Address all correspondences regarding this report to:
Timothy Milam
Custom Integrated Antennas
1322 Butcher Hollow, PO Box 116
Van Lear, KY 41265
Tel: (512) 638-2643
E-mail: an10a@cia-aa.com

Document #: CIA 2018-0017.009

Custom Integrated Antennas (CIA)

"Vocollect A7xx Series Antenna Analysis"

Submitted to Graham Byrne on:

May 21, 2018

Table of Contents

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

Revision History

Date of Revision	Revision Comments	Pages Affected
05/21/2018	Entire Document	All

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

A7xx Series Antenna Comparison (Beretta vs. Liverpool)

Vocollect has updated their Beretta A7xx Series product with more modern components and special attention has been paid to keeping the legacy antenna performance as close as possible to Beretta, so legacy customers will experience similar or same performance as the previous product. This report compares the performance of Beretta and Liverpool to confirm the antenna performance has stayed comparable.

Beretta A710

Beretta A720

Beretta A730

Liverpool A710

Liverpool A720

Liverpool A730

1 Configurations Tested

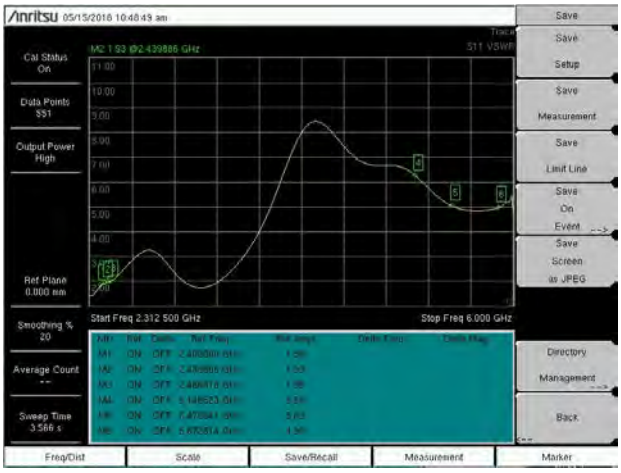
To have a thorough understanding of the combined impact of the product changes on each antenna, several configurations were tested. These configurations are listed below.

1. Beretta A710 Bluetooth In Free Space
2. Beretta A720 Bluetooth In Free Space
3. Beretta A730 Bluetooth In Free Space
4. Beretta A710 Bluetooth On Body
5. Beretta A720 Bluetooth On Body
6. Beretta A730 Bluetooth On Body
7. Beretta A710 WiFi In Free Space
8. Beretta A720 WiFi In Free Space
9. Beretta A730 WiFi In Free Space
10. Beretta A710 WiFi On Body
11. Beretta A720 WiFi On Body
12. Beretta A730 WiFi On Body
13. Liverpool A710 Bluetooth In Free Space
14. Liverpool A720 Bluetooth In Free Space
15. Liverpool A730 Bluetooth In Free Space
16. Liverpool A710 Bluetooth On Body
17. Liverpool A720 Bluetooth On Body
18. Liverpool A730 Bluetooth On Body
19. Liverpool A710 WiFi In Free Space
20. Liverpool A720 WiFi In Free Space
21. Liverpool A730 WiFi In Free Space
22. Liverpool A710 WiFi On Body
23. Liverpool A720 WiFi On Body
24. Liverpool A730 WiFi On Body

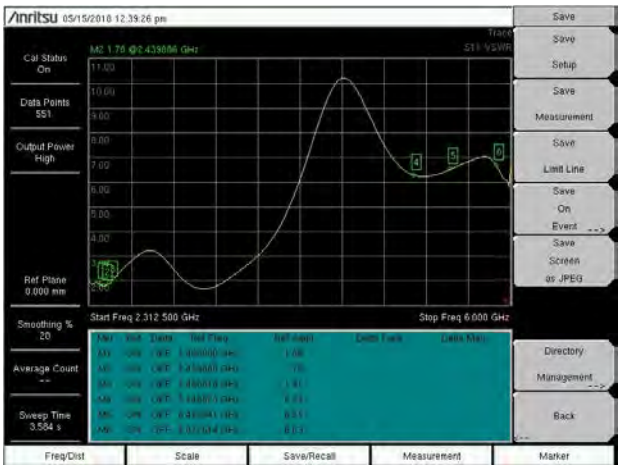
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

2 VSWR

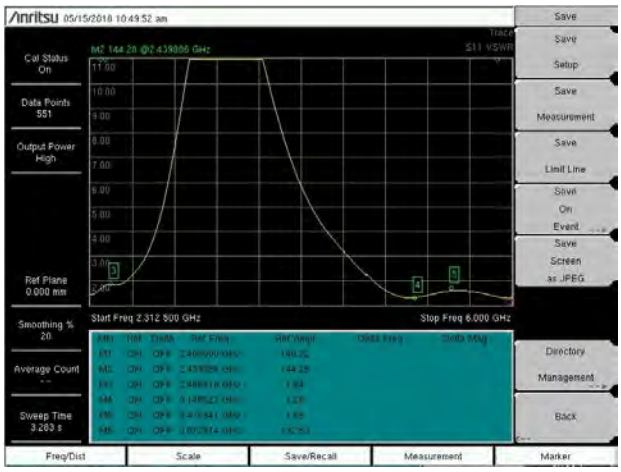
2.1 Free Space



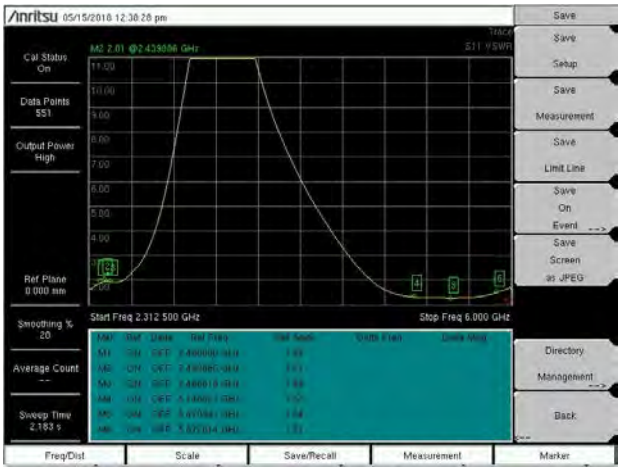
Beretta A710 Bluetooth



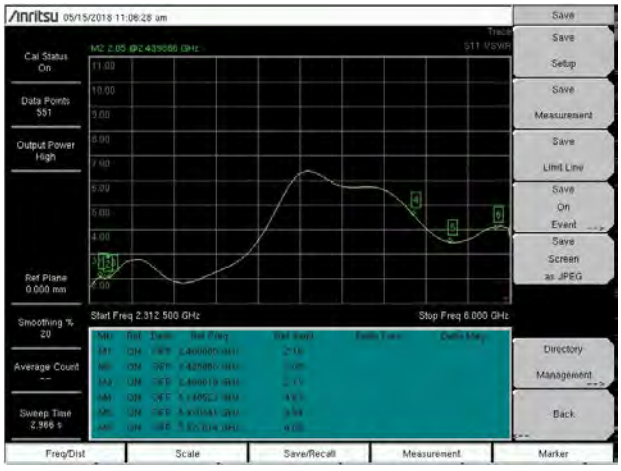
Liverpool A710 Bluetooth



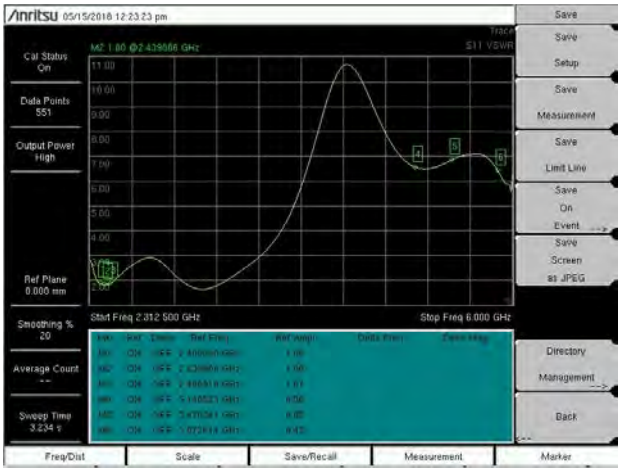
Beretta A710 WiFi



Liverpool A710 WiFi

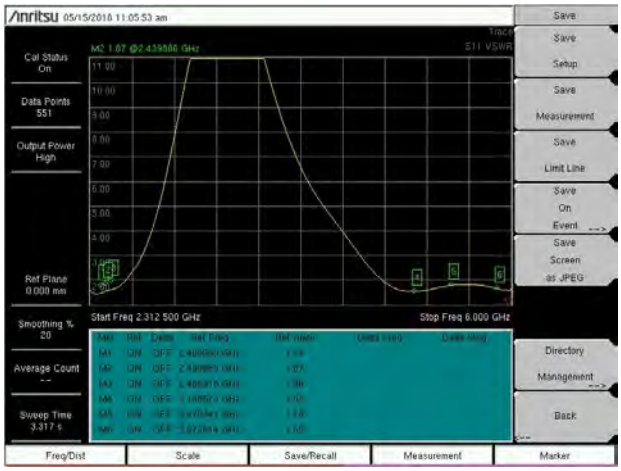


Beretta A720 Bluetooth

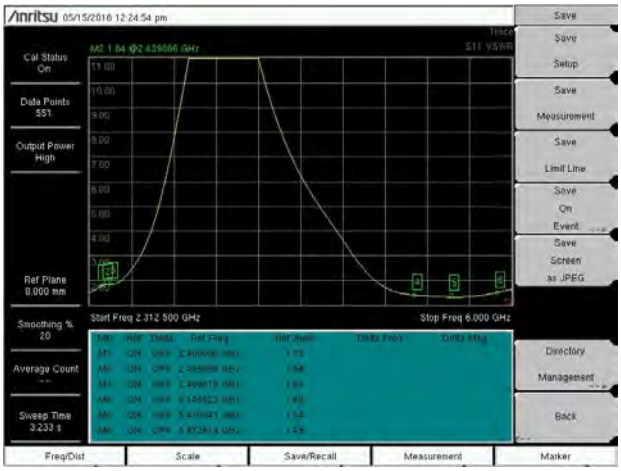


Liverpool A720 Bluetooth

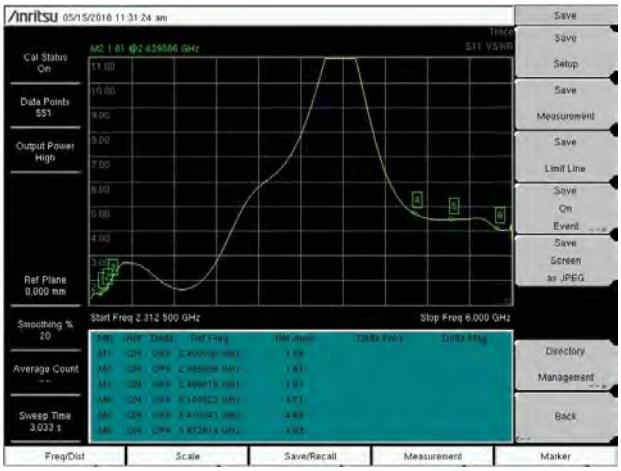
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643



