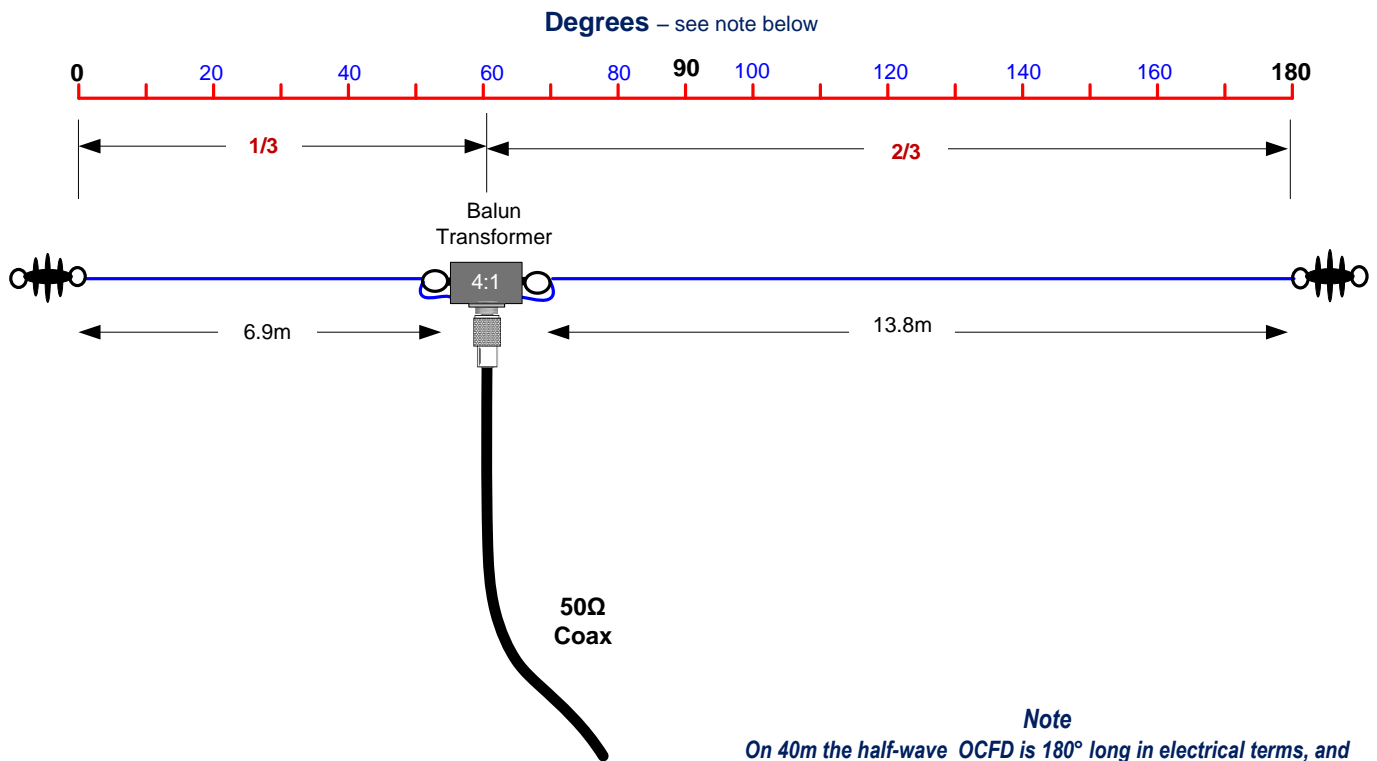


# FD3 (40m-20m-10m) OCF antenna - G8ODE

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## FD3 OFF CENTRE DIPOLE



**Note**  
On 40m the half-wave OCFD is 180° long in electrical terms, and 360° long - full wave on 20m and 720° long on 10m - 2 full waves long. ( see page 2 )

### Brief History of the OCFD Antenna's' Development

During the mid 1920's Associate Professor Bill Everett and his student John Byrne conducted research on dipoles being fed by single wire transmission lines. Everett's university friend L Windom (W9GZ), who often helped in the experiments, published the experimental results in the September 1929 issue of QST and clearly stated he was reporting on the work of others. The following month Everett's research was finally published in the Proceedings of the IRE with Associate Professor Everett and Byrne listed as authors.

