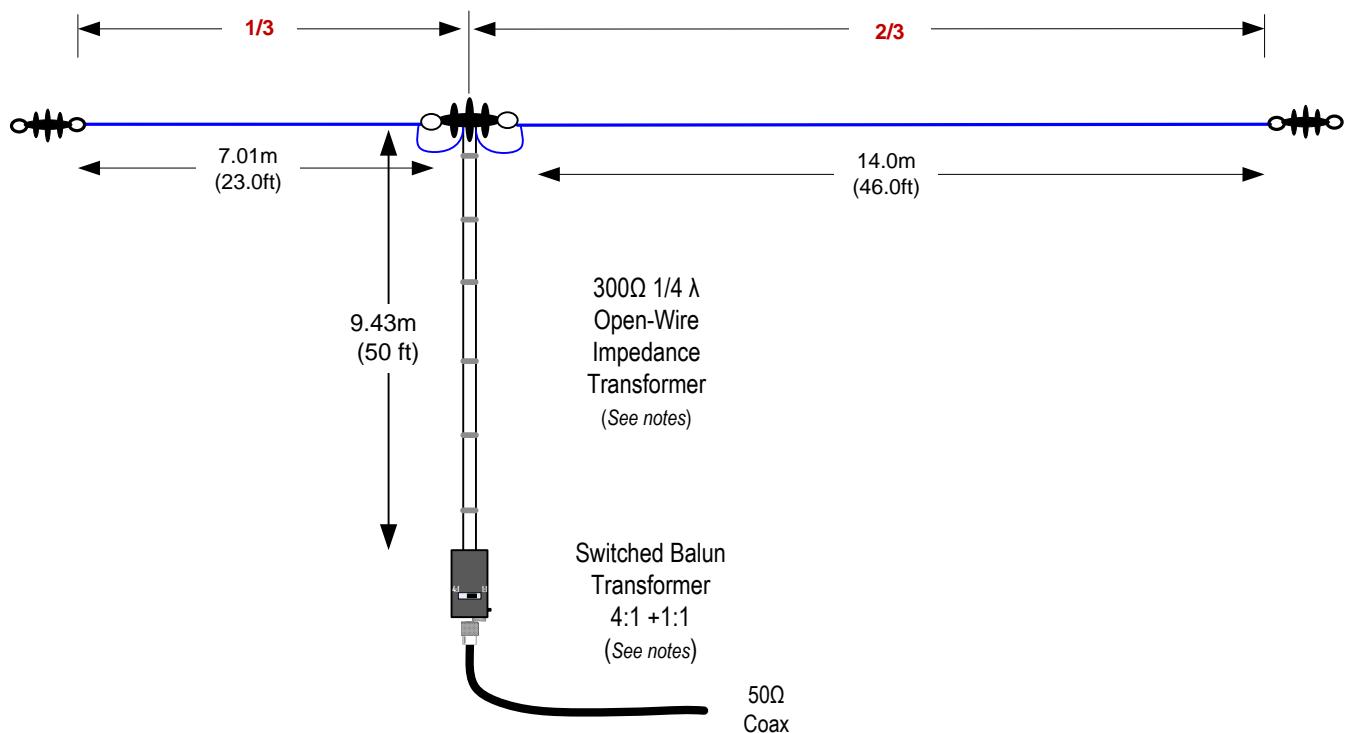


Study of G0FAH Off Centre Fed Dipole (OCFD) (40m-20m-15m 10m)



HISTORY

Bill Wright (G0FAH) described his 4-band OCFD in QST during February 1996. The idea for the antenna came from QSO's with European radio amateurs who said they were using the FD3 antenna. After investigating the FD3 3-band 40-20-10m OCFD, he came up with a way to add the 15m band and the G0FAH 4-band antenna was born. The result is an antenna, similar to the 1950's Windom, that was also fed with 300Ω twin lead feeder the difference being the addition of a tuned length of feeder and a dual ratio balun.

Bill claimed that the antenna is usable on most bands without a tuner (SWR <2:1) by adding a 1/4 λ wave transmission line impedance transformer cut for 15m and changing the balun ratio to 1:1. The inconvenience of the switched balun can be overcome if the feeder end and balun are brought into the shack. Using a tuner the antenna also works on 30, 17 & 12m.