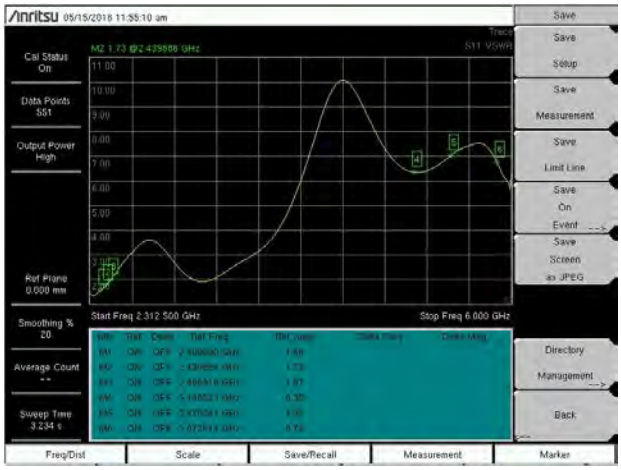
Beretta A720 WiFi



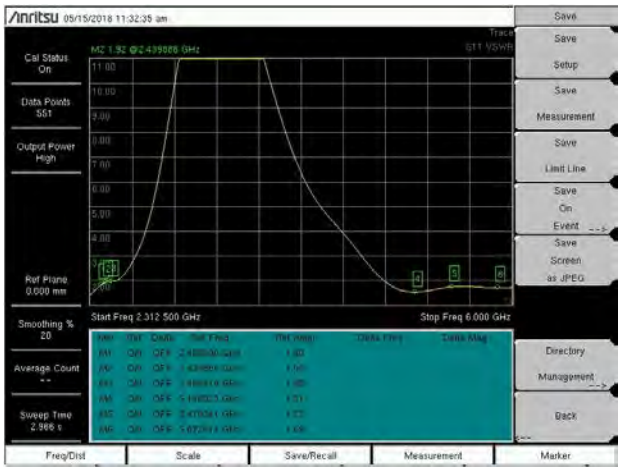
Liverpool A720 WiFi



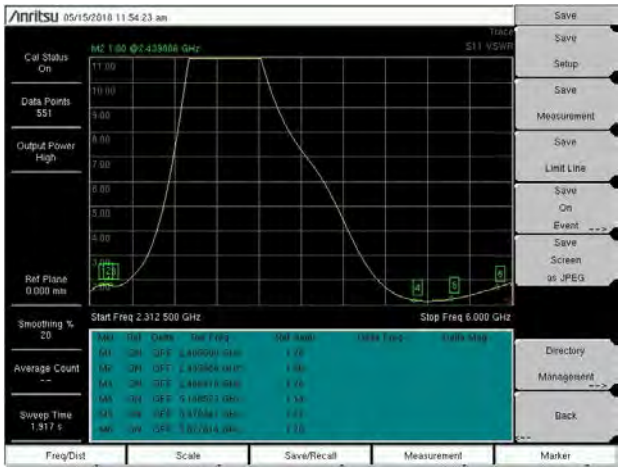
Beretta A730 Bluetooth



Liverpool A730 Bluetooth



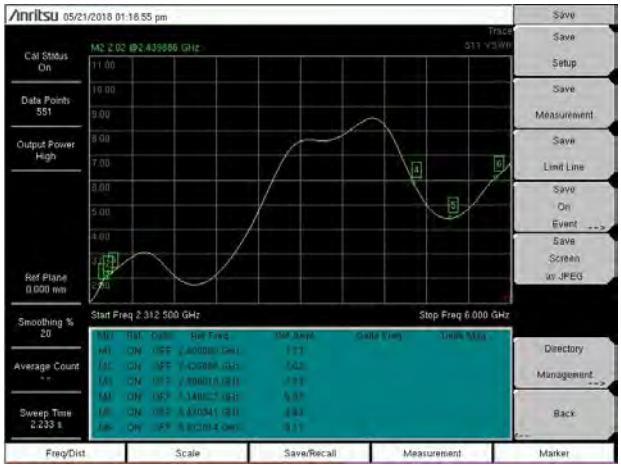
Beretta A730 WiFi



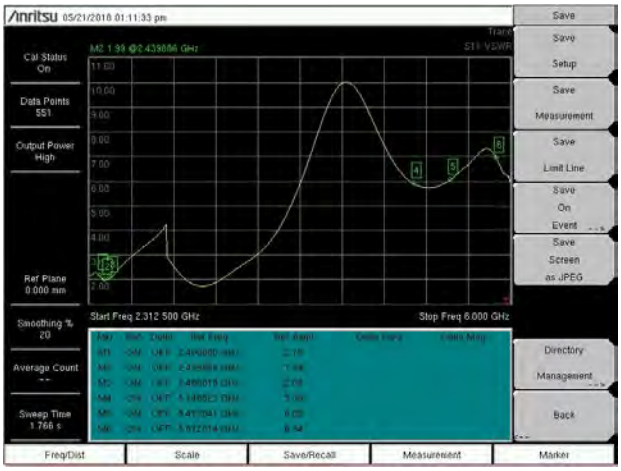
Liverpool A730 WiFi

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

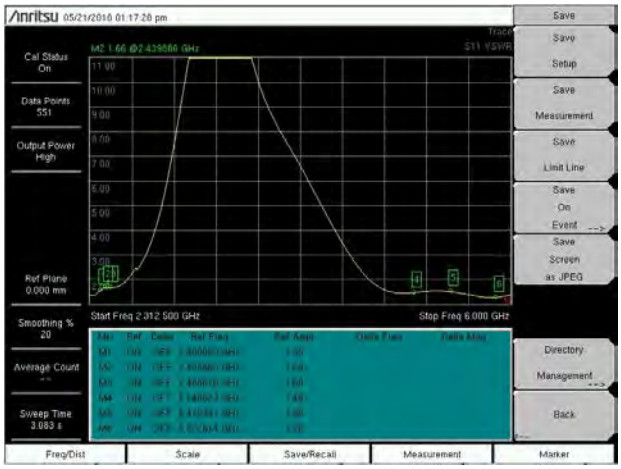
2.2 On Belt



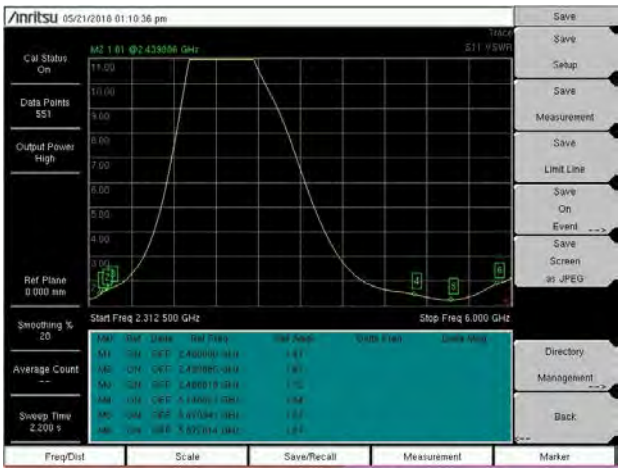
Beretta A710 Bluetooth



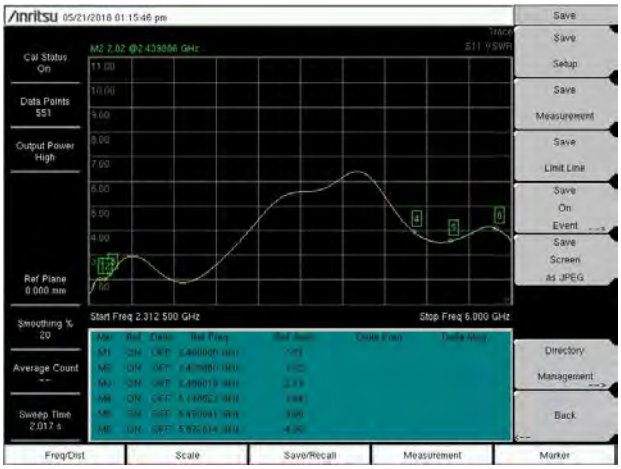
Liverpool A710 Bluetooth



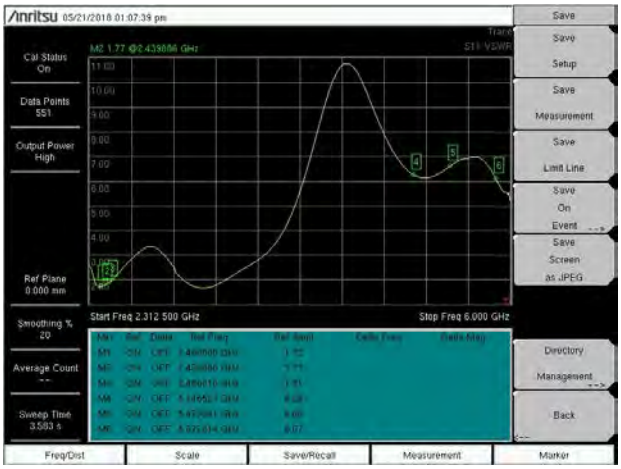
Beretta A710 WiFi



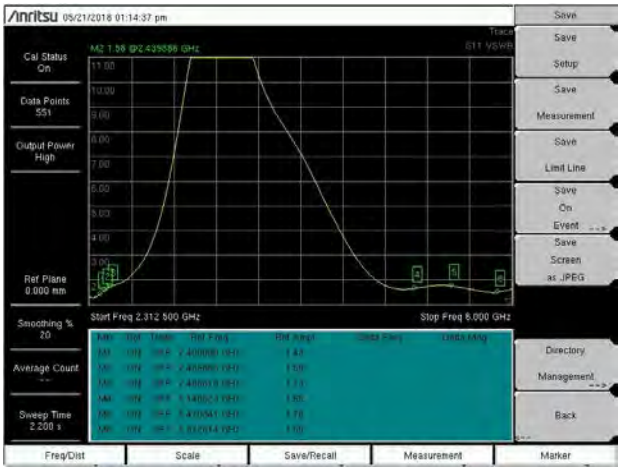
Liverpool A710 WiFi



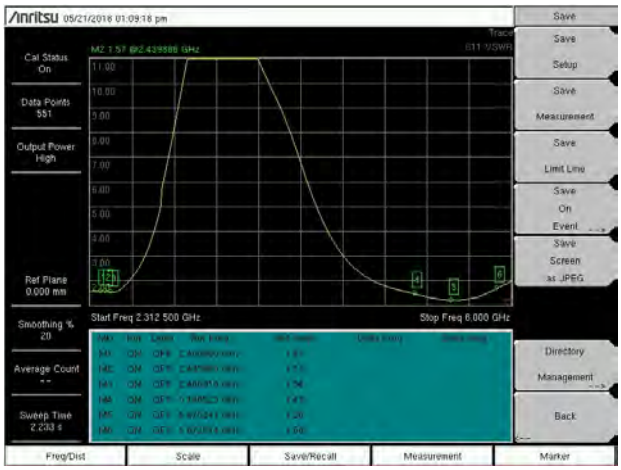
Beretta A720 Bluetooth



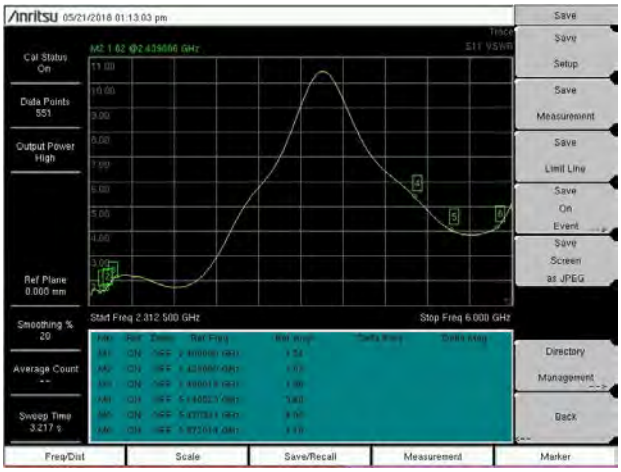
Liverpool A720 Bluetooth



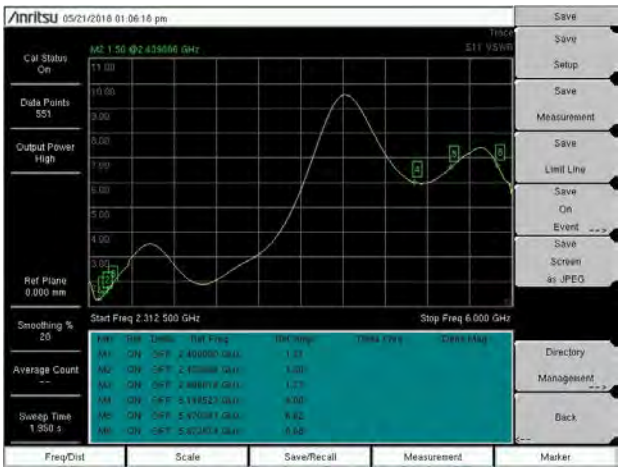
Beretta A720 WiFi



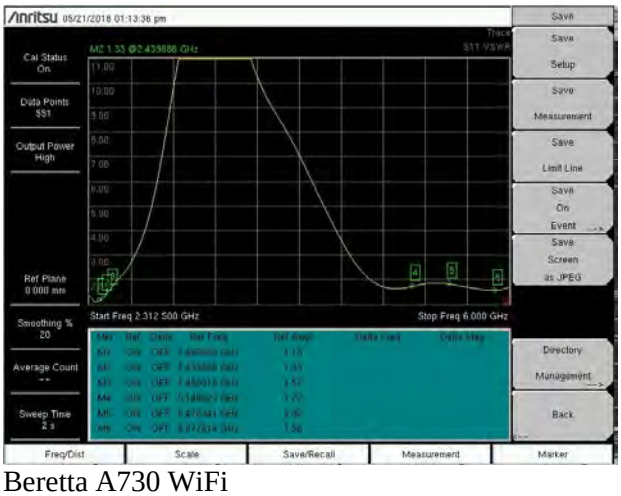
Liverpool A720 WiFi



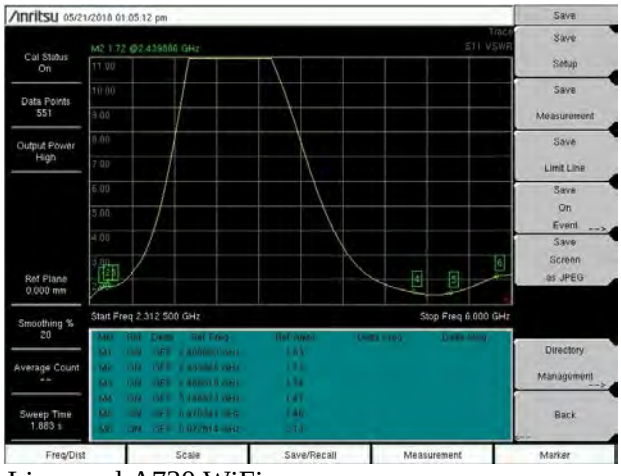
Beretta A730 Bluetooth



Liverpool A730 Bluetooth



Beretta A730 WiFi



Liverpool A730 WiFi

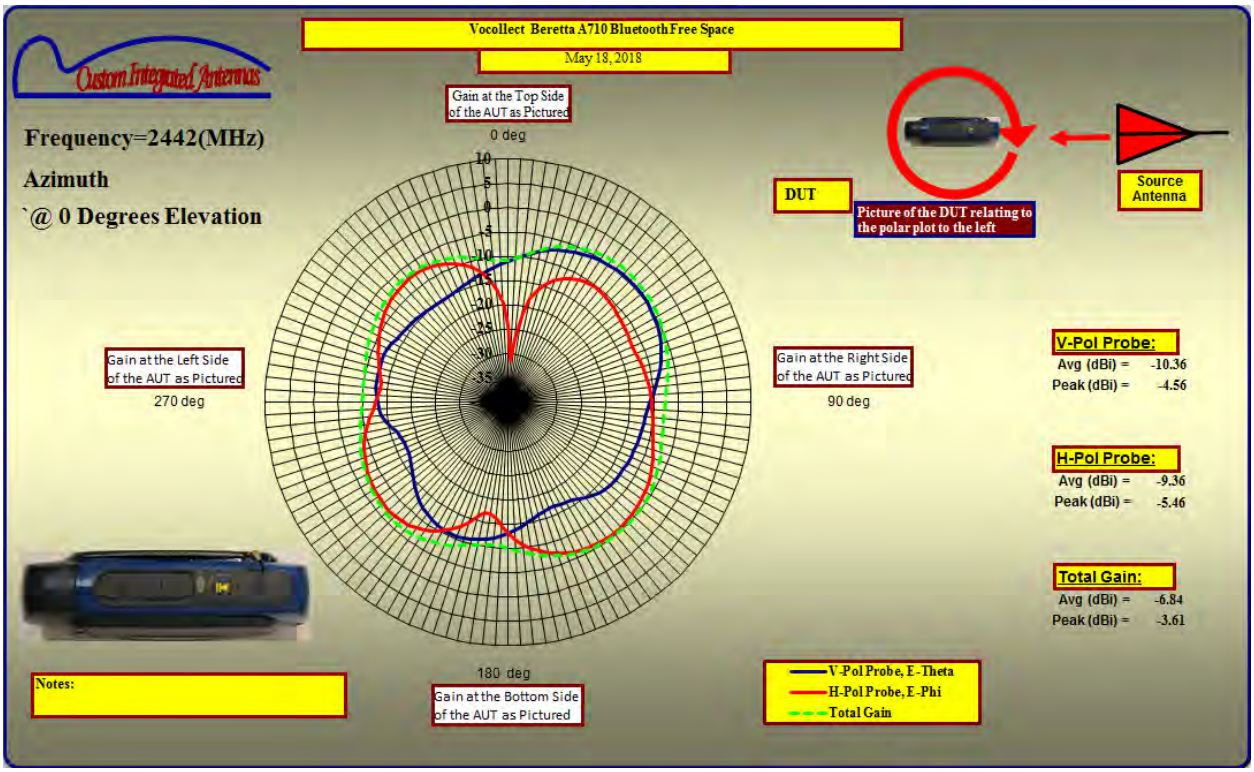
VSWR in general is better for Liverpool, but both are very close.