In 1930 the Wireless Institute of Australia published an article based on Windom's QST article and the name "Windom" became associated with the antenna. Then in 1937 J Macintosh VS1AA (GM3IAA) suggested that Windom's single wire feed be re-positioned 1/3 off-centre to enable multi-band operation. At that time the amateur bands were all harmonically related. Shortly after World War II, the Radio Society of Great Britain published an article, "Why Not a Windom?" and the name stuck.

Interest in Europe was aroused when in 1971, Dr. Fritz Spillner, DJ2KY modified the VS1AA antenna design by replacing the single feed wire with balun and a coax feeder. This became known as the Fritzel FD4 (80, 40, 20, 10m) but is more correctly described as the Off Center Fed Dipole (OCFD). The half-size version of the FD4 is known as the FD3 (40, 20, 10m) and is the subject of this article.

One of the reasons for the OCFD antenna's popularity in Europe, stems from the fact that they can be operated on their fundamental frequency  $f_0$  and **all the even harmonics** i.e.  $2f_0$ ,  $4f_0$ ,  $8f_0$  whereas the half-wave centre fed dipole can only operate on its resonant frequency  $f_0$  and the odd harmonics i.e.  $3f_0$ ,  $5f_0$ ,  $7f_0$ . Although the new WARC bands are not harmonically related to the traditional bands, the FD4 & FD3 can operate on the 30m, 17m and 12m with additional antenna matching.

