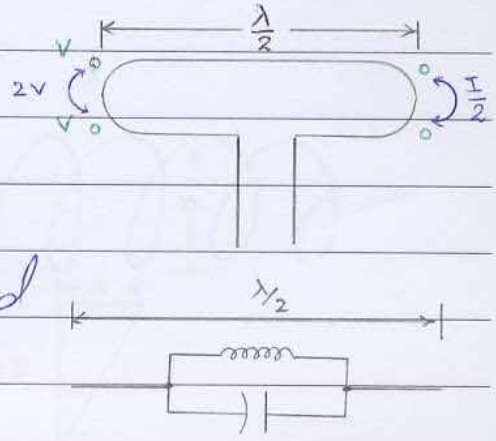
Calculation for loop ata:

* $R_r = 3.38 \times 10^{-8} (F^2 A)^2$
* $R_L = 9.96 \times 10^{-4} \left(\frac{S\sqrt{F}}{D}\right)$
* $\eta = \frac{R_r}{R_r + R_L}$
* Inductance: $L = 1.98 \times 10^8 S \left[7.353 \log\left\{\frac{96S}{D} - 6.386\right\}\right]$
* $X_L = 2\pi f L \times 10^{-6}$
* Bandwidth = $BW = F/Q$

A: Area (ft^2), S: Length of loop (ft), D: Dia of Conductor (inch)
F: Centre frequency, Q: Quality factor

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FOLDED DIPOLE



* A folded dipole is made with two parallel conductors joined at both ends separated by a distance that short compared with length of ata.
* It also have appox 4 times feedpoint impedance of an ordinary (ata) dipole, this accounts for exclusive use of 300Ω balanced line (known as twin-lead) in TV & FM recievers.
* It has a wider bandwidth i.e. range of freq within w/c its Z remains nearly resistive is larger than of single dipole ata.
* A standard halfwave dipole ata can provide same broad band characteristics as the folded dipole by incorporating a parallel tank circuit.
* Folded dipoles are also invariably used as driven element in Yagi-Uda ata.
* If F.dipole & a regular dipole radiate same amount of power, the total current in each is $\frac{I}{2}$ and voltage must be 2V then Resistance can be:

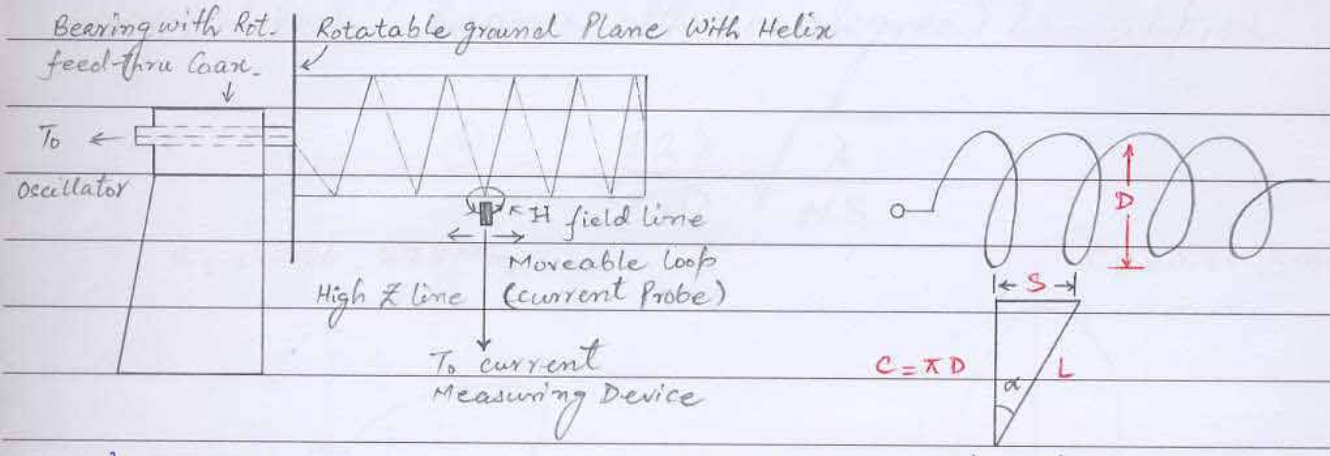
$$R_{FD} = \frac{2V}{I/2} \Rightarrow \frac{4V}{I}$$

$$R_{FD} = 4 R_{SD}.$$

* Folded dipole $\Rightarrow Z_{in} = 292\,\Omega \rightarrow R_x$
* Simple $\Rightarrow 73\,\Omega \rightarrow$ Hertz.