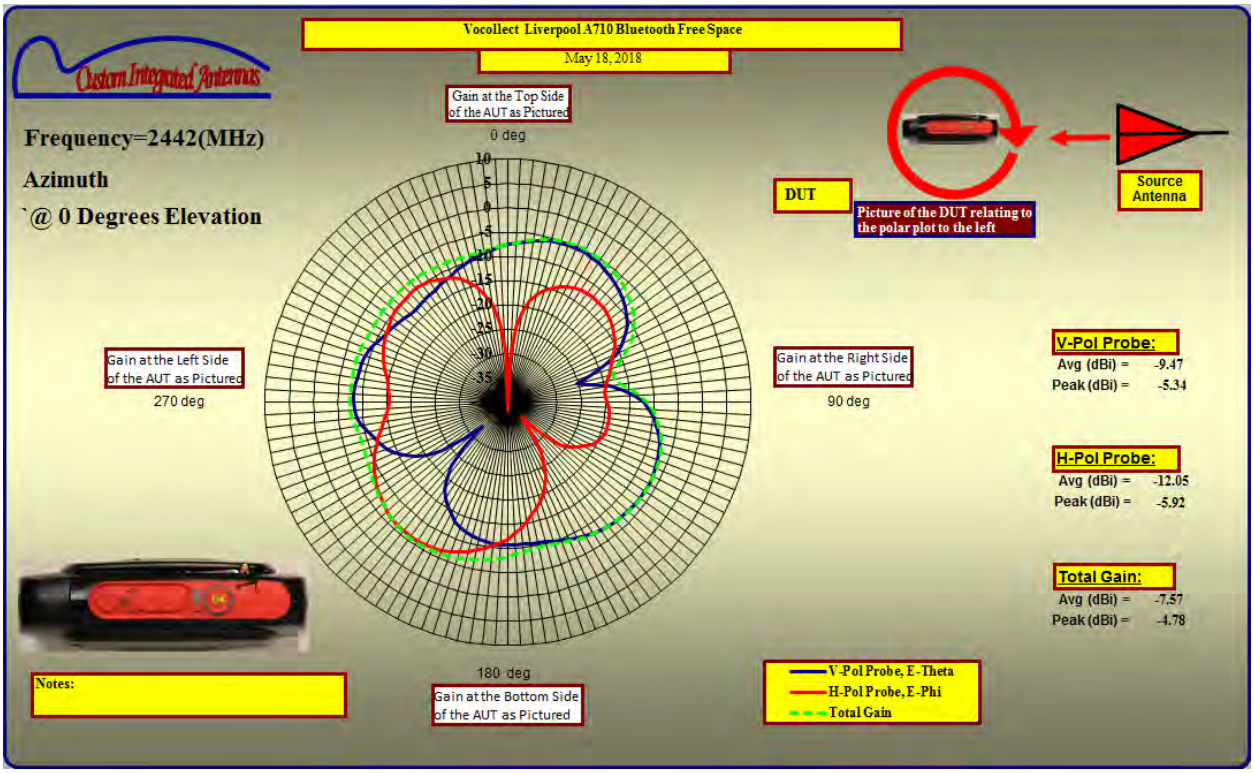
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

3 Radiated Patterns

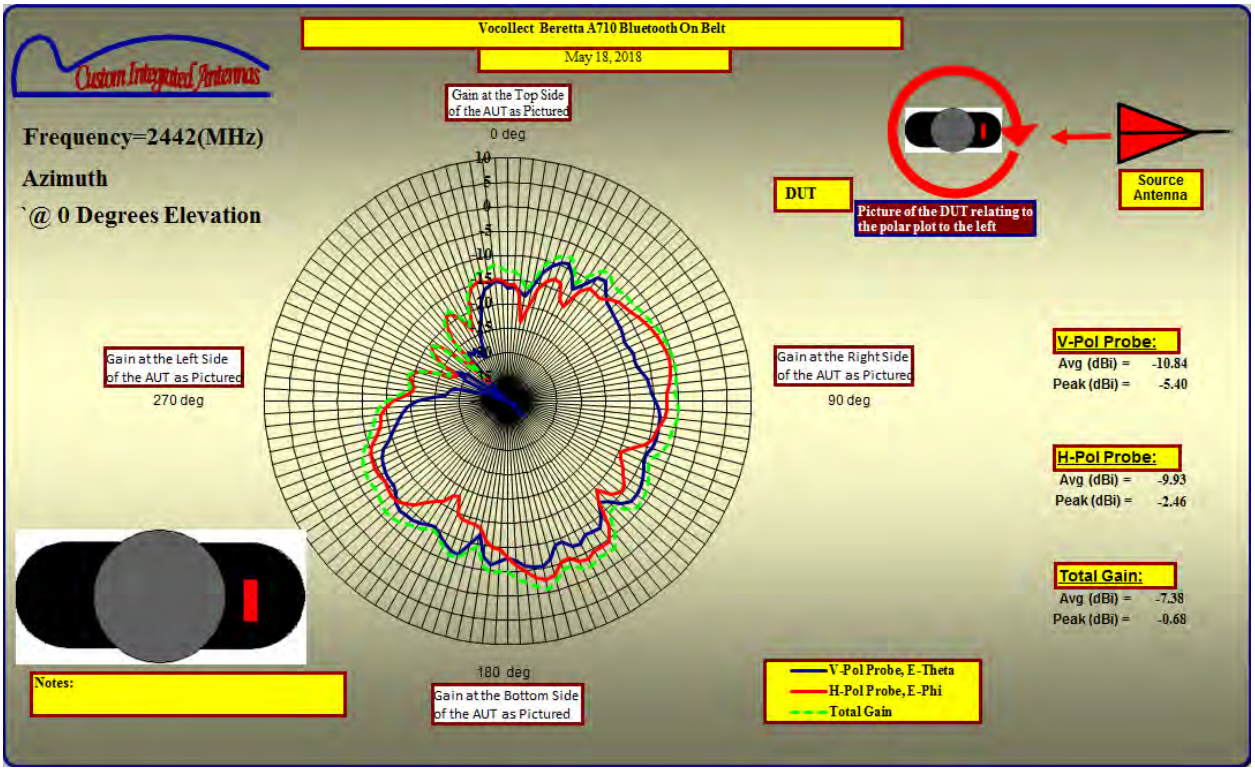
3.1 A710 Bluetooth Comparison

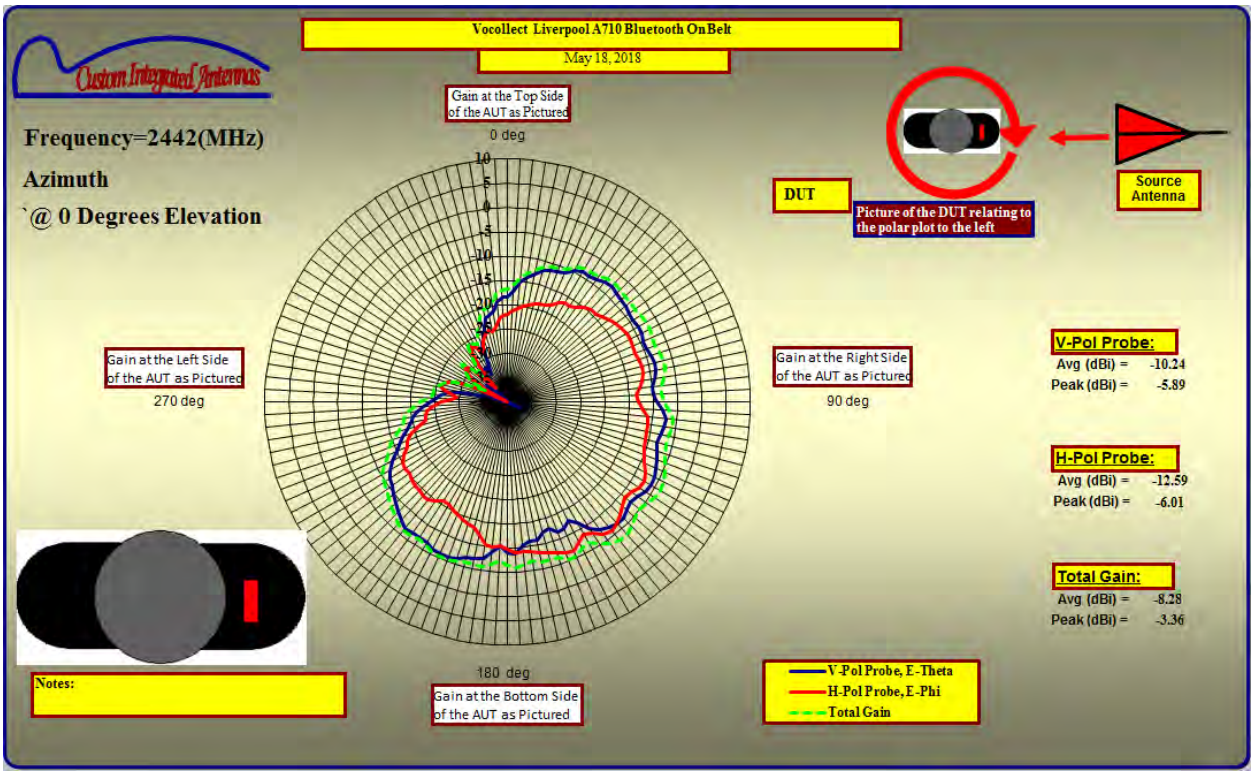
3.1.1 Free Space





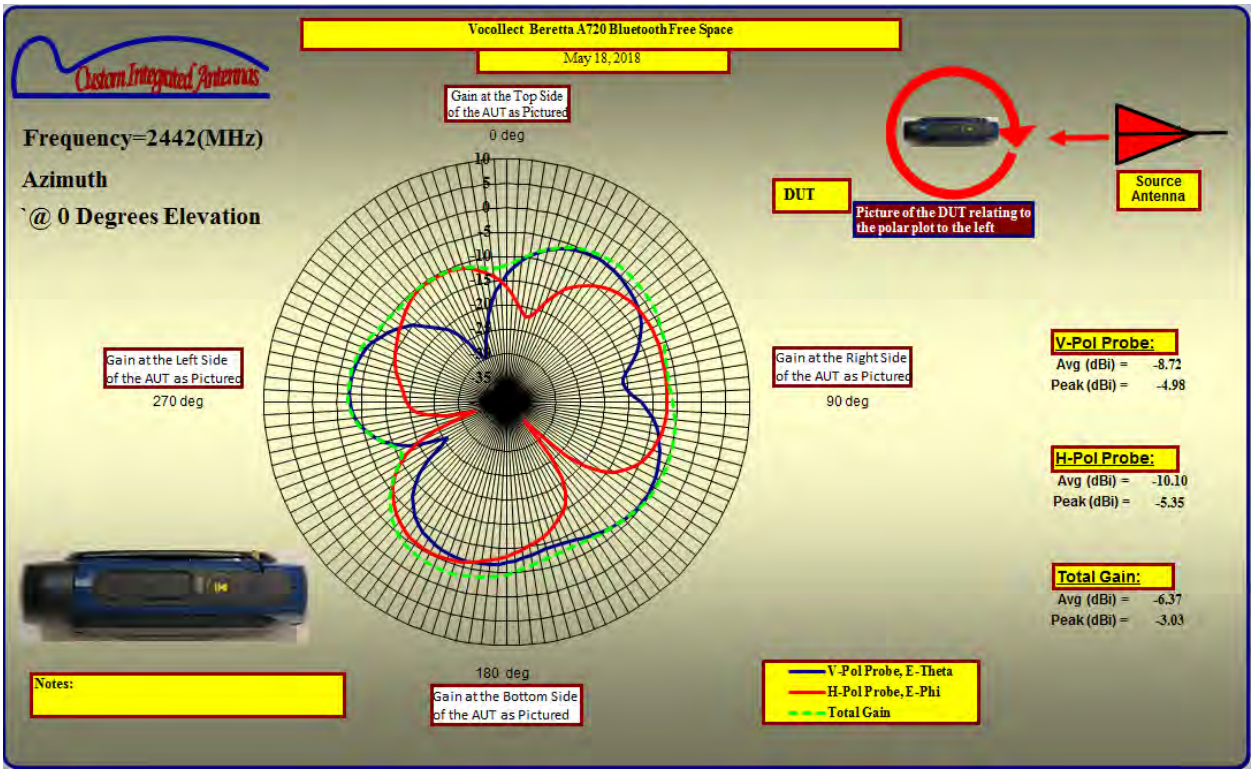
3.1.2 On Belt

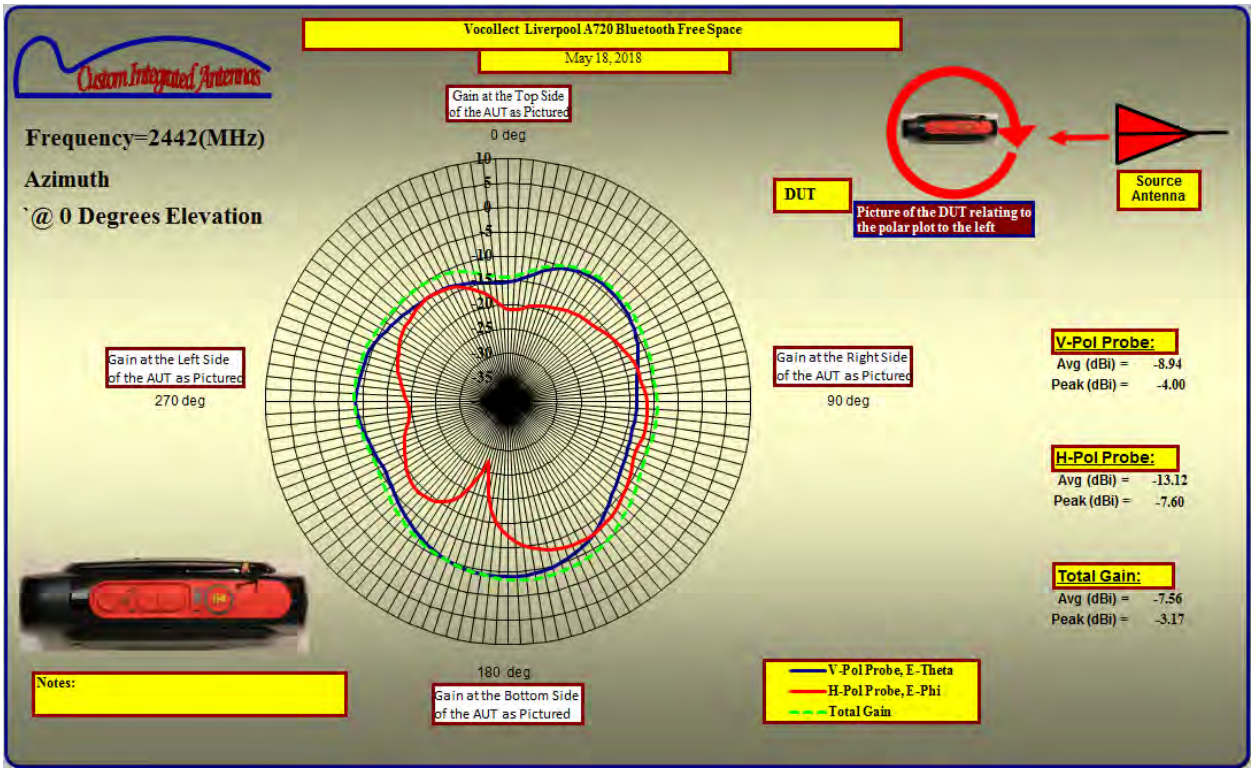

Vocollect Beretta A710 Bluetooth On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
DUT
Source Antenna
Picture of the DUT relating to the polar plot to the left
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
V-Pol Probe:
Avg (dBi) = -10.84
Peak (dBi) = -5.40
H-Pol Probe:
Avg (dBi) = -9.93
Peak (dBi) = -2.46
Total Gain:
Avg (dBi) = -7.38
Peak (dBi) = -0.68
180 deg
Gain at the Bottom Side of the AUT as Pictured
Notes:
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain


Vocollect Liverpool A710 Bluetooth On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
DUT
Source Antenna
Picture of the DUT relating to the polar plot to the left
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
V-Pol Probe:
Avg (dBi) = -10.24
Peak (dBi) = -5.89
H-Pol Probe:
Avg (dBi) = -12.59
Peak (dBi) = -6.01
Total Gain:
Avg (dBi) = -8.28
Peak (dBi) = -3.36
180 deg
Gain at the Bottom Side of the AUT as Pictured
Notes:
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain

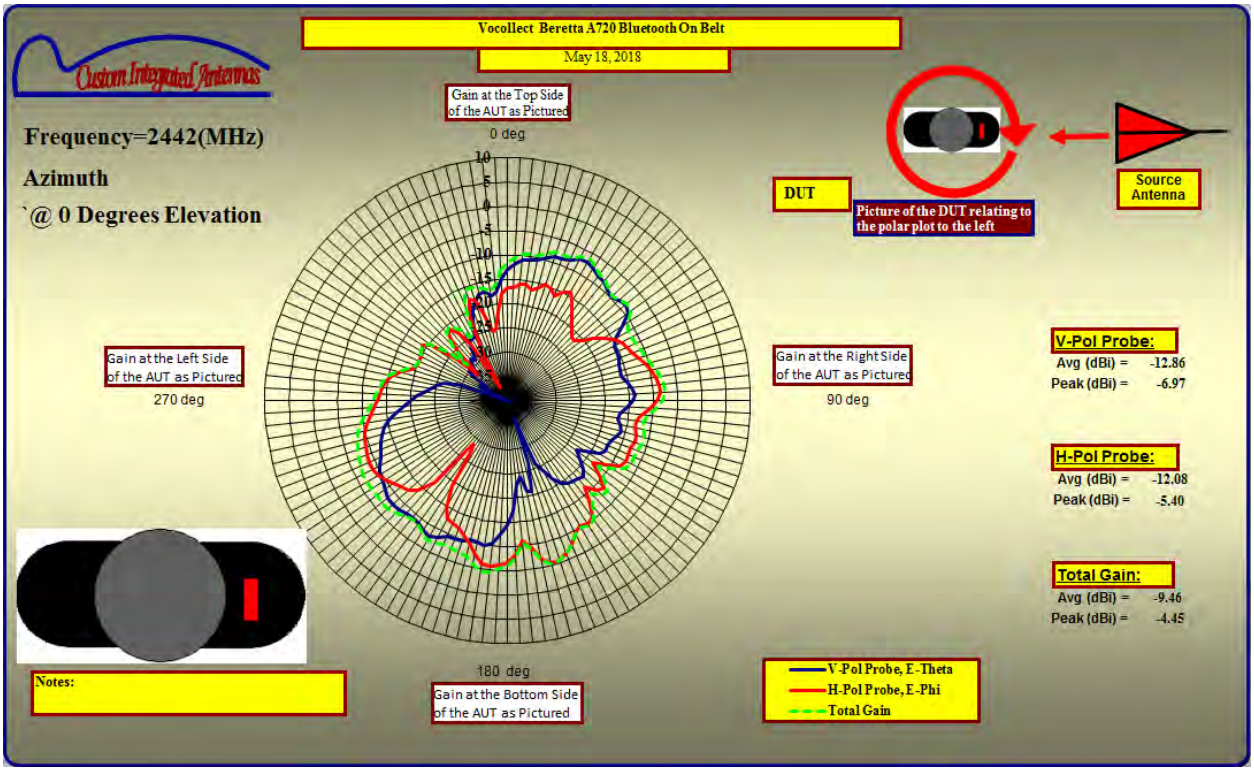
3.2 A720 Bluetooth Comparison

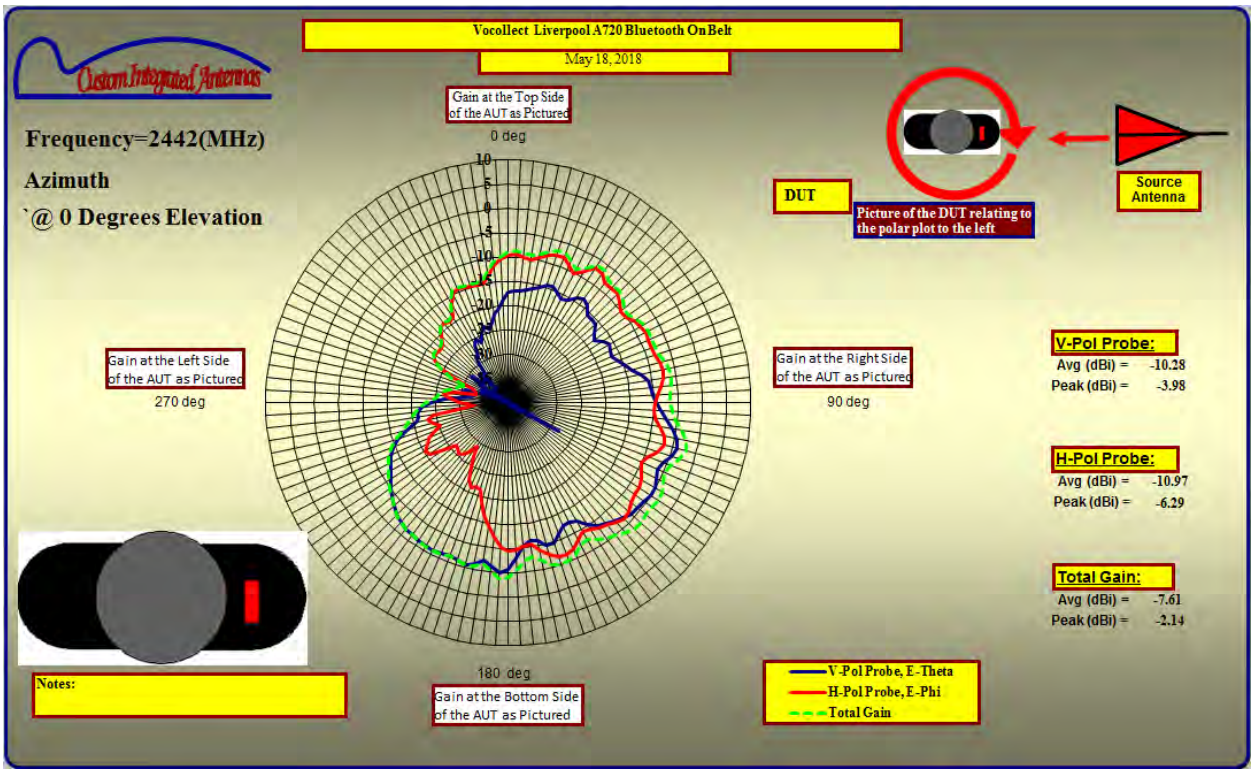
3.2.1 Free Space





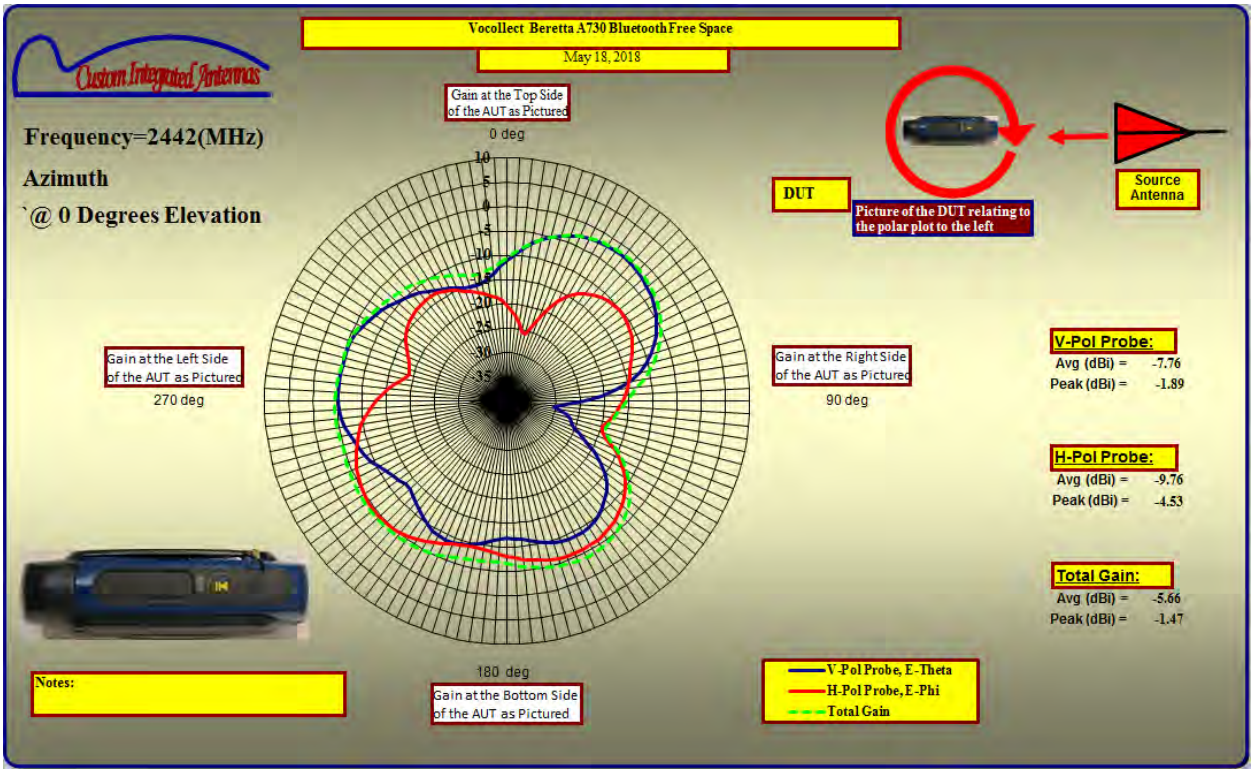
3.2.2 On Belt

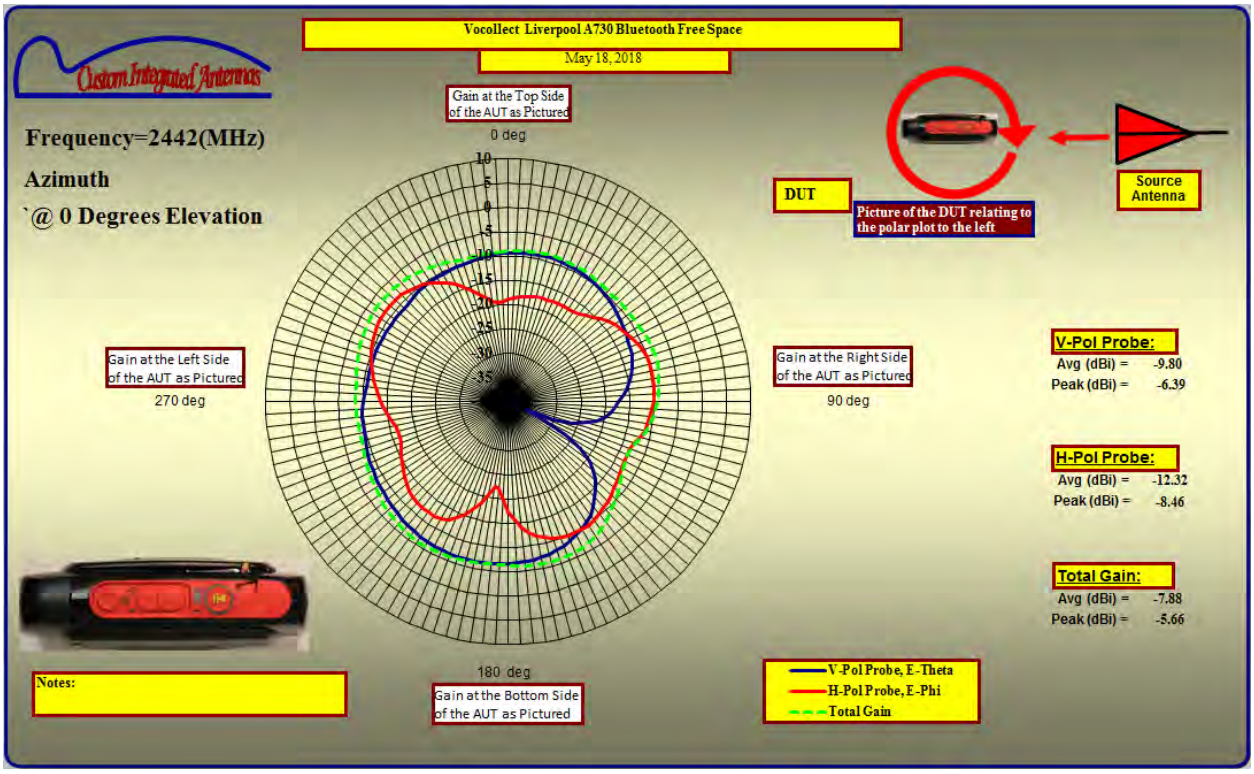

Vocollect Beretta A720 Bluetooth On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
DUT
Picture of the DUT relating to the polar plot to the left
Source Antenna
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
V-Pol Probe:
Avg (dBi) = -12.86
Peak (dBi) = -6.97
H-Pol Probe:
Avg (dBi) = -12.08
Peak (dBi) = -5.40
Total Gain:
Avg (dBi) = -9.46
Peak (dBi) = -4.45
180 deg
Gain at the Bottom Side of the AUT as Pictured
Notes:
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain


Vocollect Liverpool A720 Bluetooth On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
DUT
Picture of the DUT relating to the polar plot to the left
Source Antenna
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
V-Pol Probe:
Avg (dBi) = -10.28
Peak (dBi) = -3.98
H-Pol Probe:
Avg (dBi) = -10.97
Peak (dBi) = -6.29
Total Gain:
Avg (dBi) = -7.61
Peak (dBi) = -2.14
180 deg
Gain at the Bottom Side of the AUT as Pictured
Notes:
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain

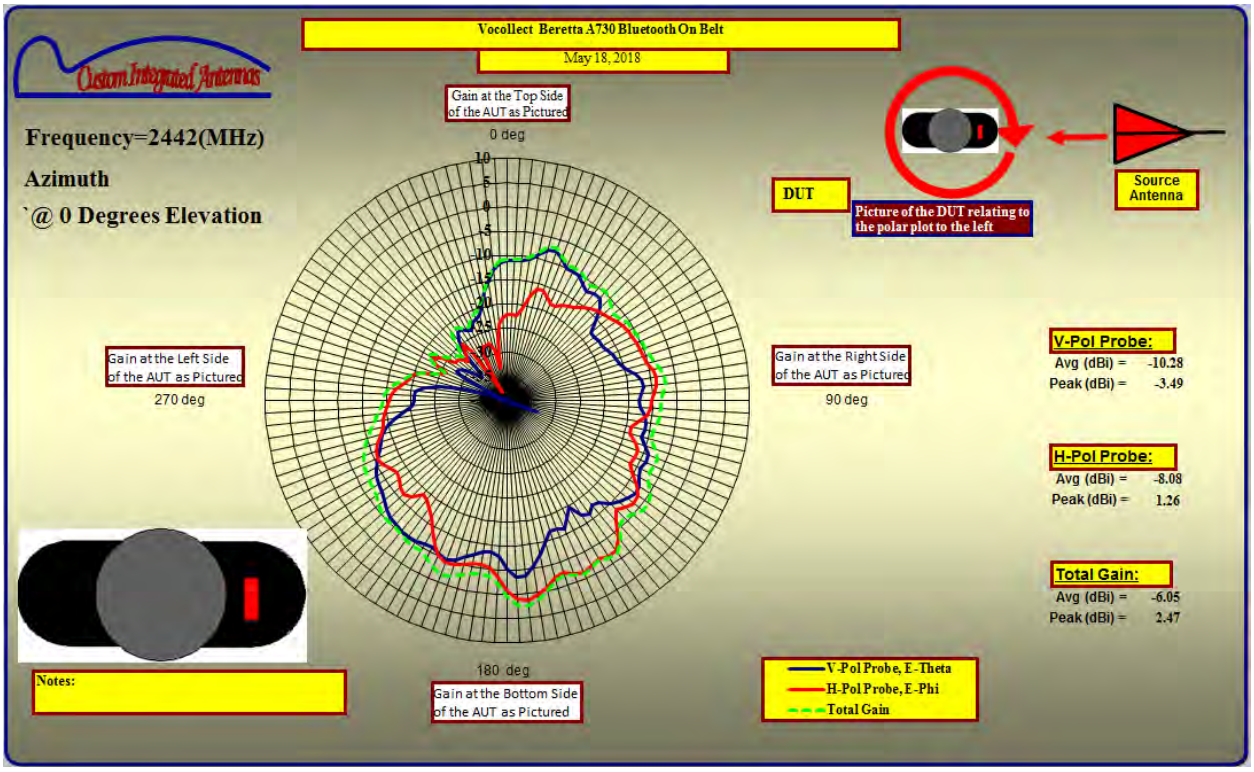
3.3 A730 Bluetooth Comparison

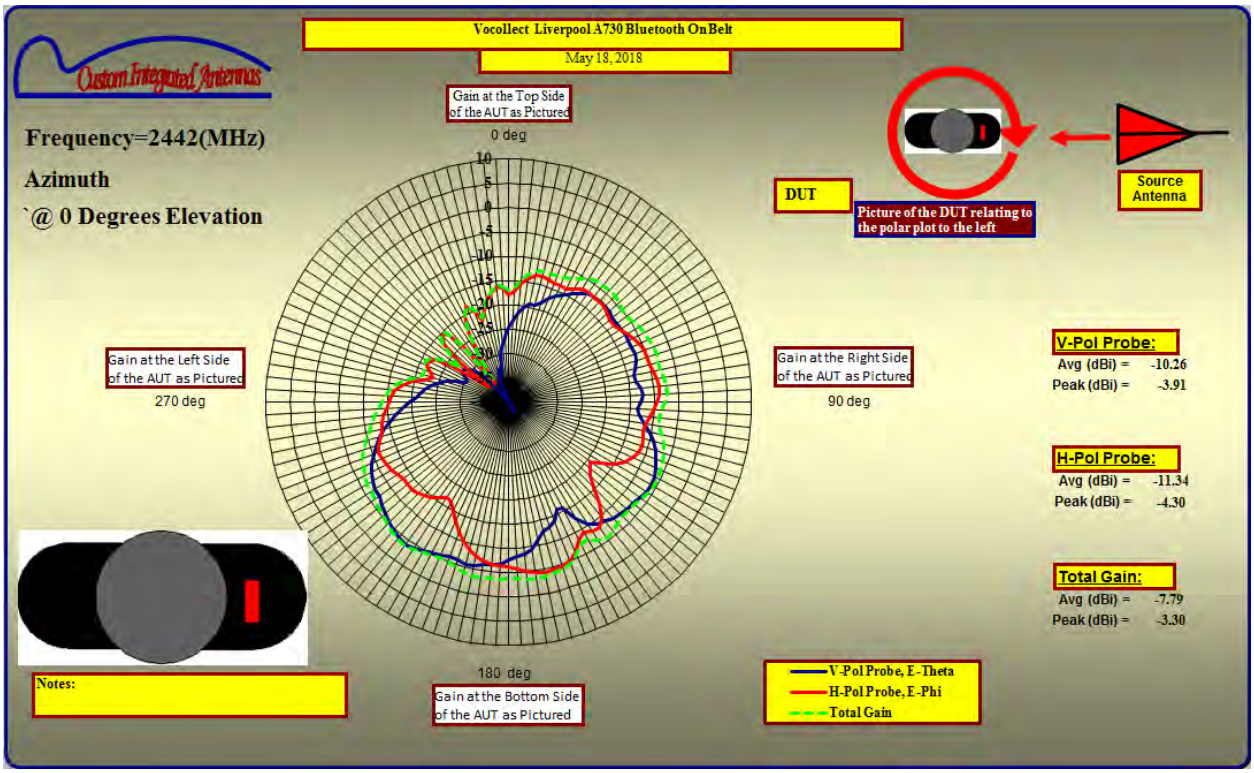
3.3.1 Free Space





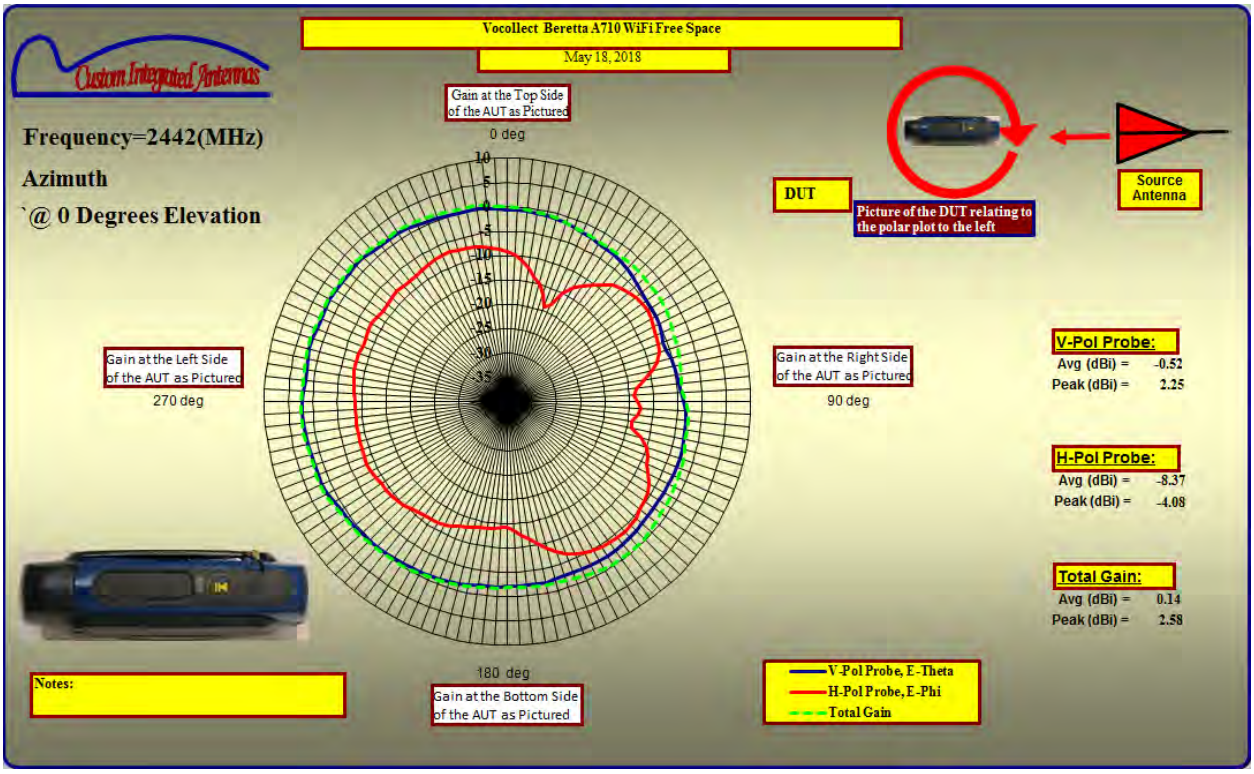
3.3.2 On Belt

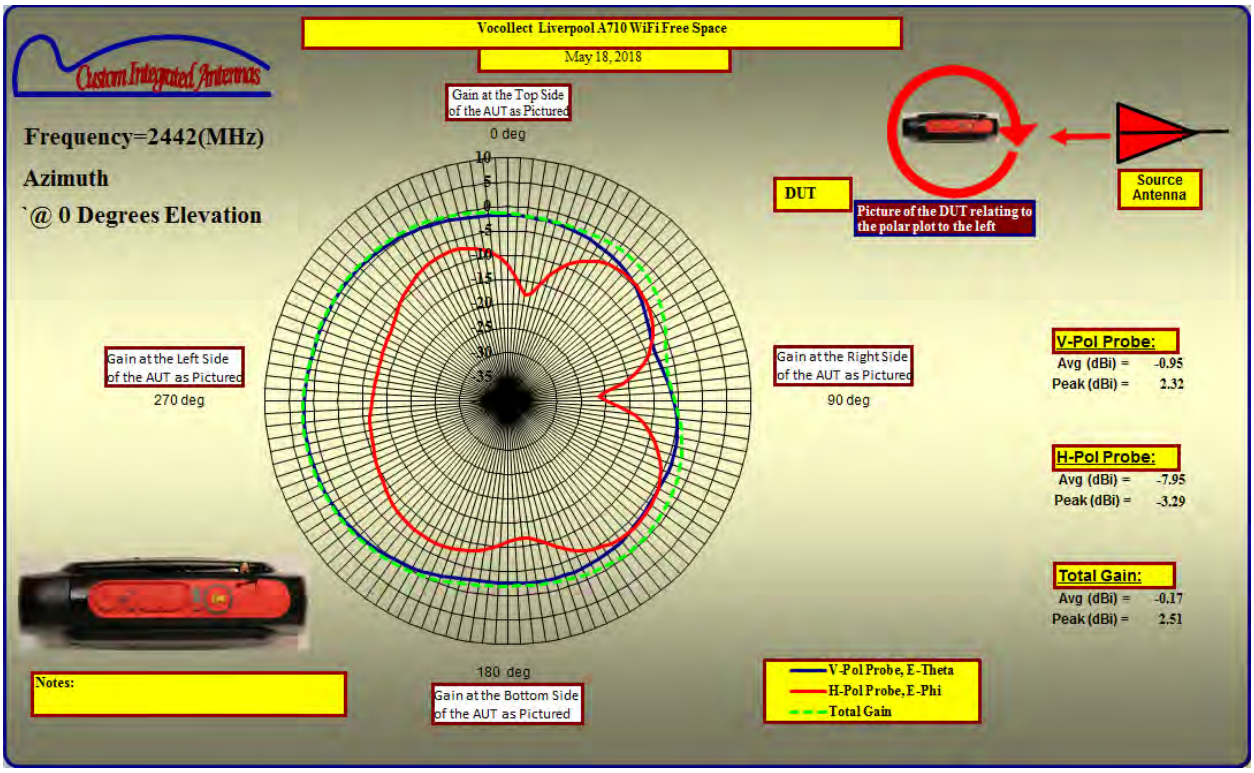

Vocollect Beretta A730 Bluetooth On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
180 deg
Gain at the Bottom Side of the AUT as Pictured
DUT
Picture of the DUT relating to the polar plot to the left
Source Antenna
V-Pol Probe:
Avg (dBi) = -10.28
Peak (dBi) = -3.49
H-Pol Probe:
Avg (dBi) = -8.08
Peak (dBi) = 1.26
Total Gain:
Avg (dBi) = -6.05
Peak (dBi) = 2.47
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain
Notes:

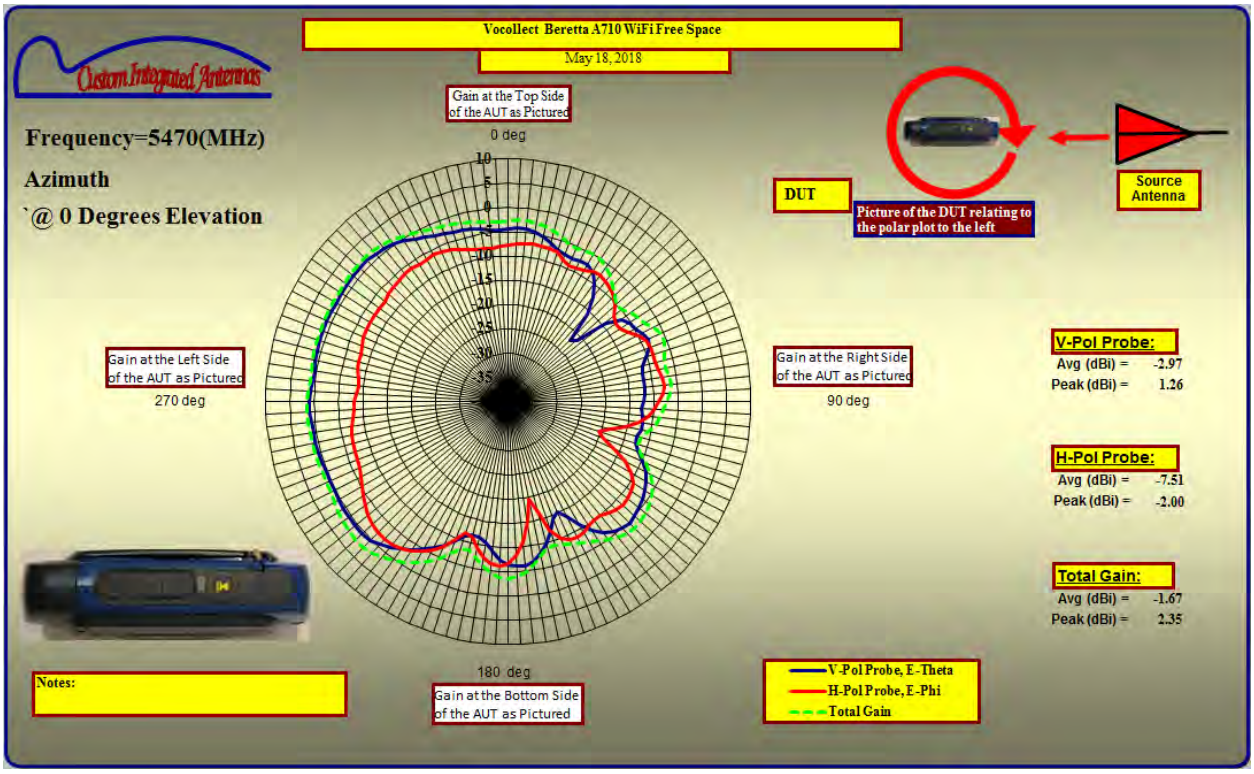

Vocollect Liverpool A730 Bluetooth On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
180 deg
Gain at the Bottom Side of the AUT as Pictured
DUT
Picture of the DUT relating to the polar plot to the left
Source Antenna
V-Pol Probe:
Avg (dBi) = -10.26
Peak (dBi) = -3.91
H-Pol Probe:
Avg (dBi) = -11.34
Peak (dBi) = -4.30
Total Gain:
Avg (dBi) = -7.79
Peak (dBi) = -3.30
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain
Notes:

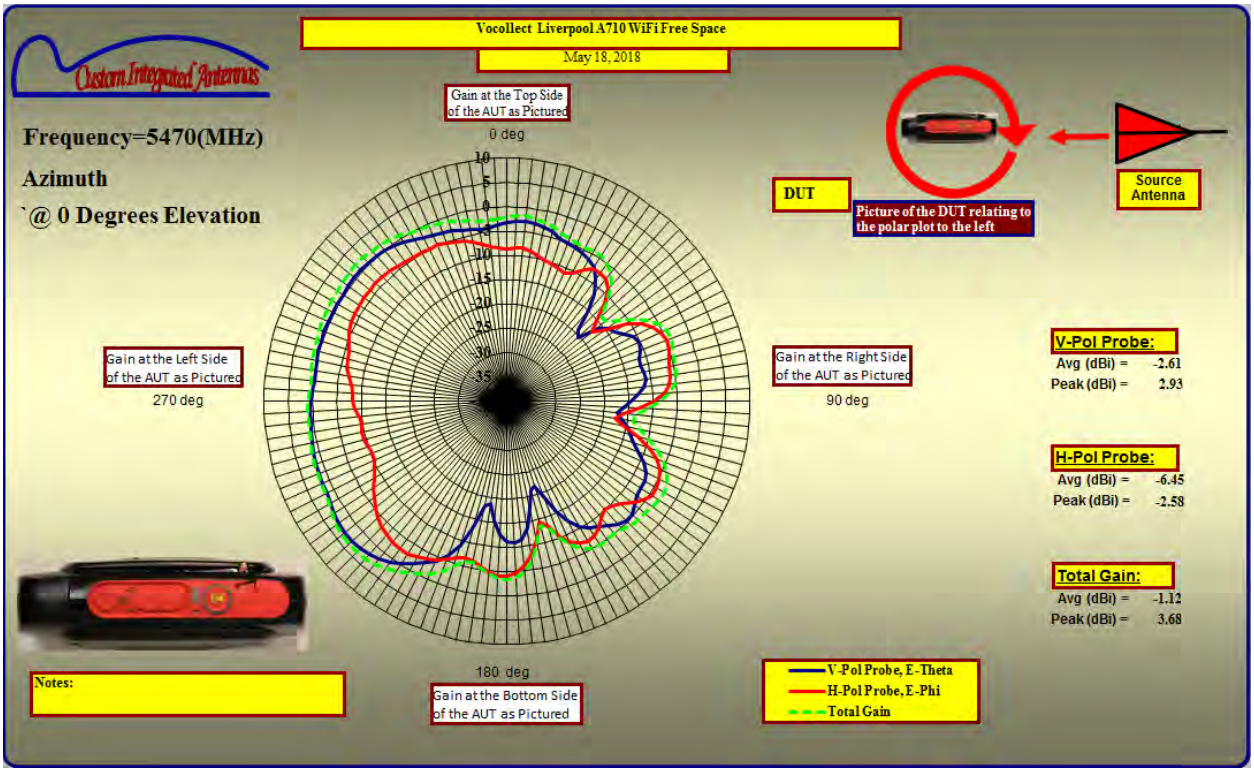
3.4 A710 WiFi Comparison

3.4.1 Free Space



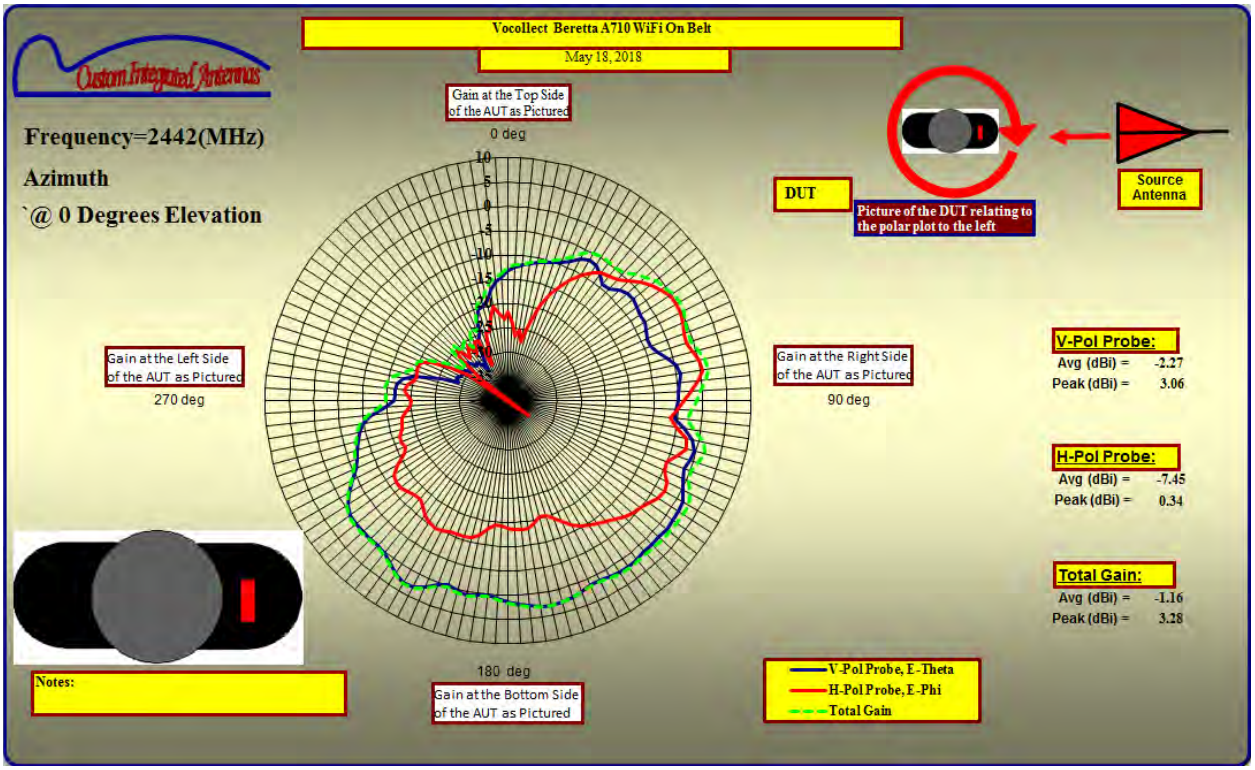


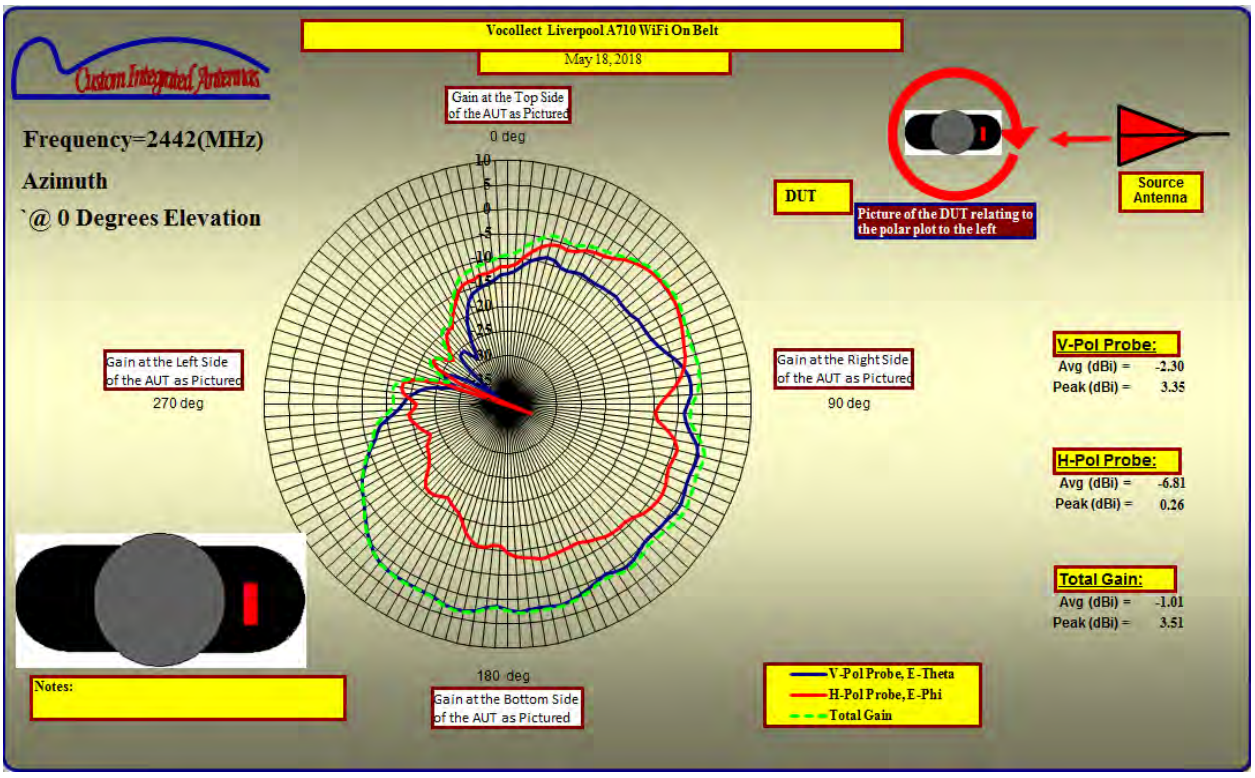




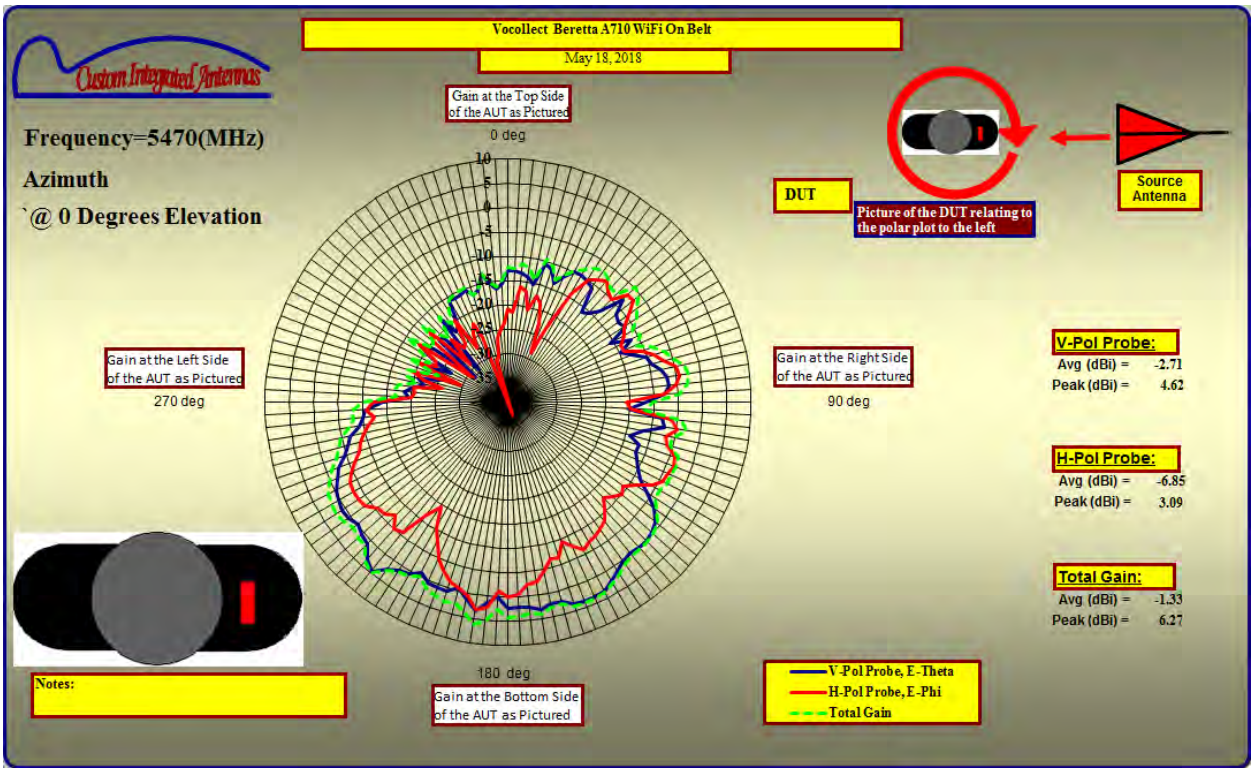
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