Bill used a quarter wave impedance transformer made from bare wire ($VF=0.95$) therefore, the length of the matching section is 3.4m (11.14 ft). To reach the antenna feed point, the overall length of feeder should be an odd multiple of 3.4m, but Bill stated that, for best results on all 4 bands, the open feeder "ladder" line lengths are :-

16.76m (55 ft) or 33.83m (111 ft) 450Ω ladder line (recommended).
15.24m (50 ft) or 30.48m (100 ft) 300Ω ladder line can also be used.

The first set of figures Bill suggested are approx 5 x 11.143 but the second set are 10x and not an odd multiple. He also states that these lengths should get to back to the shack with room to spare, so perhaps he implies a bit of trimming is required.

See appendix for details of calculations

Since I have my own version of the FD3 antenna, I was intrigued by this modification and decided to model the antenna. This proved more difficult than I first thought and so I sought help from the Yahoo groups for MMANA-GAL & RSGBTECH. My special thanks go to Alastair NH7O, Steve G3TXQ and Dave G3YMC, who provided a copy of the original ARRL QST article "Four Bands, Off Center Feb 1996", to enable me to write this article.

Mario G8ODE

Study of G0FAH Off Centre Fed Dipole (OCFD)

(40m-20m-15m 10m)



The MMANA-GAL 40m-20m-10m RESULTS FOR THE G0FAH (File G0FAH-200R.mma)

The G0FAH 4-band antenna is modelled using MMANA-GAL basic freeware antennal analysis software. The model assumes that antenna is 10.75m above "real" ground with a conductivity of 5mS/m and a dielectric of 13. Since MMANA-GAL cannot cope with changing the feed point impedance mid-calculation, two separate models were created. The model was initially created with a feed point impedance of 200Ω and optimised on all 4 bands. The file was saved as G0FAH 200R.maa. The SWR results simulating the 4:1 balun connected to a 300Ω twin line are shown below



No.	F (MHz)	R (Ohm)	jX (Ohm)	SWR 200	Gh dBD	Ga dBi	F/B dB	Elev.	Ground	Add H.	Polar.
3	7.05	60.22	10.89	3.33	---	1.28	-1.11	29.3	Real	0.5	vert.
2	14.15	167.9	-72.1	1.53	---	7.28	-9.16	21.6	Real	0.5	hori.
1	28.2	163.5	-104.0	1.82	---	6.55	-7.88	39.7	Real	0.5	vert.

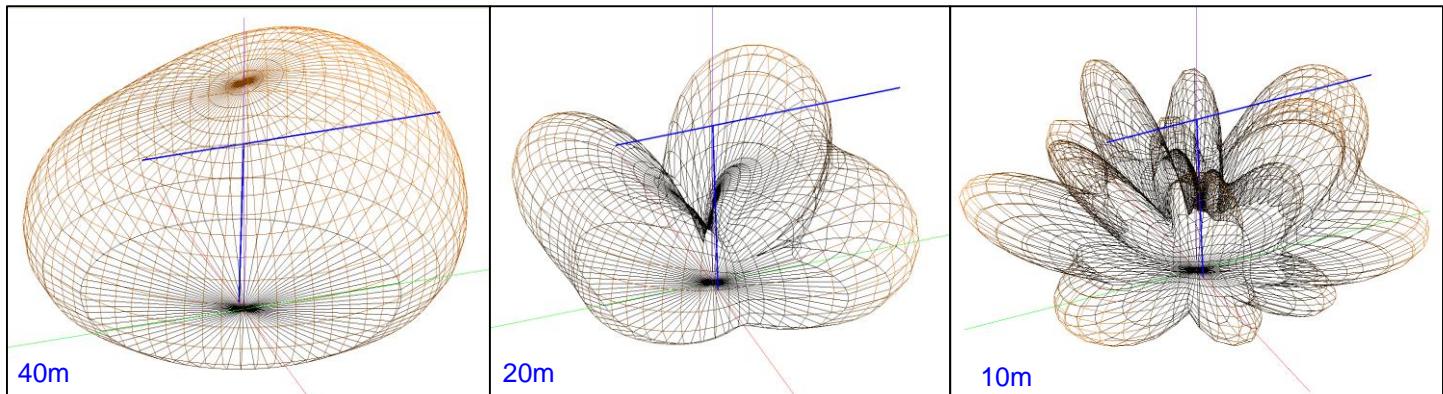
The results give a good idea of how the antenna may perform in locations where there are no trees, bushes or metal objects in the near field. The results differ slightly from Bill Wright's results for his 40ft high OCFD with 300Ω feeder. The model's lower height only affects the 40m band where the SWR is 3.33:1. The antenna current plots at the top of the page show that the vertical feeder radiates in each case. This is not necessarily a bad thing since this can improve the antennas DX operation.

