



THE
SILSDEN
CROSSED
FIELD
ANTENNA .

Extracts from the report on the performance of an elevated 8 Metre CFA constructed and tested at Silsden in West Yorkshire.

Extracts from Silsden CFA Report

Schedule of Contents.

1. Introduction.
2. CDL/KAT and Arqiva Ltd. Test results.
3. Interpretation of results.
4. Comparison of Results and Conclusions.

APPENDICES.

- 3a. Ground Wave Attenuation Curves.
- 4.CDL/KAT Table of Field Strength Measurements.
- 5.CDL Graphs of Field Strength versus Distance (10 mS/s)
- 5a.CDL Graphs of Field Strength versus distance (7 mS/s)
- 6.CDL /KAT Graph of VSWR versus Frequency (CFA)
- 7.CDL /KAT Smith Chart 7& Impedance Graphs. (CFA)

8. ArQiva Table of Field Strength Measurements
- 9.Arqiva graphs of Field Strength versus Distance (10mS/s)
- 9a. Arqiva graphs of Field strength versus distance (7mS/s)
10. Arqiva Smith Chart. (CFA)
11. Arqiva Graph showing VSWR versus Frequency.(CFA)

Note:- All the graphs and charts were prepared by CDL, to be in the same format, using the results of measurements made by CDL/KAT and Arqiva Ltd.

CFA Report Extracts

A. INTRODUCTION

During the period August 2008 to September 2009 Communications Dynamics (I.o.M.) Limited and Kabbary Antenna Technology (Egypt) cooperated in the construction and testing of a number of crossed field antennas at Silsden in West Yorkshire. The purpose of these test was to establish :-

- 1.1 The Bandwidth and Relative Emission Efficiency of CFA's when positioned on the ground and when elevated to simulate mounting above a transmitter or other building.
- 1.2 To determine the size versus frequency ratios for efficient operation.
- 1.3 To investigate and record near and far field emission characteristics with a view to confirming Field strength versus Distance characteristics
- 1.4 To confirm omni-directional emission characteristics.

On conclusion of the CDL/KAT tests a company called ARQIVA Ltd. (recommended by OFCOM) was invited to conduct tests on an 8 metre elevated CFA in the expectation of independent confirmation of the CDL/KAT results.

B. "CDL/KAT " and " Arqiva Ltd." Test Results.

The recorded results of the tests conducted by the are reproduced in graphic and table form .

For CDL/Kat Results refer to Appendices 4,5,5a, 6 and 7.

For Arqiva Limited Results refer to Appendices 8,9,9a,10 and 11.

Also Refer to Appendix 3a.

C. Interpretation of results.

When comparing the performance of a real antenna with that of a theoretically perfect antenna it is important to take into account all the factors which may affect the real antenna and apply these to the theoretical model.

To enable this comparison and take into account the effects of ground conductivity and distance Appendix 3a was prepared to show Inverse Distance attenuation and attenuation due ground conductivities of 10mS/s and 7 mS/s . The relative emission efficiency is determined by comparing the actual field strength readings for the antenna under test with those which would be obtained for the theoretically perfect antenna suffering the same ground wave attenuation. Both the CDL/KAT and Arqiva results are plotted on this basis.

D. Comparison of Results and Conclusions.

Tests were conducted by CDL/KAT between 23rd and 26th September 2009 to confirm earlier results prior to the tests conducted by Arqiva on 28th September 2009. The results of tests at 1,593 kHz. are shown in the indicated appendices.

Whilst there are slight differences in the settings for the CFA on the two dates it is immediately evident that the Arqiva results are a clear confirmation of those obtained by CDL/KAT.

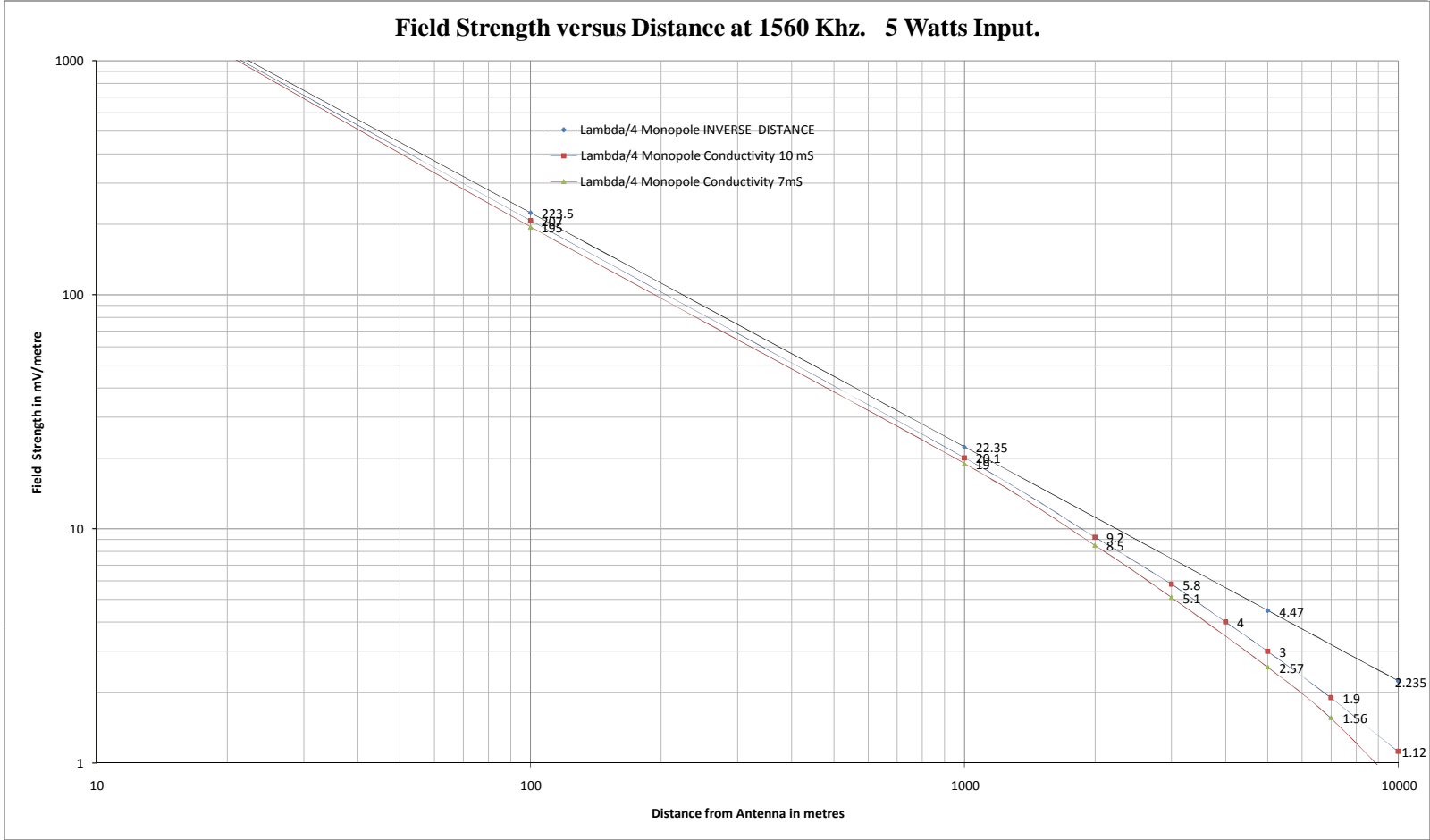
The conclusions reached from examination of these verified results are :-