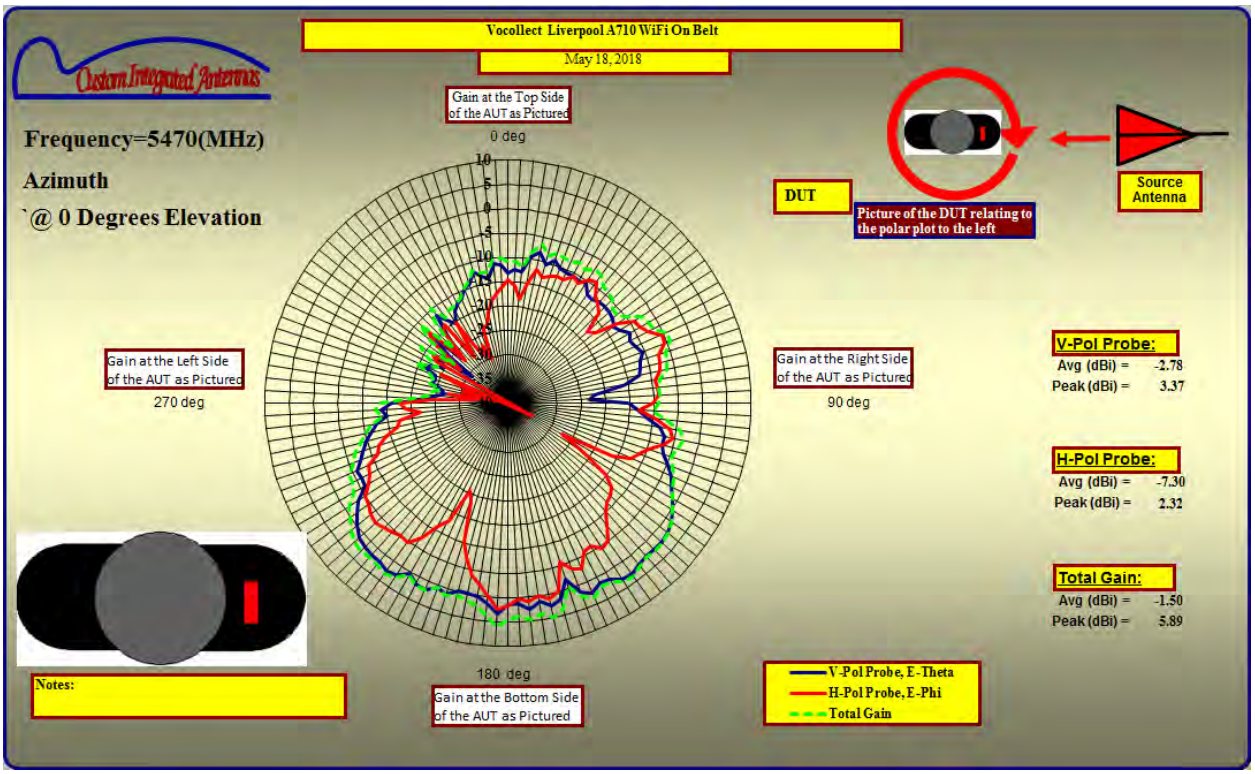
3.4.2 On Belt





Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

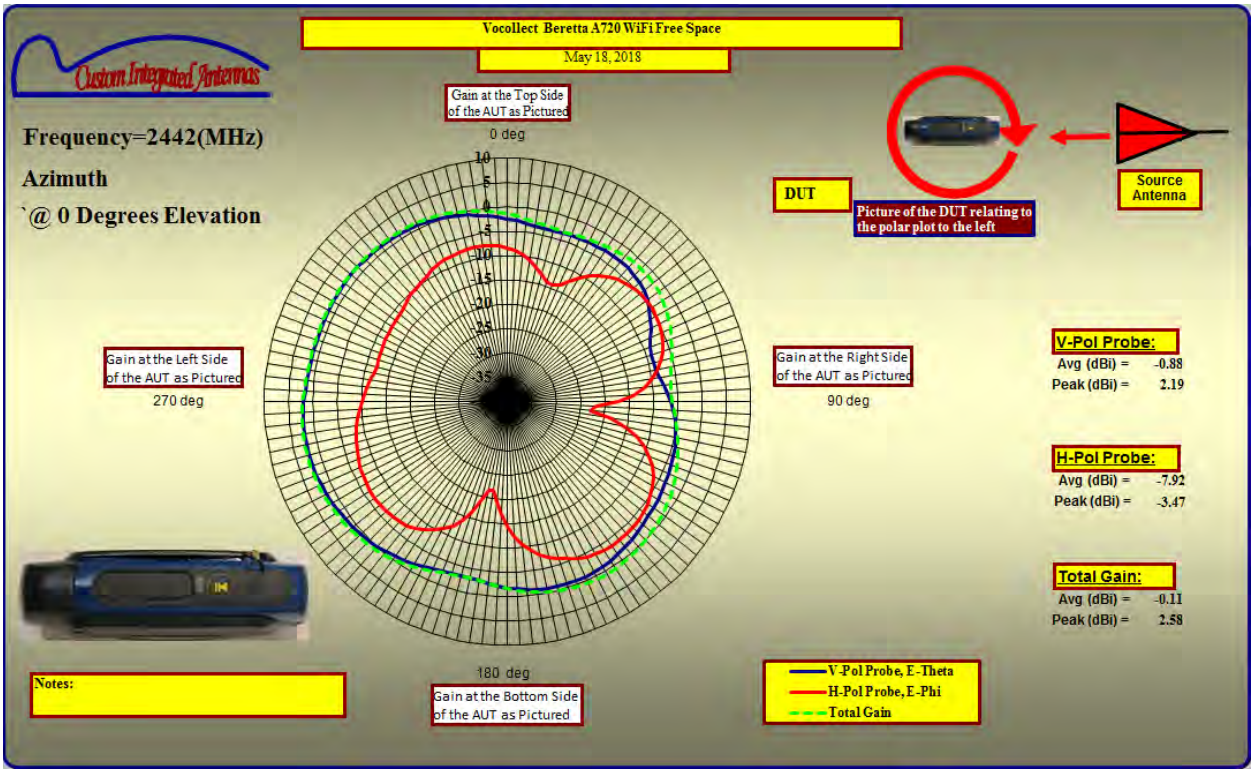


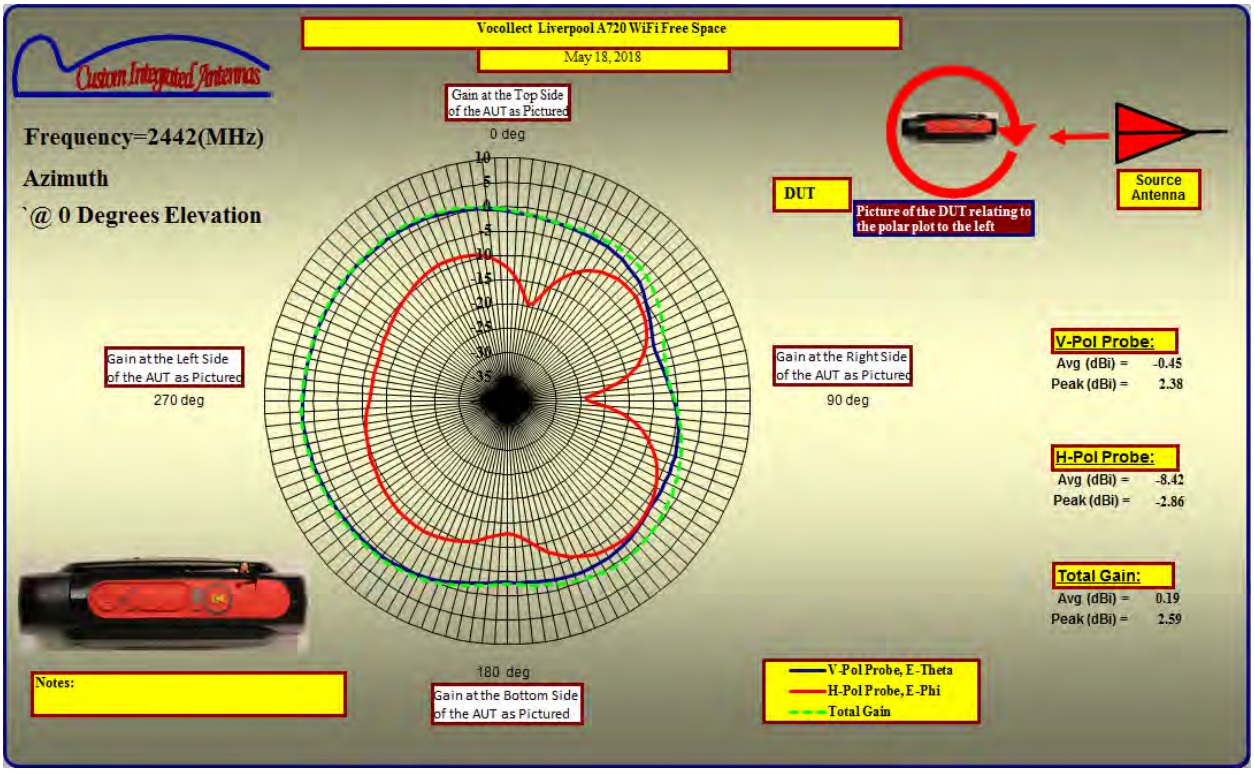


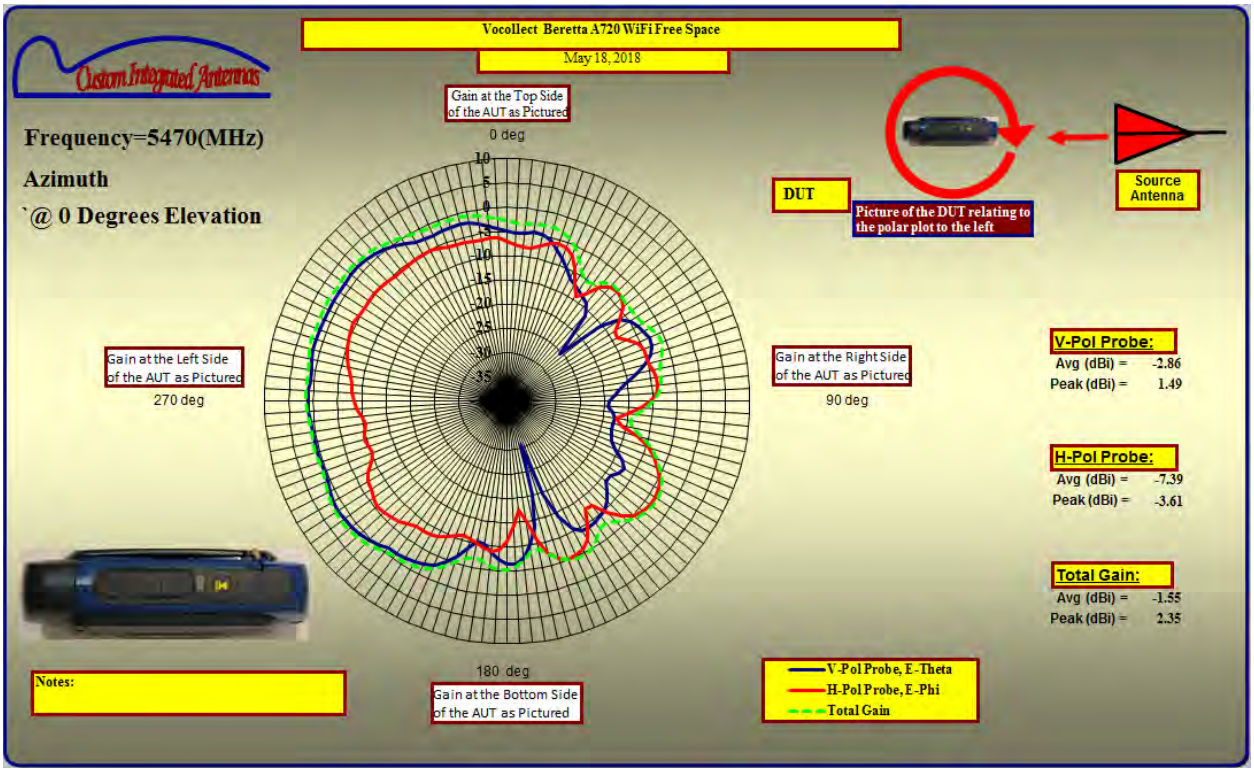
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