Study of G0FAH Off Centre Fed Dipole (OCFD)

(40m-20m-15m 10m)

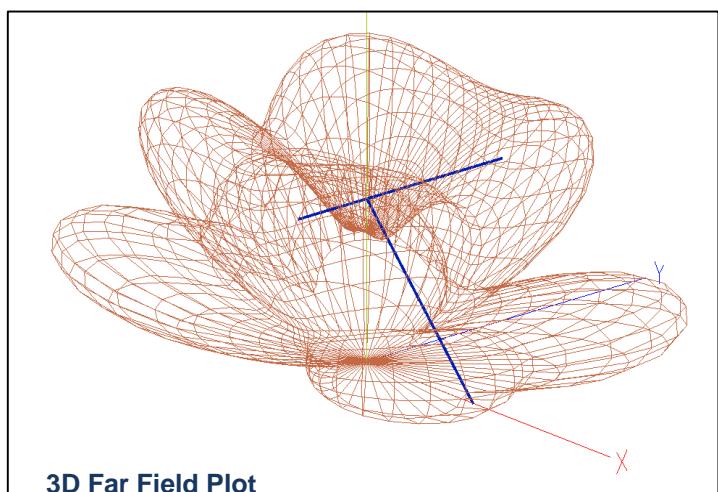
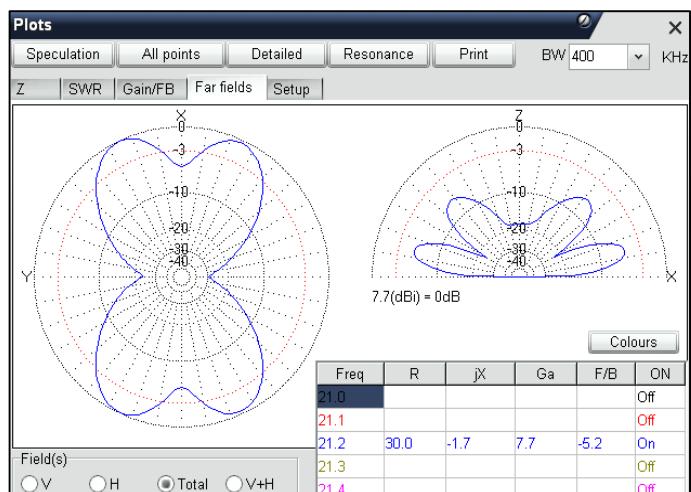


G0FAH 3-D FAR FIELD RESULTS WITH 4:1 BALUN (File G0FAH-200R.mma)

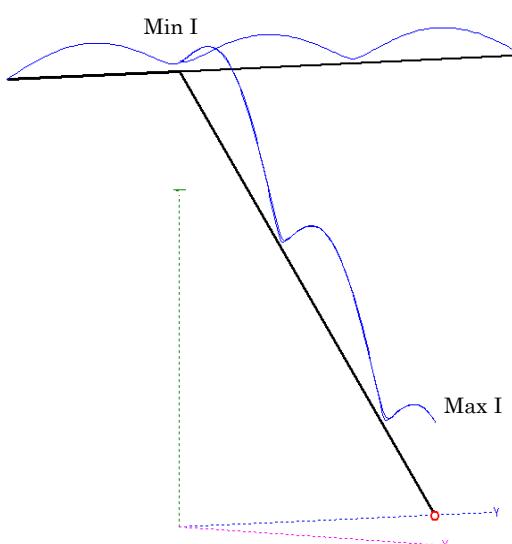


G0FAH RESULTS WITH 1:1 balun (File G0FAH-50R.mma)

No.	F (MHz)	R (Ohm)	jX (Ohm)	SWR 50	Gh dBd	Ga dBi	F/B dB	Elev.	Ground	Add H.	Polar.
1	21.2	29.97	-1.834	1.07	---	7.75	-5.25	14.0	Real	1.0	hori.