1. The elevated 8 metre CFA has a Relative Emission Efficiency at 1,593 kHz. which is at least equal to that of of a full size $\text{Lambda} / 4$ Vertical monopole .(At 1,593kHz $\text{Lambda}/4$ is 47 metres)
2. The CFA performance complies easily with VSWR and Bandwidth requirements set by the OFCOM engineering code. (VSWR must be less than 1.5 for $f_{\text{carrier}} \pm \text{or- } 4.5\text{ kHz.}$)

Note . The results of CFA Size versus Frequency and the near field measurements are confidential to CDL/KAT but it is evident from the reported signal strengths that close to a $1/d$ characteristic was achieved.

For more information refer to the full 28 page report on the KAT Web site.

GRAPHS SHOWING VARIATION IN GROUND WAVE ATTENUATION DUE TO DISTANCE AND CONDUCTIVITY



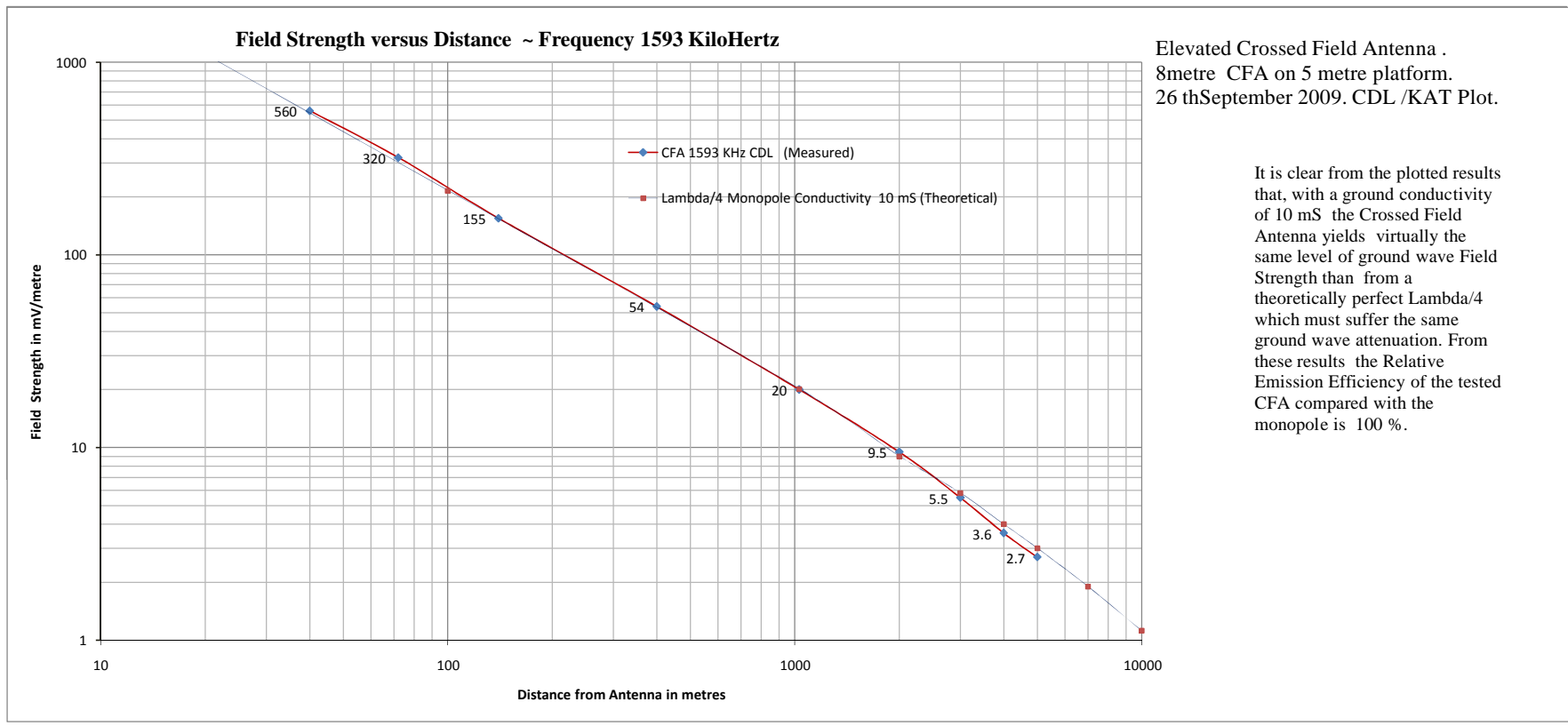
APPENDIX 3A
GRAPH 2

CDL/KAT~ FIELD STRENGTH MEASUREMENTS~ TABLE OF RESULTS													
26th September 2009. 8 metre Elevated Crossed Field Antenna. Frequency 1,593 KiloHertz.													
Input Power to Antenna 5Watts RMS (Unmodulated Carrier) Nominal Input Impdace 50 Ohms.													
Field Strength Measurements with Potomac FIM 41 Serial No. 622.													
Generally to South and West of CFA													
Point No.	Description of Location	Map Reference	Field Strength mV/m	Distance from CFA metres									
1	CFA Position	53/56'06.90"N-1/55'54'14"W	Not Applicable	0									
2	1st Probe Stake CFA Field	53/56'07.96"N-1/55'52.84"W	560	40									
3	CFA Field Gate	53/56'08.84"N-1/55'51.07"W	320	71									
4	Middle Adjacent Field	53/56'09.182"N-1/55'48.74"W	155	140									