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Helical Antenna



* A quarter wave monopole (Marconi) ata can be shortened and wound into Helix (spiral) is called "Helical ata".
* The helical ata can be used to receive circularly polarized wave with same sense & can also used to receive plane-polarized waves in any direction.
* The gain is proportional to no of turns & can be several dB greater than a dipole.
* The circumference of each turn is about one-wavelength and turns are about one-quarter 'λ' apart. ($C = \lambda$, $S = 0.225\lambda$ at f_{cen})
* $$G = \frac{15NS}{\lambda^3}(\pi D)^2$$

where;

G := gain of Isotropic radiator. N := No. of turns in Helix.
S := Turn Spacing, Generally $\left(S = \frac{\lambda}{4}\right)$
D := diameter of Helix $\left(D = \frac{\lambda}{\pi}\right)$, λ := wavelength

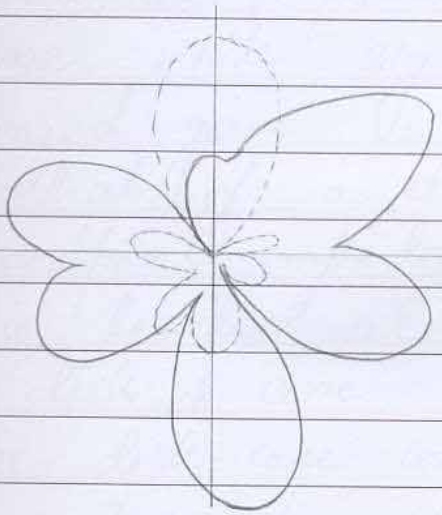
$N > 3$ Because : —— Reflector
—— Feed
—— Directive

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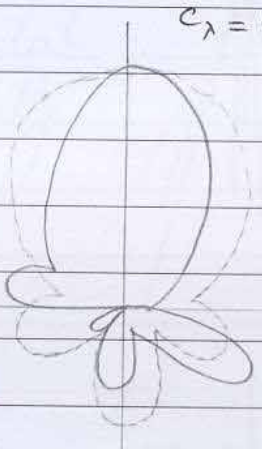
* The radiation pattern for this ata has one major lobe & several minor lobe. For 3dB (major lobe) beamwidth (in degree) is approx:

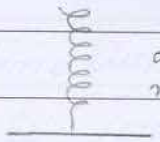
$$\Theta = \frac{52\lambda}{\pi D}\sqrt{\frac{\lambda}{NS}}$$

$C_\lambda = 0.66$, 275MHz



$C_\lambda = 0.85$, 350MHz





——— Horizontally Polarized field Component (E_ϕ)
- - - - Vertically Polarized. (E_θ)

Q: Calculate Gain & beamwidth for Helical ata of 8 turns operating at 1.2GHz, Also find L_T?

Sol: $\lambda = \frac{c}{f}$

$\lambda = 0.25m$

$D = \frac{\lambda}{\pi}$

$= 80mm$

$S = \lambda/4$

$= 62.5mm$

$L = NS$

$= 8(62.5\times10^{-3})$

$L = 500mm$

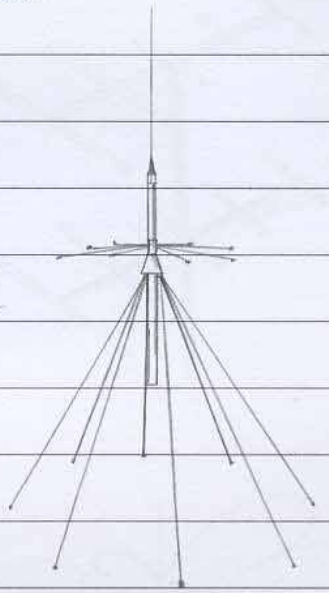
$G = \frac{15NS(\pi D^2)}{\lambda^3}$

$G = 30.319$ or $14.8\ dB_i$

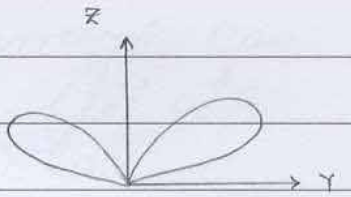
$\Theta = \frac{52\lambda}{\pi D}\sqrt{\frac{\lambda}{L}} = 36.6°$

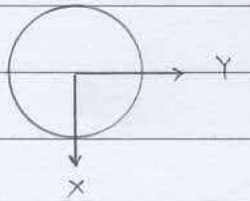
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Discone Antenna



* It is characterized by very wide bandwidth covering 10:1 frequency range & an omni-directional pattern in horizontal plane, while signal is vertically polarized gain is comparable to that of a dipole ata.
* Feedpoint impedance is 50Ω & is located at intersection of disk & cone.
* The disk-cone combination acts as a transformer to match feedline impedance of free space wc is 377Ω.





Typically length is measured along surface of cone is about one-quarter λ at lowest operating frequency.
* The wide bandwidth of discone makes it a very popular ata for reception of VHF & UHF signals. It is a favourite for use with scanners. These recievers can tune automatically to a large no. of channels & are often used for monitoring emergency services.