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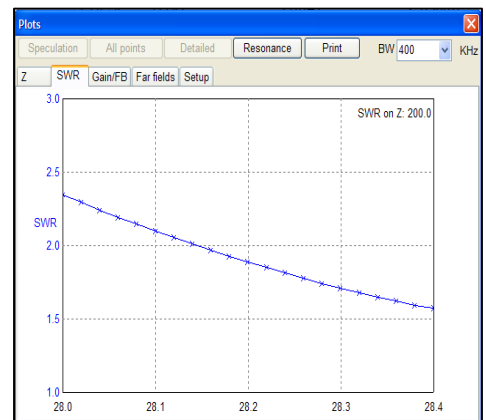
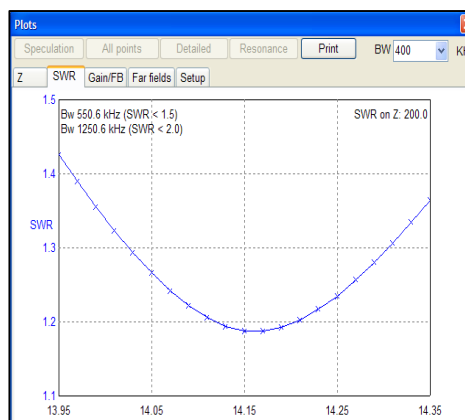
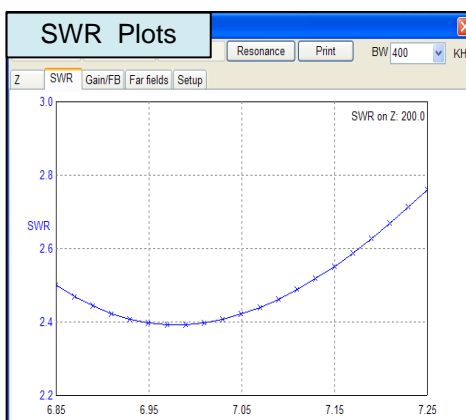
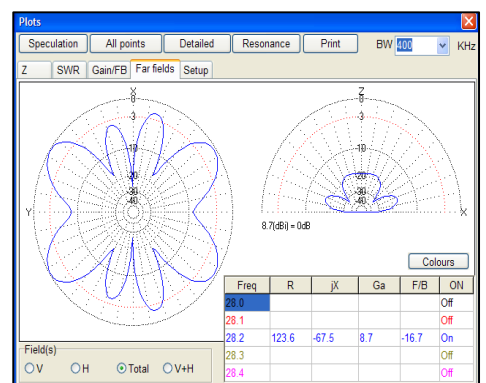
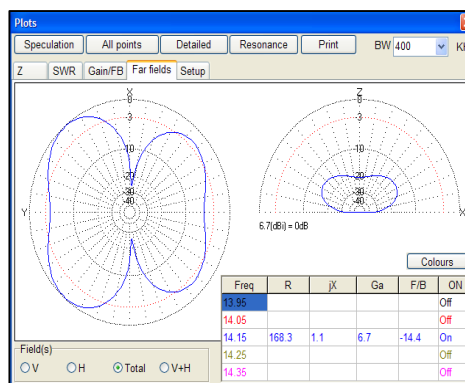
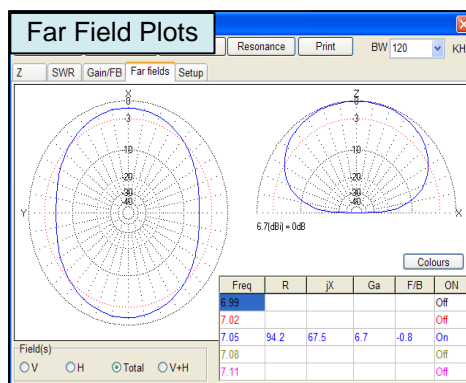
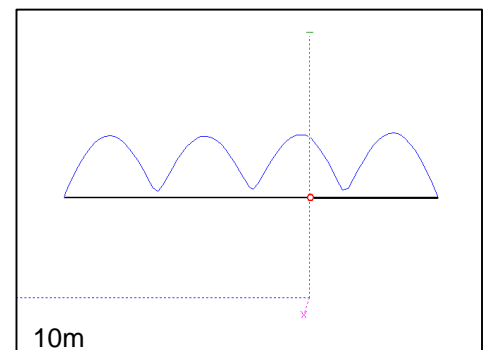
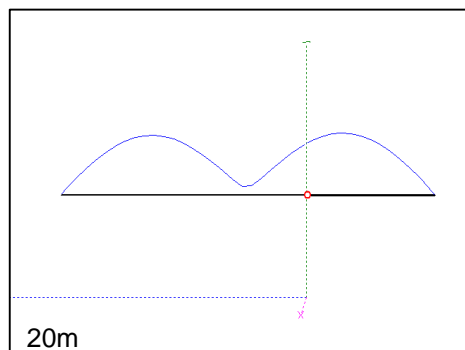
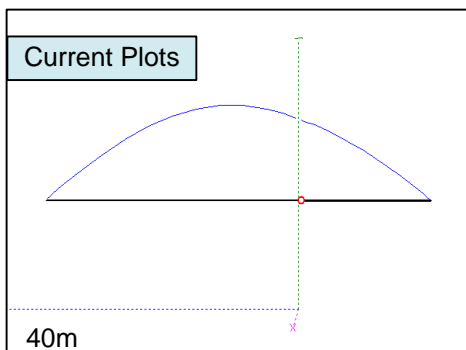


## The MMANA-GAL OCFD 40m-20m-10m MODEL

The FD3 OCFD antenna is modelled using MMANA-GAL basic freeware antenna analysis software. This assumes that antenna is 8.5 m above "real" ground with a conductivity of 5mS/m and a dielectric of 13. The software can't model a balun or 50/75 ohm coax, therefore the model simulates a 200Ω source at the feed point. Additionally the SWR on all the 3 bands was simultaneously optimised, giving 14.15 MHz priority over the 7.05MHz and 28.2 MHz frequencies.

**N.B. the low height (<10M) was chosen as this seems to be the norm for small garden antennas.**

No.	F (MHz)	R (Ohm)	jX (Ohm)	SWR 200	Gh dBd	Ga dBi	F/B dB	Elev.	Ground	Add H.	Polar.
3	7.05	94.2	67.51	2.42	---	6.7	-0.78	90.0	Real	3.0	hori.
2	14.15	168.3	1.051	1.19	---	6.69	-14.42	34.9	Real	3.0	hori.
1	28.2	123.6	-67.47	1.89	---	8.66	-16.72	17.5	Real	3.0	hori.