Antenna & Feeder Currents



MMANA-GAL basic model of the G0FAH @ 21MHz with the antenna at 10.75m (35.27ft) above "real" ground with conductivity of 5mS/m and a dielectric of 13. The quarter wave transformer used to match the high impedance at the feed point to the low impedance at the transceiver, is terminated in 50Ω to simulate the 1:1 balun and the SWR is therefore referenced to 50 Ohms.

The diagram on the left shows, that at resonance, 3 half-waves are present in the antenna wire and the feed point has a current minimum denoting a high feed point impedance. The bottom of the open twin feeder has a current maximum denoting the low impedance.

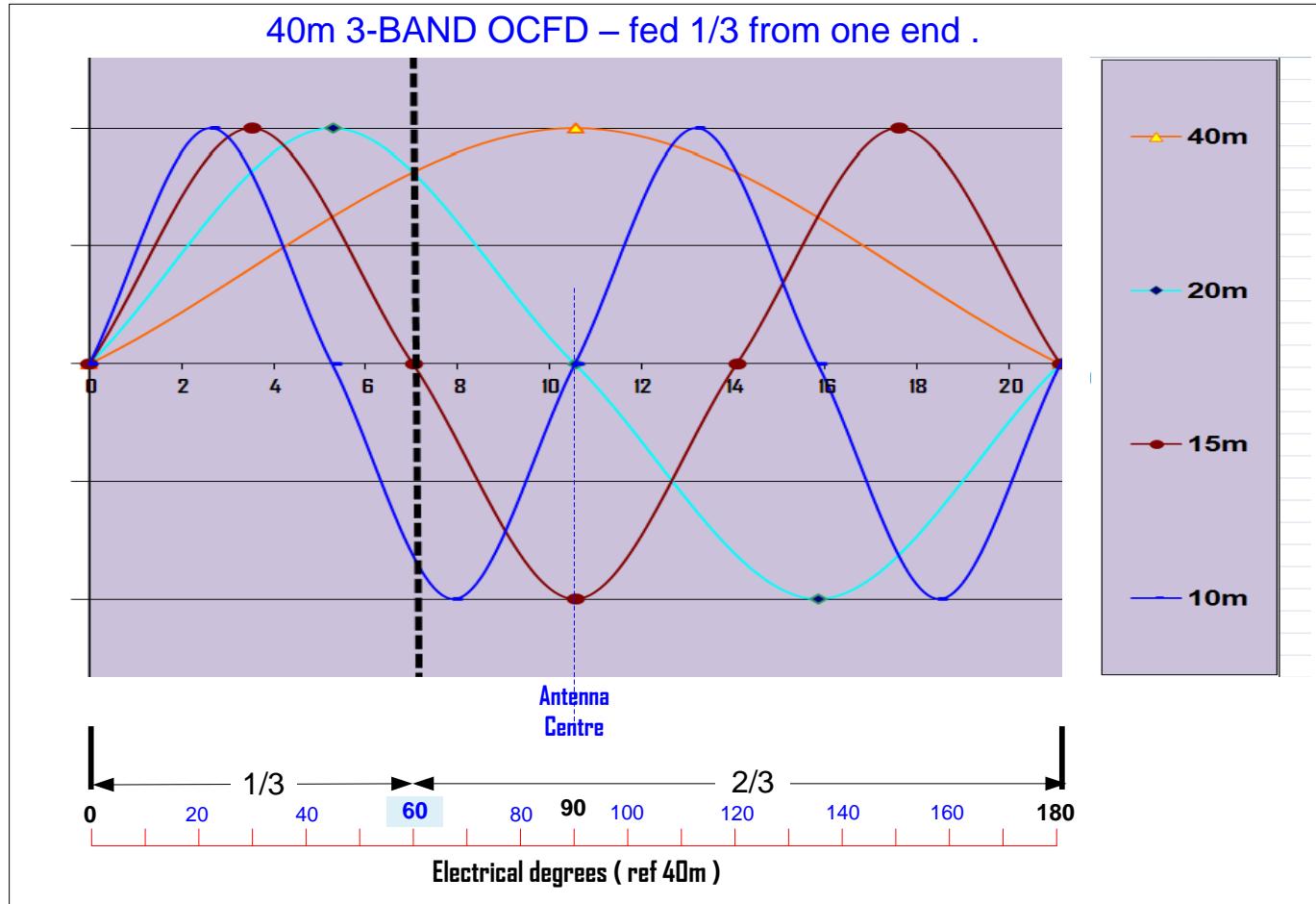
The MMANA-GAL program optimised the open wire twin feeder to a length of 17.57 m (57.6ft) and this is shown sloping to maintain the same height as the previous (40-20-10) model with the 4:1 balun.