5	Side Lawn Cringles House	53/55'57.49"N-1/55'39.21"W	54	400									
6	Entrance Schoolmaster Lane	53/55'38.19"N-1/55'35.20"W	20	1030									
7	Silsden RLWY Station Lay-by	53/53'59.37"N-1/56'41.0"W	3.8	4020									
8	Steeton Hill Top South	53/53'31.22"N-1/57'13.10"W	2.	5010									
Other measurements made on ealier occasion .													
Generally to North and West of CFA													
Point No.	Description of Location	Map Reference	Field Strength mV/m	Distance from CFA metres									
9	Nominal 1Km Test Point	53/57'51.80"N-1/56'47.67"W	20	1030									
10	Draughton Moor Lane	53/56'50.58"N-1/55'54.82"W	9.5	2020									
10	Junct A65 Draughton Lane	53.56'07.25"N-1/56'07.90"W	5.6	3025									
11	Farfield House	53/57'40.48"N-1/53.03.94"W	3.6	4300									
12	Junction A65, A59 RNDABT	53/58'11.31"N-1/58'51.44"W	2.6	5000									
													APPENDIX 4.
													Page 15

CDL/KAT ~ 8 METRE CROSSED FIELD ANTENNA ~ FIELD STRNGTH PLOT 10 mS/s

CROSSED FIELD ANTENNA TESTS 26 th SEPTEMBER 2009

Measurements of Ground Wave Field Strength at known distances from the CFA were made by CDL KAT prior to the tests to be made by ARQIVA on 28th September.2009. The results of these measurements confirmed the earlier findings of CDL. The measured values of Field Strength are plotted below together with a curve showing the results which would be obtained with a Lambda/4 Vertical monopole antenna for a ground conductivity of 10mS. These measurements were made with an input power of 5 Watts at 1,593KiloHertz.



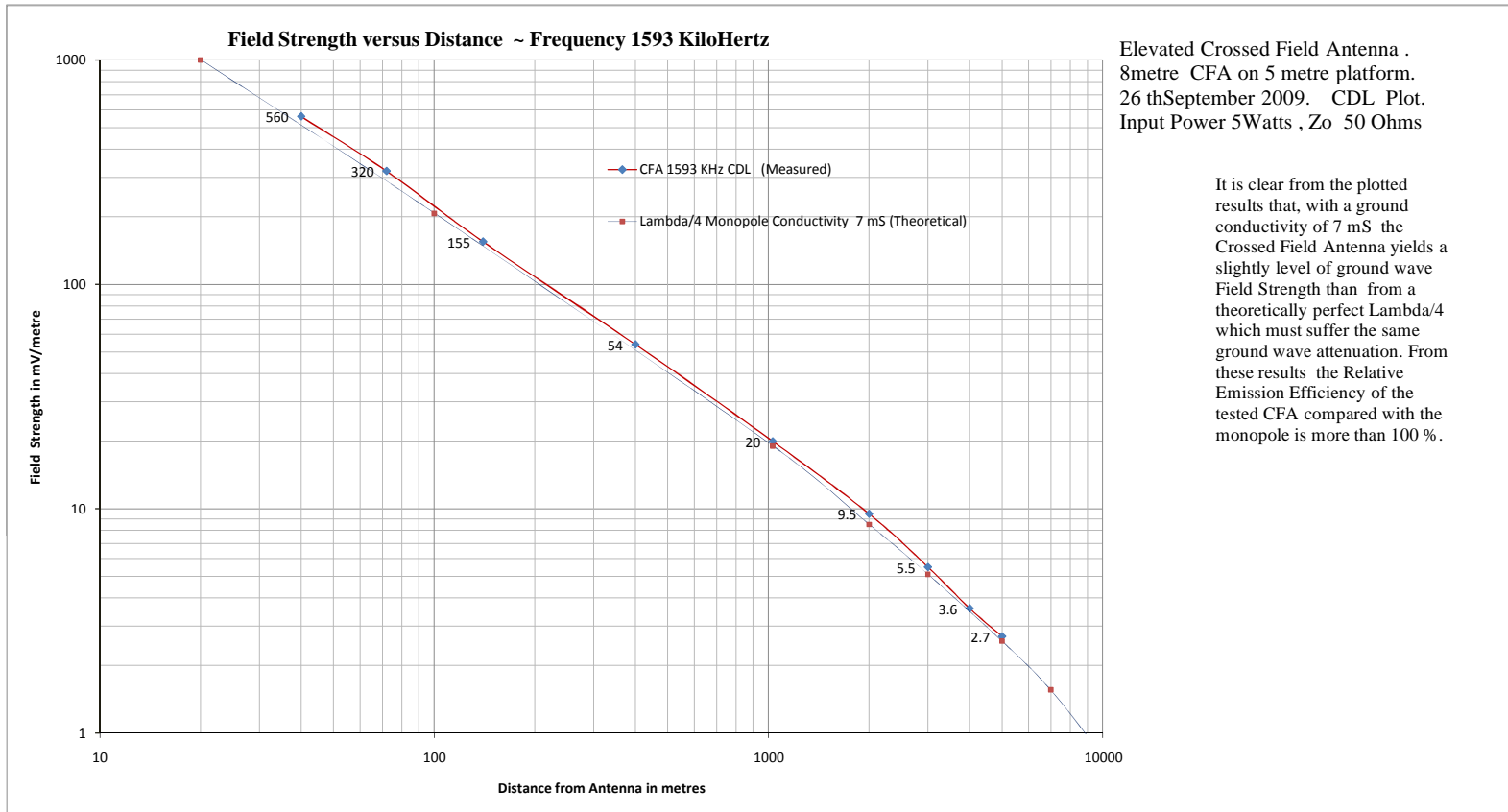
Elevated Crossed Field Antenna .
8metre CFA on 5 metre platform.
26 thSeptember 2009. CDL /KAT Plot.