The SWR plots show that the FD3 antenna has a low SWR on 20 & 10m band, and that for these bands there is an upward shift of the resonant frequency due to end effects. The 40m SWR results indicate that some antenna matching is required due to ground reflections because the antenna is lower than a quarter wavelength on this band. The far field plots also show that this low height affects the overall shape and the number of lobes that are created and hence, the take off angle.

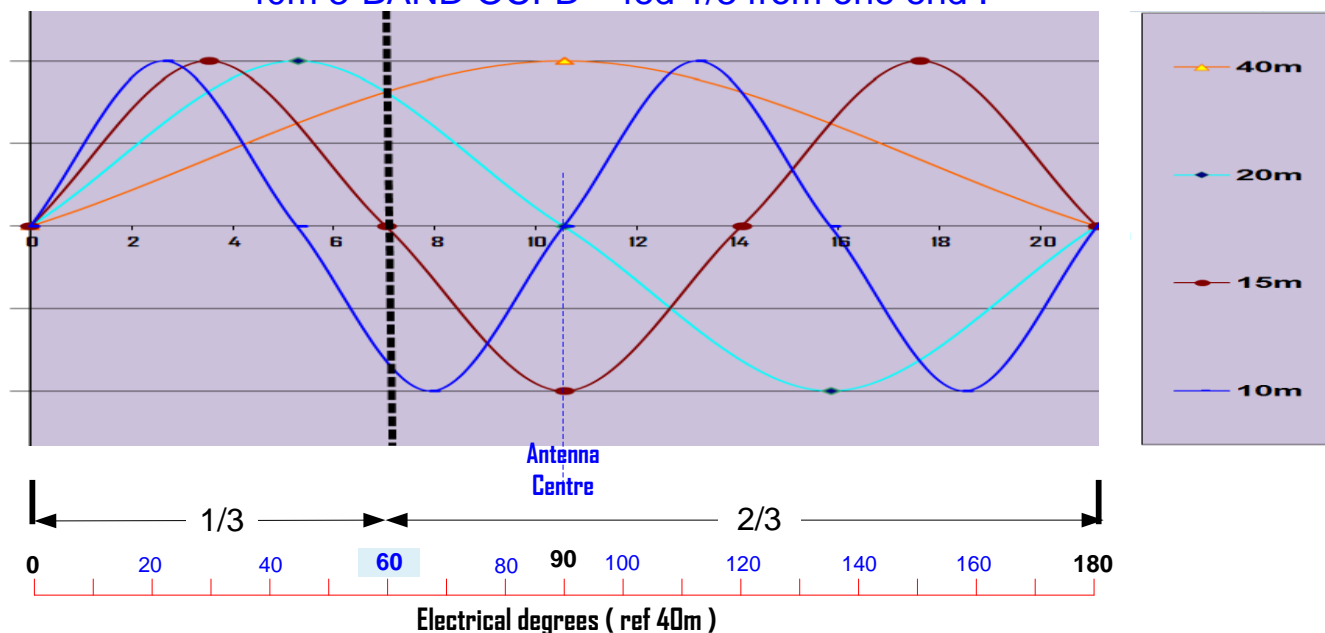
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## THEORY OF OPERATION