The difference between the MMANA-GAL model results and the feeder length suggested by G0FAH is possibly due to the program's inability to accurately account for the local environment and ground effects

Study of G0FAH Off Centre Fed Dipole (OCFD) (40m-20m-15m 10m)



THEORY OF OPERATION



G0FAH's OCFD half-wave antenna cut for 40m enables it to operate on its even harmonics on the 40m, 20m, 10m bands. The graph above shows that these three sine waves all have non-zero values on the dotted line at the 1/3 off centre point (electrically 60 ° on the fundamental frequency) where the impedance is given by $(50\Omega / \cos^2 \theta) = 50 / \cos^2 (60^\circ) = 50 / (0.5)^2 = 200\Omega$. However, the 15m wave has a zero value at this point indicating that the impedance is very high.

Therefore, the antenna can be matched using a 4:1 ratio current balun on the 40m, 20m and 10m bands, but, on 15m, G0FAH solves the problem of a very high impedance by using a 1/4 λ transmission line to match the high impedance to the low impedance at the transmitter end and using a balun with a 1:1 ratio.

The MMANA-GAL model shows that adding the transmission line to the OCFD and having the balun at the bottom alters the operating characteristics of the antenna, consequently the 40, 20 and 10m bands have vertical radiation from the transmission line. This is due to the fact that the asymmetric currents are not cancelled out in the feeder. This is similar to the operation of the Carolina Windom TM, however, the MMANA_GAL model shows that on 15m, the antenna performs like a normal dipole with no feeder radiation when the 1:1 Balun is switched in.

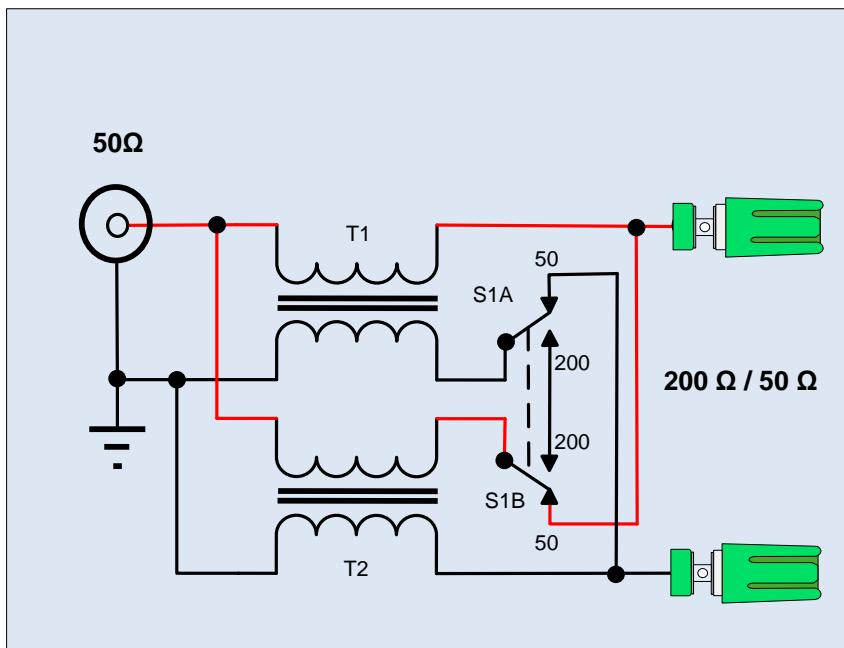
Ideally, the switched ratio balun should be connected to the end of the transmission line in an accessible and waterproof location.