It is clear from the plotted results that, with a ground conductivity of 10 mS the Crossed Field Antenna yields virtually the same level of ground wave Field Strength than from a theoretically perfect Lambda/4 which must suffer the same ground wave attenuation. From these results the Relative Emission Efficiency of the tested CFA compared with the monopole is 100 %.

COMMUNICATIONS DYNAMICS LIMITED ~ 8 METRE CROSSED FIELD ANTENNA Field Strength Plot

CROSSED FIELD ANTENNA TESTS 26 th SEPTEMBER 2009

Measurements of Ground Wave Field Strength at known distances from the CFA were made by CDL prior to the tests to be made by ARQIVA on 28th September, 2009. The results of these measurements confirmed the earlier findings of CDL. The measured values of Field Strength are plotted below together with a curve showing the results which would be obtained with a Lambda/4 Vertical monopole antenna for a ground conductivity of 7 mS/s. These measurements were made with an input power of 5 Watts at 1,593 KiloHertz.



Elevated Crossed Field Antenna .
8 metre CFA on 5 metre platform.
26 th September 2009. CDL Plot.
Input Power 5 Watts , Zo 50 Ohms

It is clear from the plotted results that, with a ground conductivity of 7 mS the Crossed Field Antenna yields a slightly level of ground wave Field Strength than from a theoretically perfect Lambda/4 which must suffer the same ground wave attenuation. From these results the Relative Emission Efficiency of the tested CFA compared with the monopole is more than 100 %.

Created 26.09.2009

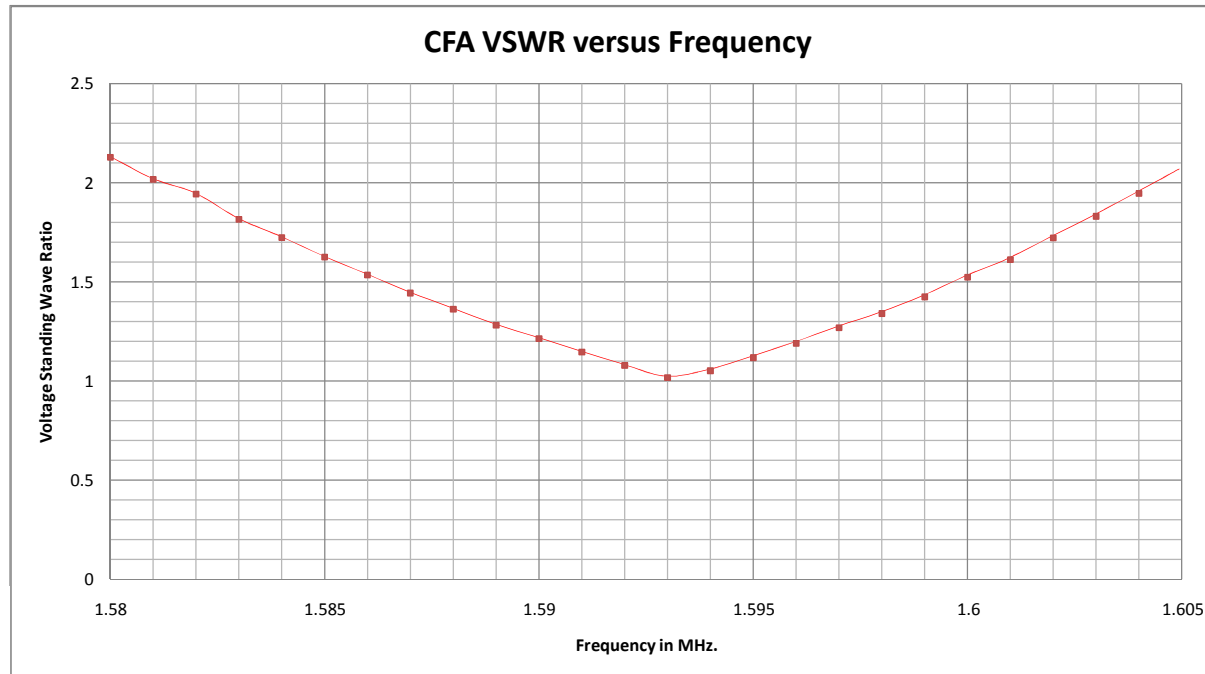
CFA Voltage Standing Wave Ratios ~ CDL/KAT

Measurements made with ARRAY SOLUTIONS Antenna Impedance Analyser

Type AIM 4170C Serial No.3077. Calibrated June 2009

VSWR DATA

Freq(MHz)	SWR
1.580002	2.128403
1.581002	2.016507
1.582002	1.942953
1.583002	1.815772
1.584002	1.723439
1.585002	1.624848
1.586002	1.534829
1.587002	1.443836
1.588002	1.362805
1.589002	1.282121
1.590002	1.214336
1.591002	1.146037
1.592002	1.078895
1.593002	1.017712
1.594002	1.051678
1.595003	1.117891
1.596003	1.189729
1.597003	1.268228
1.598003	1.340407
1.599003	1.424459
1.600003	1.523718
1.601003	1.61241
1.602003	1.721909
1.603003	1.830598
1.604003	1.946504
1.605003	2.064371



The VSWR of the CFA for the frequency range $f_{carrier} \pm 6.0$ KHZ. Is 1.5.
This confirms that the Bandwidth /VSWR comply with the Ofcom Engineering Code
i.e. An upper limit of VSWR at 1.5 for $f_{carrier} \pm 4.5$ KHZ.