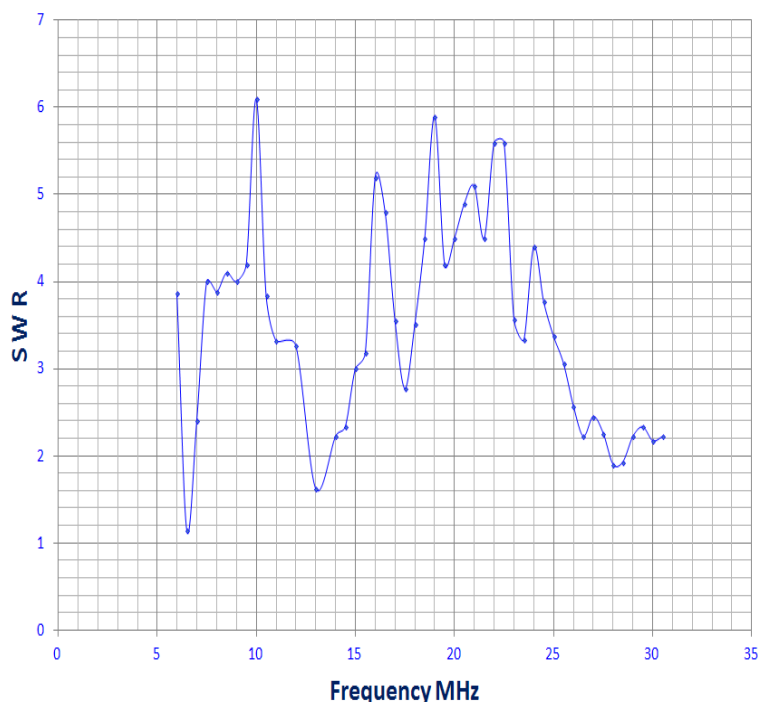
### 40m 3-BAND OCFD – fed 1/3 from one end .



The FD3 OCFD operates on its fundamental frequency  $f_0$  and all the even harmonics i.e.  $2f_0$ ,  $4f_0$ ,  $8f_0$  on its even harmonics on the 40m , 20m, 10m bands. The graph above shows that three sine waves all have non-zero values on the dotted line at the 1/3 off centre point ( electrically  $60^\circ$  on the fundamental frequency  $f_0$ ) where the impedance is given by  $(50\Omega / \cos^2 \theta) = 50 / \cos^2 (60^\circ) = 50 / (0.5)^2$  or  $200\Omega$  . However, the odd harmonic 15m wave has a zero value at this point indicating that the impedance is very high.

(See RSARS e-library G0FAH article to explain how to modify the antenna so it can be used on 15m)

### 40m OCF Dipole



The SWR plot on the left is for my homemade FD3 using a Moonraker™ 4:1 400 watt current balun. Three clamp-on ferrites were added at the top of the 12m long Mini-8 coax feeder I use to connect my remote antenna relay box. The SWR measurements were taken at the end of the Mini-8 coax using an Autek™ VA1 antenna analyser.

The antenna is supported by a tall tree on the shorter section and by a 16ft(5m) mast attached to the wall of my garage. The last 4-5m of the longer section is over the sloping garage roof.

I found that my antenna was slightly off-tune with  $f_0$  about 6.8Mhz, but by using my MFJ989B antenna tuner I can operate the FD3 on all the bands 40-10m very easily. The 40 & 20m bands that I used regularly require very little roller coaster inductance.

Mario G8ODE

# Study of the Off Centre Fed Dipole Antenna - G8ODE

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## THE EFFECT OF HEIGHT ABOVE THE GROUND ON THE ANTENNA'S IMPEDANCE.

In the initial study, the antenna was modelled at a height of only 8.7m, however, further investigations were carried out to see how the performance would be affected by changes in height above ground. The antenna calculations were optimised at a specific frequency, at 6 different heights and over both perfect and real ground, the latter with a conductivity of 5mS/m and a dielectric of 13.

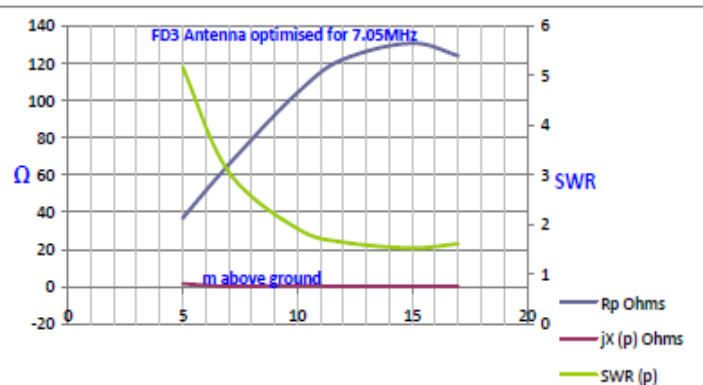
The graphs show that the impedance for perfect and real ground are very close and that the impedance of the FD3 is not 300 ohms as is often suggested in the articles for the OCFD. What in fact changes in these two situations is the antenna gain and the elevation of the radiation, but this was not the point of interest of this study so these details have been omitted.