Study of G0FAH Off Centre Fed Dipole (OCFD) (40m-20m-15m 10m)



Suitable Baluns for the G0FAH OCFD Antenna.

G8ODE Version of 4:1 & 1:1 SWITCHED BALUN



Notes

Parts list

1. *4 x 500mm multi-stranded insulated wire (black, orange, yellow and blue) hook up wire (7/0.2)*
 2. *2 x 4mm screw terminals and solder tags*
 3. *Switch - 2 pole changeover*
 4. *Small Plastic box approx 75mm x 50mm x 25mm*
 5. *2 x small nuts, bolts and washer to secure switch.*

Construction

Twist the pairs of wires are tight as you can and feed them through one side of the binocular core so that there are three turns visible on the outside and wires poking out from each end.

Repeat this for the other side. To maintain a balance between the two windings, the two pairs of wires must be kept the same length.

Alternative commercial and homebrew designs

1. The ELCRAFT™ BL2 Wideband binocular 1:1 & 4:1 250W Balun
http://www.elecraft.com/mini_module_kits/mini_modules.htm. Shown on KC7FYS Flicker web site.
 2. KC8AON's homebrew version uses a toroid rather than a binocular core .

Study of G0FAH Off Centre Fed Dipole (OCFD) (40m-20m-15m 10m)



Quarter wave Transformer Calculations

Formula ..1 $C = F \times \lambda$

Where C = velocity of light 3×10^8 m/s, F = frequency in MHz, λ = wavelength in m

Formula ..2 $1/4\lambda = 75/\text{MHz m}$

this does not include corrections for velocity factor and end effects

Formula ..3 Conversion of imperial to metric measurements, $1\text{m} = 3.28\text{ ft}$

Example $1/4\lambda_{(21\text{MHz})} = 75/21 = 3.57\text{m or } 11.72\text{ ft}$

Note 1. RG-58, RG-59, RG-174, RG-213 and RG-214 have Velocity Factor (VF) = 0.66.

450 Ohm vinyl covered window line VF = 0.91

300 Ohm vinyl covered window line VF = 0.90

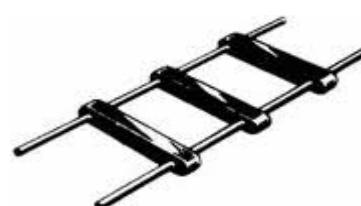
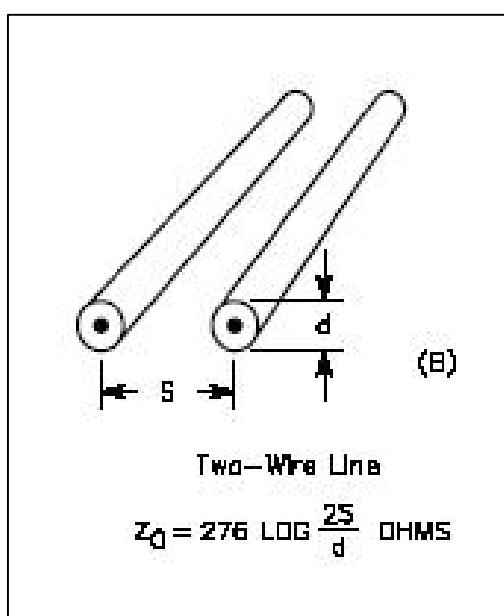
300 Ohm TV-type solid vinyl covered window line VF = 0.82

$1/4\lambda_{(21\text{MHz}-300\text{ twin line})} = 3.57 \times 0.9\text{ m} = \text{ or } 11.72 \times 0.9 = 10.553.213\text{m ft}$



Dimensions for Open-Wire Feeder

Note 2 . The velocity factor of an open uninsulated wire is 0,95.



Open Two Wire Line		
	300Ω	450Ω
<i>s</i>	6	32
<i>d</i>	1	1.5
<i>Z₀</i>	297.85	449.9
	300Ω	450Ω
<i>s</i>	12	43
<i>d</i>	2	2
<i>Z₀</i>	297.85	450.84
Dimensions in mm		

Useful link:- http://www.arcticpeak.com/antennapages/quarter-wave_transformer.htm