APPENDIX 6

Page 18

8 METRE CROSSED FIELD ANTENNA ~ CDL/KAT~ SMITH CHART + Rs, Xs and Z GRAPHS.

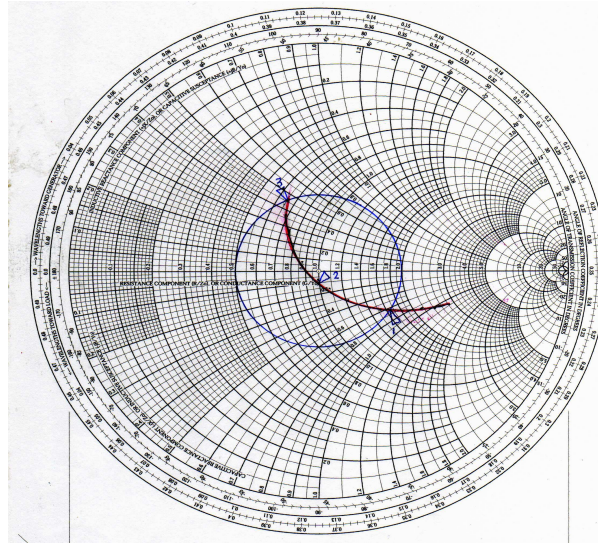
SMITH CHART and GRAPHS of Rs, Xs & Z mag.
 Measurements with Array Solutions Antenna Analyzer Type 170C Ser.No.3077
 Created: 09-26-2009 12:22:18

APPENDIX 7

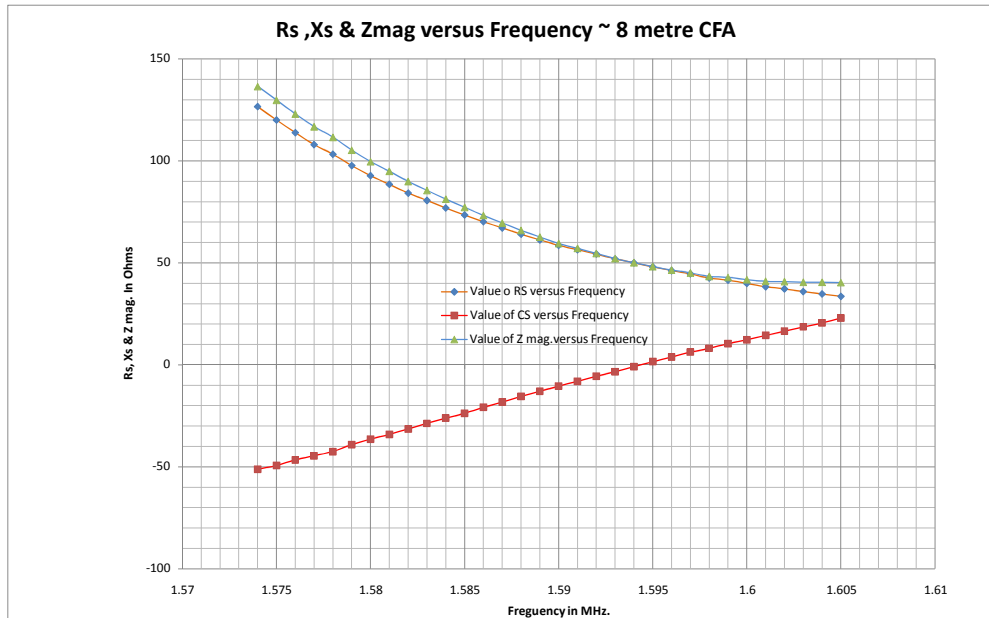
Page 19

ANALYZER DATA			
f MHz	Rs	Xs	Z mag
1.571001	140.6154	-55.9147	158.4621
1.572001	132.8388	-54.6786	150.8723
1.573002	126.5494	-52.8746	142.975
1.574002	120.0211	-51.2537	136.5346
1.575002	113.8438	-49.3848	129.7841
1.576002	107.9653	-46.607	123.0147
1.577002	103.2179	-44.5697	116.8031
1.578002	97.67417	-42.5325	111.6376
1.579002	92.74521	-39.1829	105.2404
1.580002	88.50876	-36.4262	99.64206
1.581002	84.221	-34.1254	94.85961
1.582002	80.64716	-31.4122	89.88828
1.583002	76.89939	-28.6979	85.52563
1.584002	73.50378	-26.1842	81.23501
1.585002	70.21735	-23.7409	77.24273
1.586002	67.12532	-20.8539	73.24863
1.587002	64.07126	-18.227	69.55595
1.588002	61.31448	-15.4622	65.91058
1.589002	58.60324	-12.9648	62.67019
1.590002	56.48497	-10.3867	59.51659
1.591002	54.34945	-8.04924	57.05561
1.592002	51.97458	-5.62604	54.63986
1.593002	50.06082	-3.3307	52.08119
1.594002	48.0842	-0.87626	50.06849
1.595003	46.26825	1.560412	48.10951
1.596003	44.65162	3.851708	46.4283
1.597003	42.61274	6.240599	45.08561
1.598003	41.58231	8.14241	43.38369
1.599003	39.95652	10.43457	42.87153
1.600003	38.33226	12.32127	41.81312
1.601003	37.33715	14.45228	40.96621
1.602003	35.96097	16.54939	40.84048
1.603003	34.78488	18.63067	40.50053
1.604003	33.66325	20.5904	40.42218
1.605003	31.84255	23.00333	40.34224
1.606003	30.02265	24.55151	39.8733

Smith Chart
 Data from ARRAY SOLUTIONS Antenna Impedance Analyser 26th September 2009