The graphs clearly show that the height above ground does affect the impedance of the antenna, the lowest value is on the 40m band at a height of 5m ( $\ll 0.25\lambda$ ) and only rises to 130 $\Omega$  at 15m. Generalising for all three situations, once the antenna height is at least a  $0.25\lambda$  above the ground the radiation  $R > 100\Omega$ . On 20m this averages 125 $\Omega$  and 140 $\Omega$  for the 10m band. At 10m above the ground the SWR ranges from 1.92:1 (40m), 2.2:1(20m) and 3.3:1(10) most antenna matching units can cope with these values.

*N.B. SWR reference 200 $\Omega$  in all three situations*

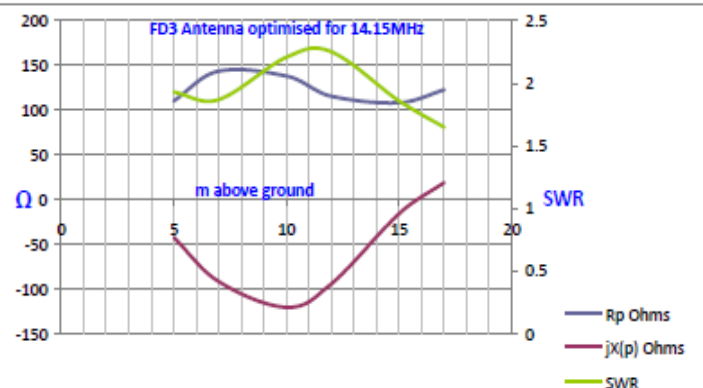
### RESULTS FD3 Optimised for 7.05 MHz

Height above ground (m)	Over Perfect Ground			Over Real Ground 5mS/m dielectric 13		
	R $\Omega$	jX $\Omega$	SWR	R $\Omega$	jX $\Omega$	SWR
5	36.68	1.543	5.17	38.56	0.001	5.19
7	65.45	-0.0343	3.06	65.45	-0.034	3.06
10	104.1	0.54	1.92	104	-0.0026	1.92
12	122.1	-0.037	1.64	122.1	-0.0372	1.64
15	130.7	-0.034	1.53	130.7	-0.0343	1.53
17	124	0.013	1.61	124	0.0131	1.61



### RESULTS FD3 Optimised for 14.15 MHz

Height above ground (m)	Over Perfect Ground			Over Real Ground 5mS/m dielectric 13		
	R $\Omega$	jX $\Omega$	SWR	R $\Omega$	jX $\Omega$	SWR
5	110.2	-41.9	1.93	110	-44.74	1.94
7	143.4	-91.4	1.87	143.4	-91.4	1.87
10	138.1	-120.1	2.21	138.1	-121.1	2.22
12	115.5	-94.05	2.25	115.5	-94.05	2.25
15	108.2	-15.57	1.86	108.2	-15.57	1.86
17	122.8	19.06	1.65	122.8	19.08	1.65



### RESULTS FD3 Optimised for 28.5 MHz

Height above ground (m)	Over Perfect Ground			Over Real Ground 5mS/m dielectric 13		
	R $\Omega$	jX $\Omega$	SWR	R $\Omega$	jX $\Omega$	SWR
5	146.9	-183.6	2.9	146.9	-183.6	2.9
7	117.5	-210.7	3.92	117.5	-210.7	3.92
10	129.5	-192	3.31	129.4	-193.6	3.34
12	123.6	-132.5	2.55	131.1	-135.7	2.48
15	152.7	-46.82	1.46	152.7	-46.83	1.46
17	152.3	6.048	1.32	152.3	6.038	1.32