- Point No.1 1.581 k
- Point No.2 1.593 k
- Point No.3 1.604.5



ARQIVA~ FIELD STRENGTH MEASUREMENTS~ TABLE OF RESULTS						
28th September 2009. 8 metre Elevated Crossed Field Antenna. Frequency 1,593 KiloHertz.						
Input Power to Antenna 5Watts RMS (Unmodulated Carrier) Nominal Input Impdance 50 Ohms.						
Field Strength Measurements with Potomac FIM 41 Serial No. 570						
Power Measurement with Marconi Instrument 2965 _ Bit 150W Through Line 50 OHM Load						
RUN No.1						
Point No.	Description of Location	GPS Grid Reference	Field Strength mV/m	Distance from CFA metres		
0	CFA Position	SE0457648819	Not Applicable	0		
1	CFA Field Gate CFA in view	SE0463448860	340	71		
2	Entrance Schoolmaster Place CFA in view	SE0370649456	20	1030		
3	Post Office (Silsden) No view of CFA	SE0420646375	5.8 ?	2450		
4	Silsden Railway Station No view of CFA	SE0370044747	4.1	4020		
5	Approach Steeton Hill Top CFA in view	SE0290943299	2.84	5800		
6	Road to Steeton Tarn	SE0298442925	2	6500		
RUN No.2						
Point No.	Description of Location	GPS Grid Reference	Field Strength mV/m	Distance from CFA metres		
0	At CFA	SE0457648819		0		
7	Whitaker House No View of CFA	SE0787650856	4.75	3900		
8	Blubberhouse Road Layby No View of CFA	SE0972754299	1.37	7500		
9	Layby before Bolton Abbey No View of CFA	SE0708452519	2.2	4700		
10	Layby Chelker Reservoir No view of CFA	SE0642950849	5.5	2800		
APPENDIX 8						
Page 23						

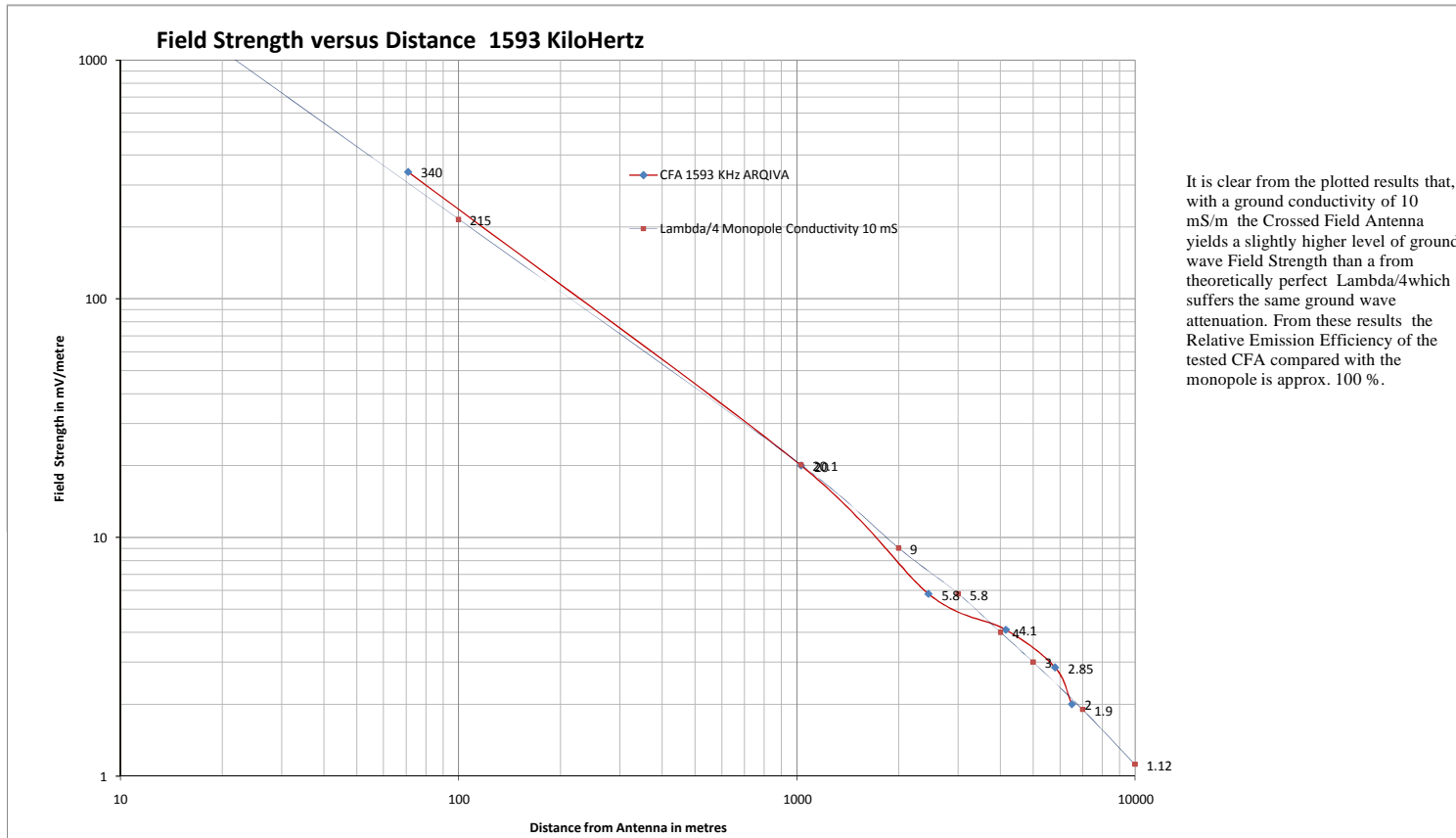
8 METRE CROSSED FIELD ANTENNA ~ THE ARQIVA FIELD STRENGTH MEASUREMENTS
ARQIVA FIELD TESTS RUN NO.1 ON 28th September 2009.

Measurements of Field Strength at known distances from the CFA were made by K.Thorley of ARQIVA

The measured values of Field Strength are plotted below together with a curve showing the results which would be obtained with a Lambda/4 Vertical monopole antenna for a ground conductivity of 10mS/m.

These measurements were made with an input power of 6 Watts at 1,593KiloHertz .

ARQIVA Run No, 1 Results



It is clear from the plotted results that, with a ground conductivity of 10 mS/m the Crossed Field Antenna yields a slightly higher level of ground wave Field Strength than a from theoretically perfect Lambda/4 which suffers the same ground wave attenuation. From these results the Relative Emission Efficiency of the tested CFA compared with the monopole is approx. 100 %.

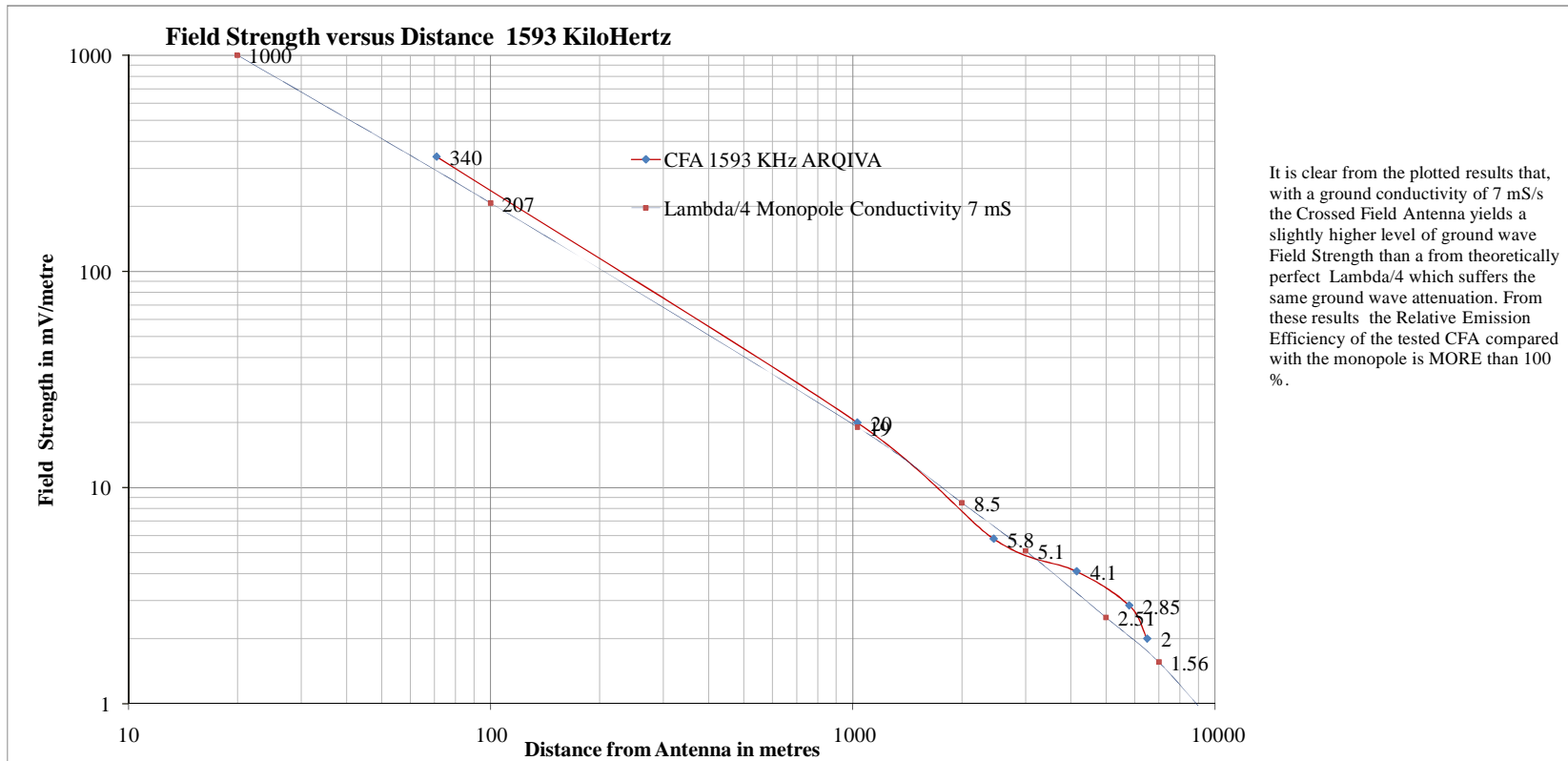
8 METRE CROSSED FIELD ANTENNA ~ THE ARQIVA FIELD STRENGTH MEASUREMENTS ARQIVA FIELD TESTS RUN NO.1 ON 28th September 2009.

Measurements of Field Strength at known distances from the CFA were made by K.Thorley of ARQIVA

The measured values of Field Strength are plotted below together with a curve showing the results which would be obtained with a Lambda/4 Vertical monopole antenna for a ground conductivity of 7 mS/s.

These measurements were made with an input power of 5 Watts at 1,593 KiloHertz .

ARQIVA Run No, 1 Results.



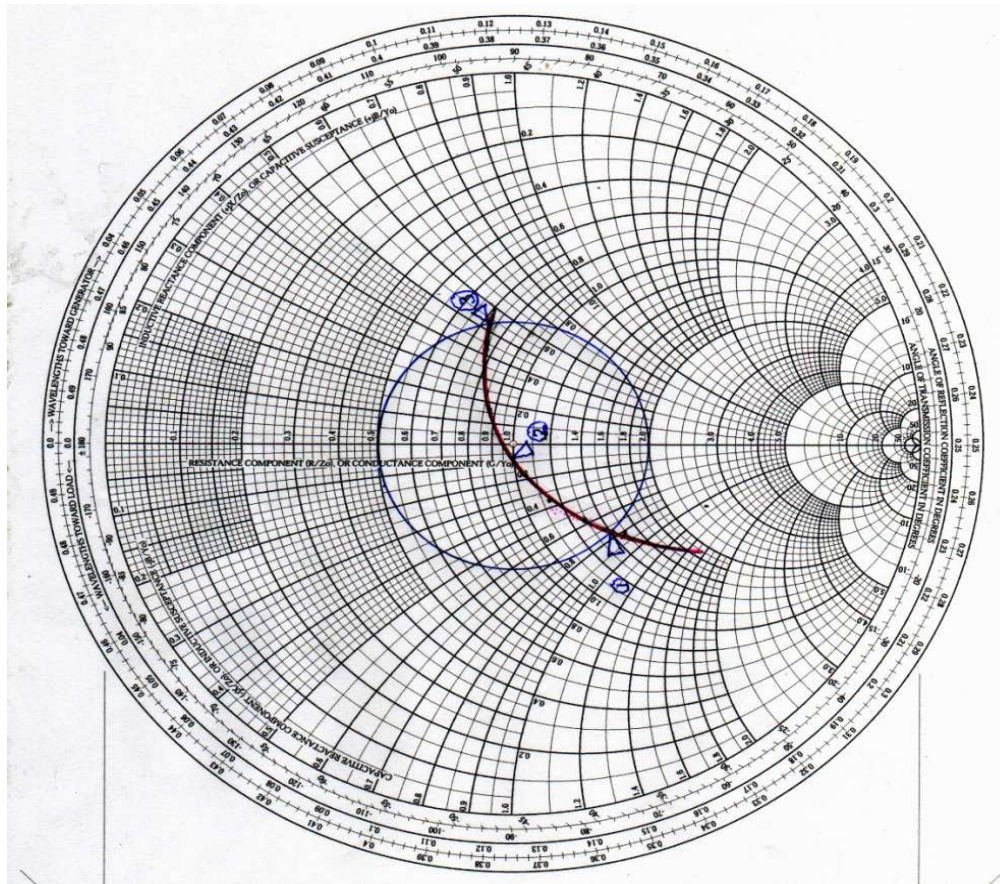
It is clear from the plotted results that, with a ground conductivity of 7 mS/s the Crossed Field Antenna yields a slightly higher level of ground wave Field Strength than a from theoretically perfect Lambda/4 which suffers the same ground wave attenuation. From these results the Relative Emission Efficiency of the tested CFA compared with the monopole is MORE than 100 %.

Reproduction of Arqiva Antenna System Impedance Measurements.

The measurements were taken on 28th September 2009 with the equipments listed in the Schedule of Apparatus used in the ARQIVA Field Test

Page 26

The Smith Chart was prepared by CDL/KAT using data supplied by Arqiva Ltd.



Antenna System Impedance measured at Tx.

Frequency	Rs	Xs
1,583.0 kHz	64.6	-j 30.4
1,588.5 kHz	57.9	-j 18.0
1,,593.0 kHz	50.3	-j 4.5
1,597.5 kHz	43.8	+j 8.0
1,603.0 kHz	38.5	+j 21.3

POINT 1 VSWR = 2.0 at 1,579. kHz

POINT 2 VSWR = 1.09 at 1,593 kHz.

POINT 3 VSWR = 2.0 at 1,605 kHz.

APPENDIX 10

Created 28-09-2009

CFA Voltage Standing Wave Ratios ~ ARQIVA

CARRIER CENTRE FREQUENCY 1,593 KiloHertz.

Measurements made with Hewlet Packard

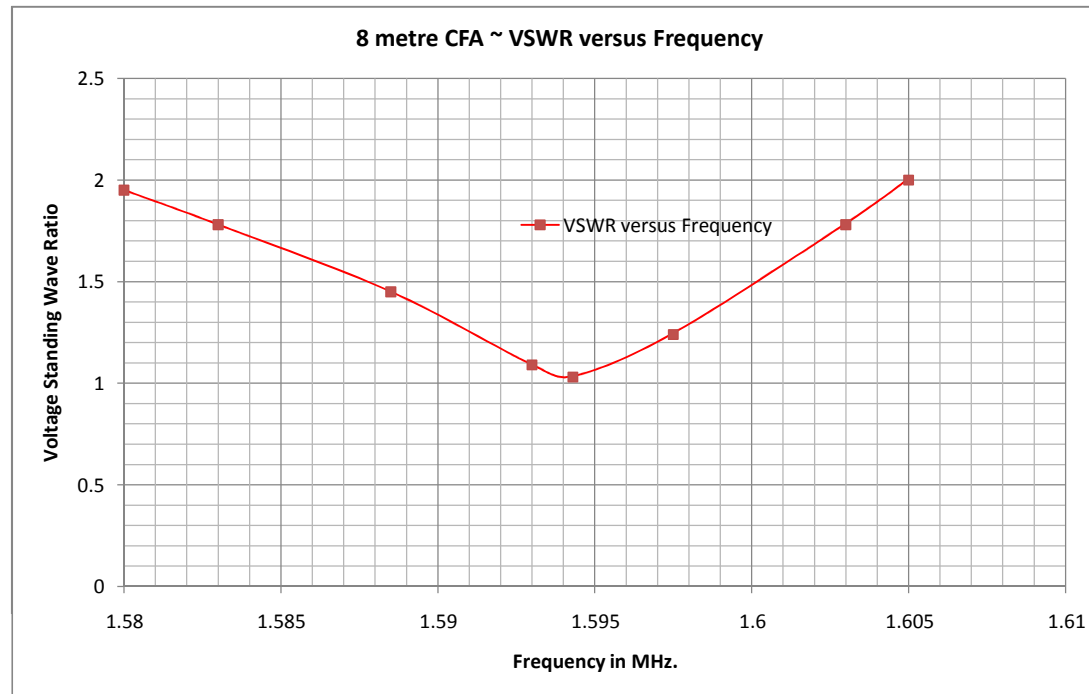
Network Analyzer HP87531D

VSWR DATA

Freq(MHz)	SWR
1.58	1.95 *
1.583	1.78
1.5885	1.45
1.593	1.09
1.5943	1.03 **
1.5975	1.24
1.603	1.78
1.605	2 *

The above data was derived from the Frequency versus Impedance data used to produce the Smith Chart shown in Appendix 10. Points * and ** are from extrapolation and interpolation of the Arqiva data.

The VSWR versus Frequency graph was prepared by CDL using data supplied by Arqiva and is in the same format as the CDL/KAT graphs.



The VSWR of the CFA in the frequency range carrier +/- 5.0 KHz. Is less than 1.5. This is well within the limit set in the OFCOM Engineering Code which sets a lower limit of +/- 4.5 KHz. at VSWR of 1.5.