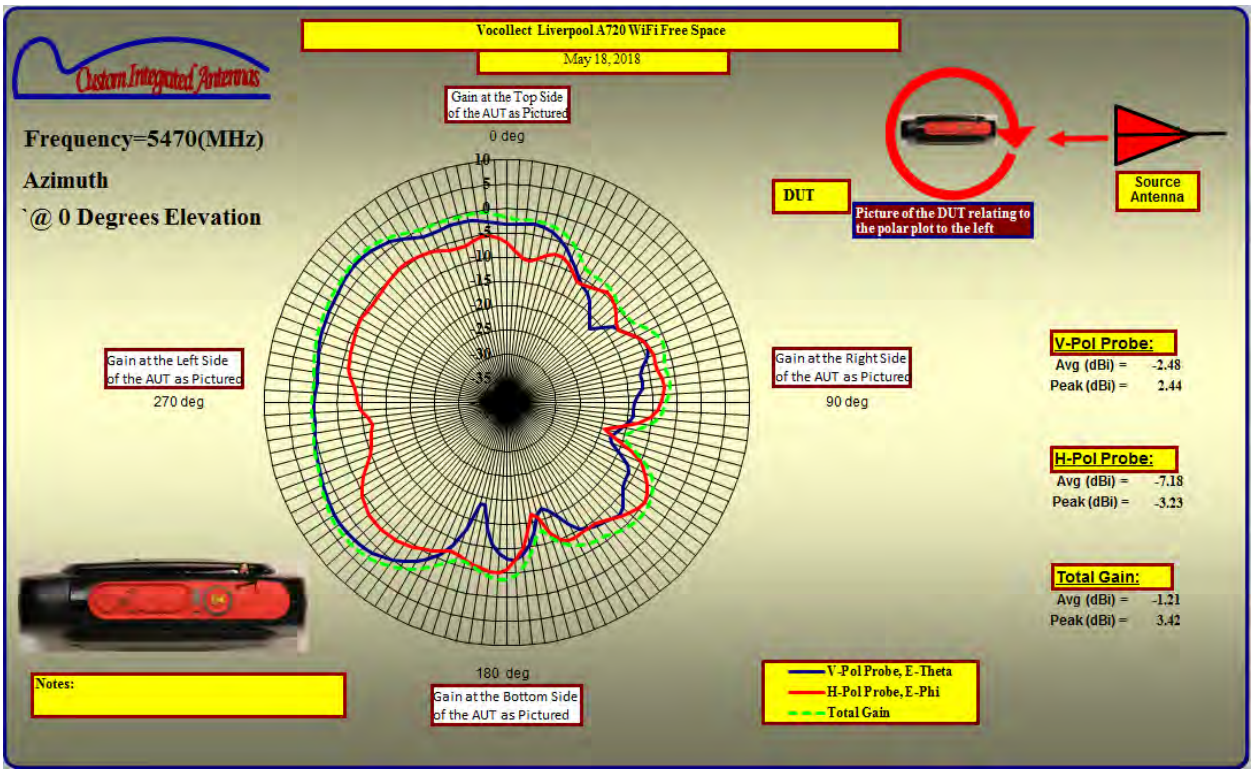
3.5 A720 WiFi Comparison

3.5.1 Free Space



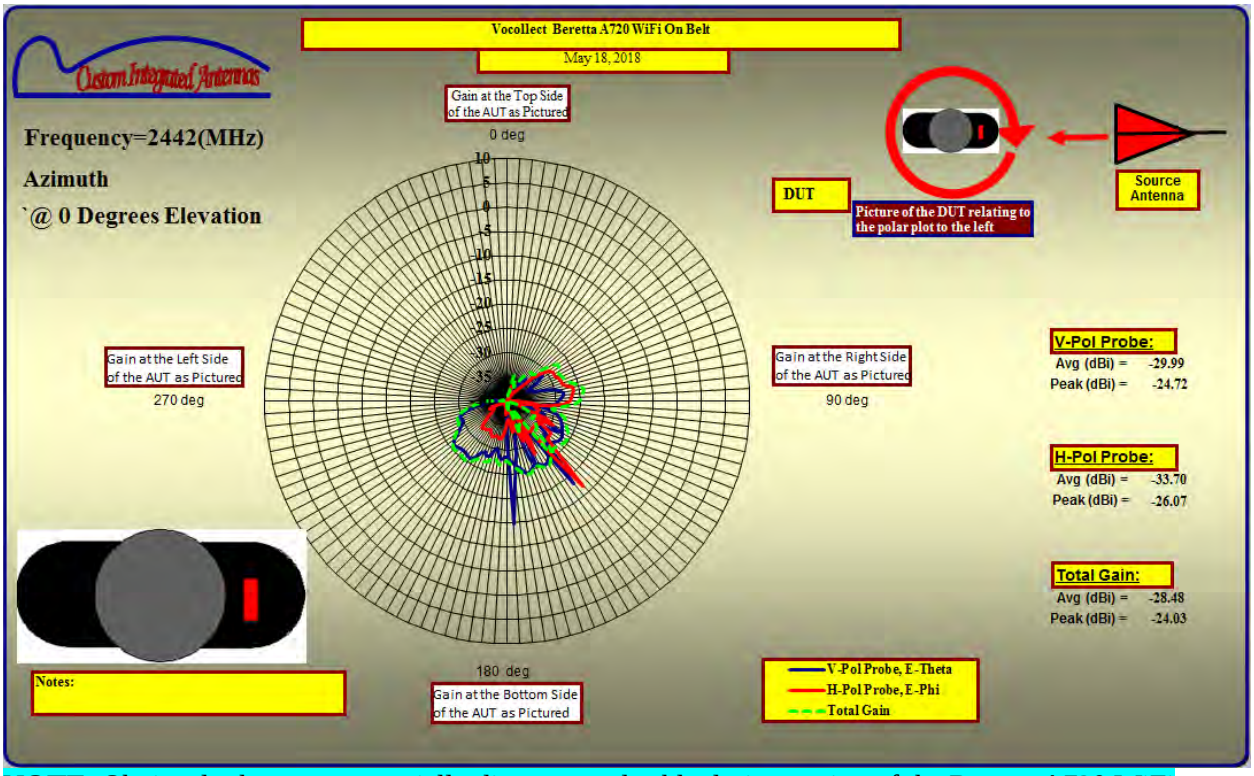




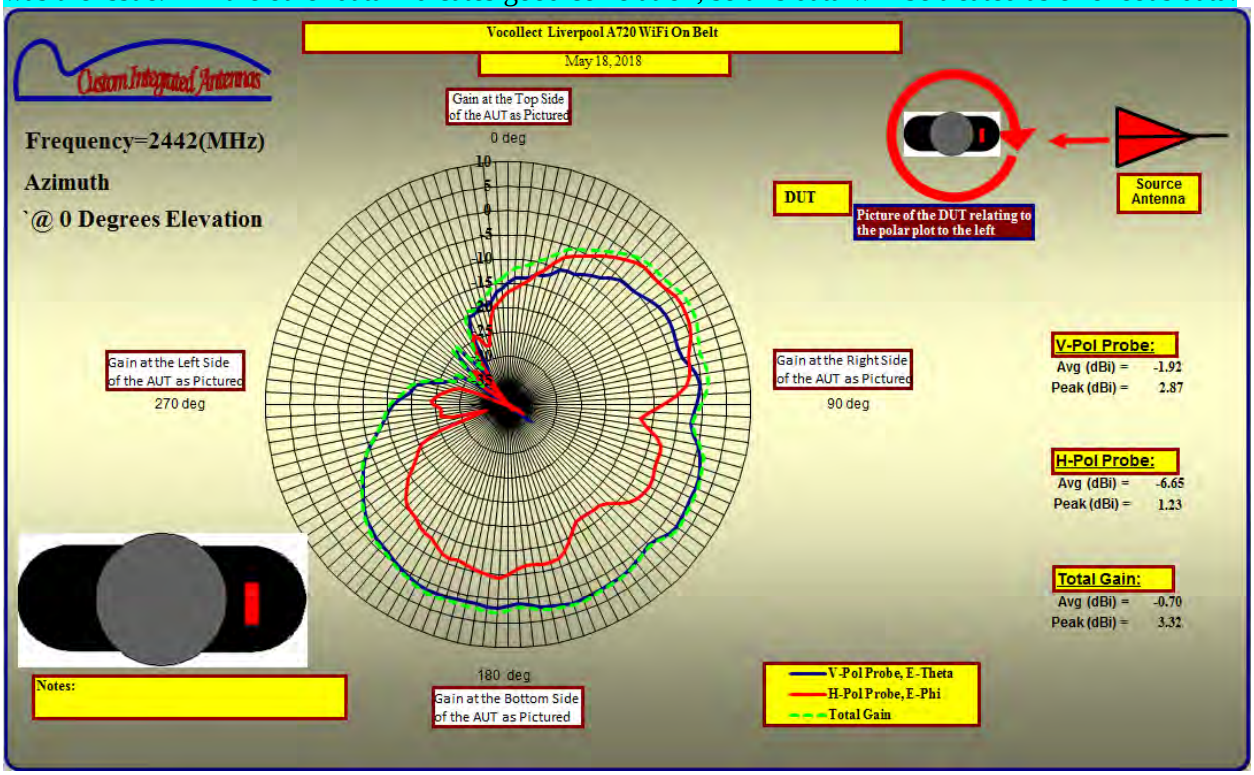


Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

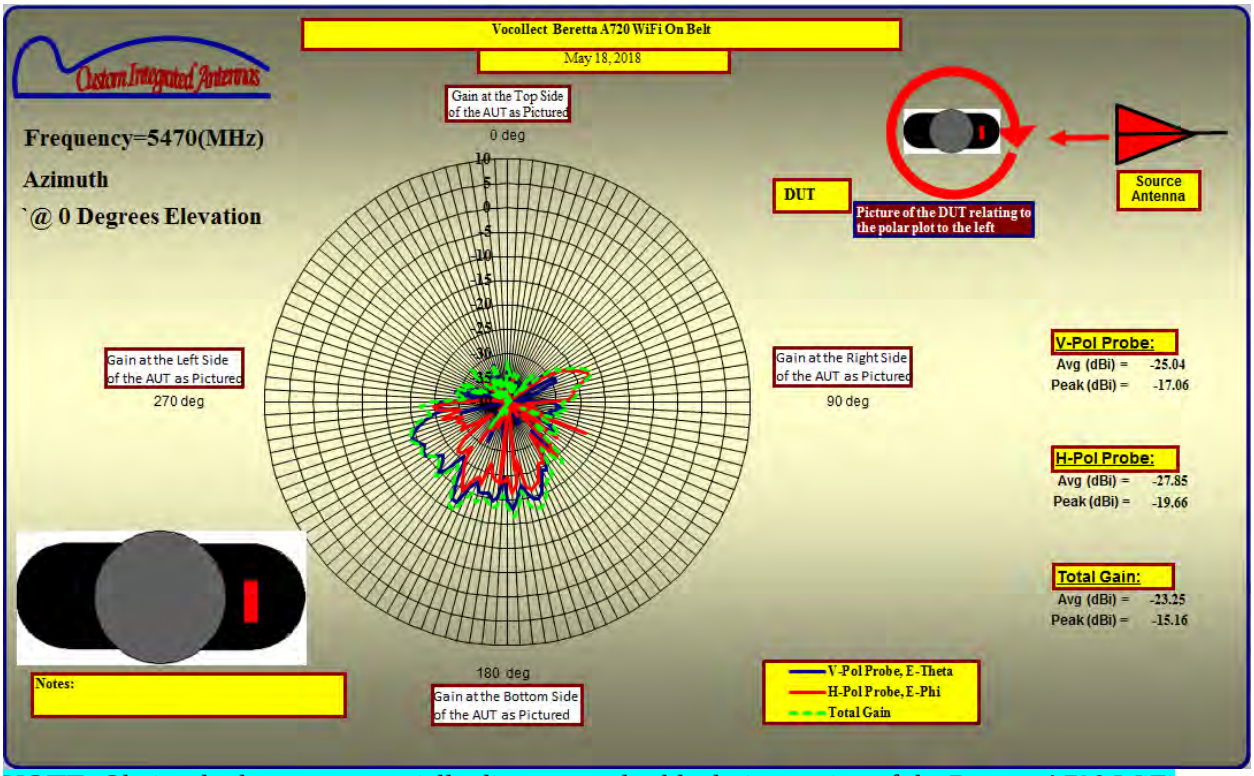
3.5.2 On Belt



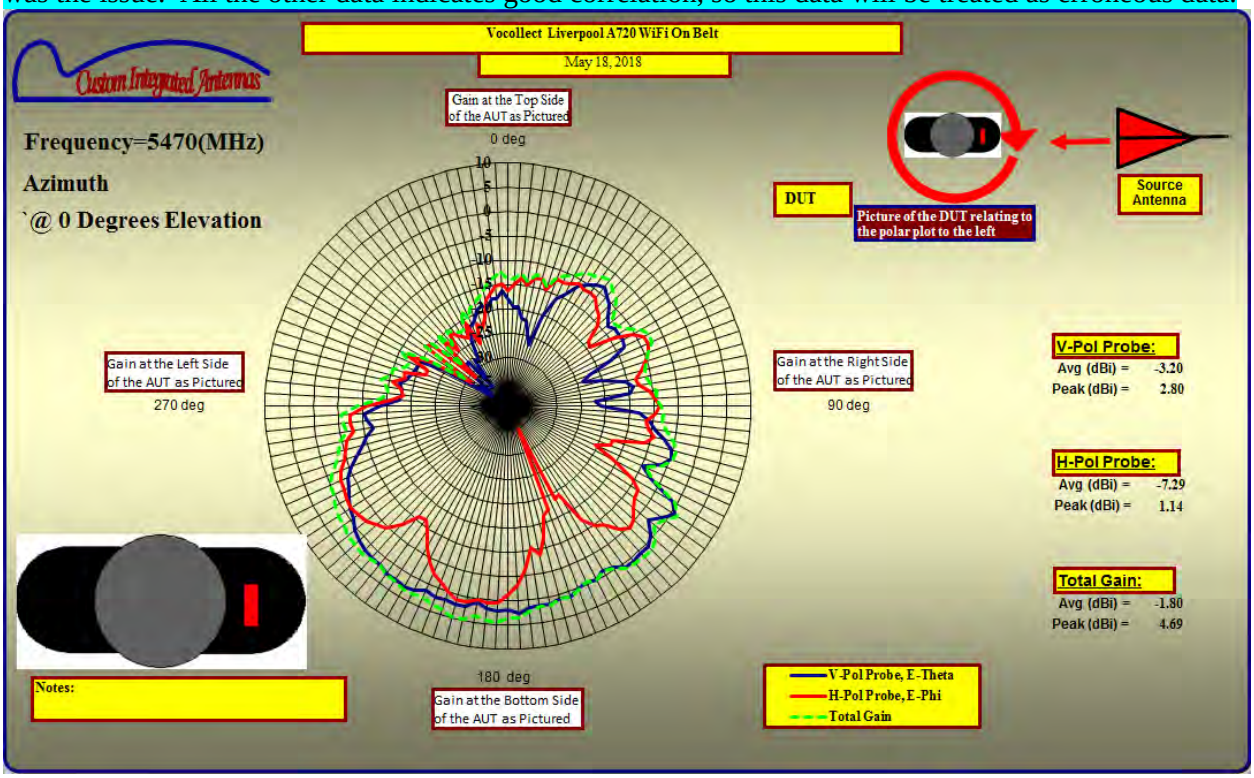
NOTE: Obviously there was a partially disconnected cable during testing of the Beretta A720 WiFi Antenna. Since I was the human test subject I could not monitor the output in real time and this was not caught while still at the lab. In light of all the other data being consistent, it is apparent the connection was the issue. All the other data indicates good correlation, so this data will be treated as erroneous data.



Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643



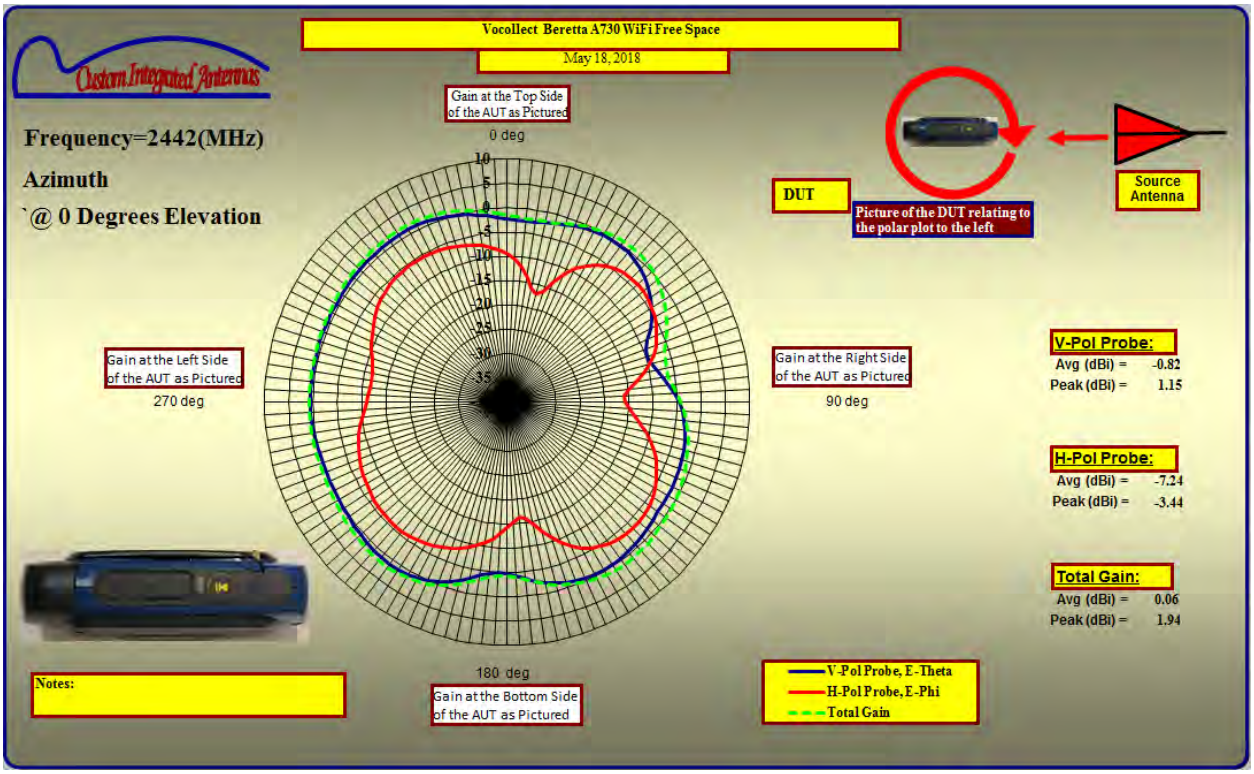
NOTE: Obviously there was a partially disconnected cable during testing of the Beretta A720 WiFi Antenna. Since I was the human test subject I could not monitor the output in real time and this was not caught while still at the lab. In light of all the other data being consistent, it is apparent the connection was the issue. All the other data indicates good correlation, so this data will be treated as erroneous data.

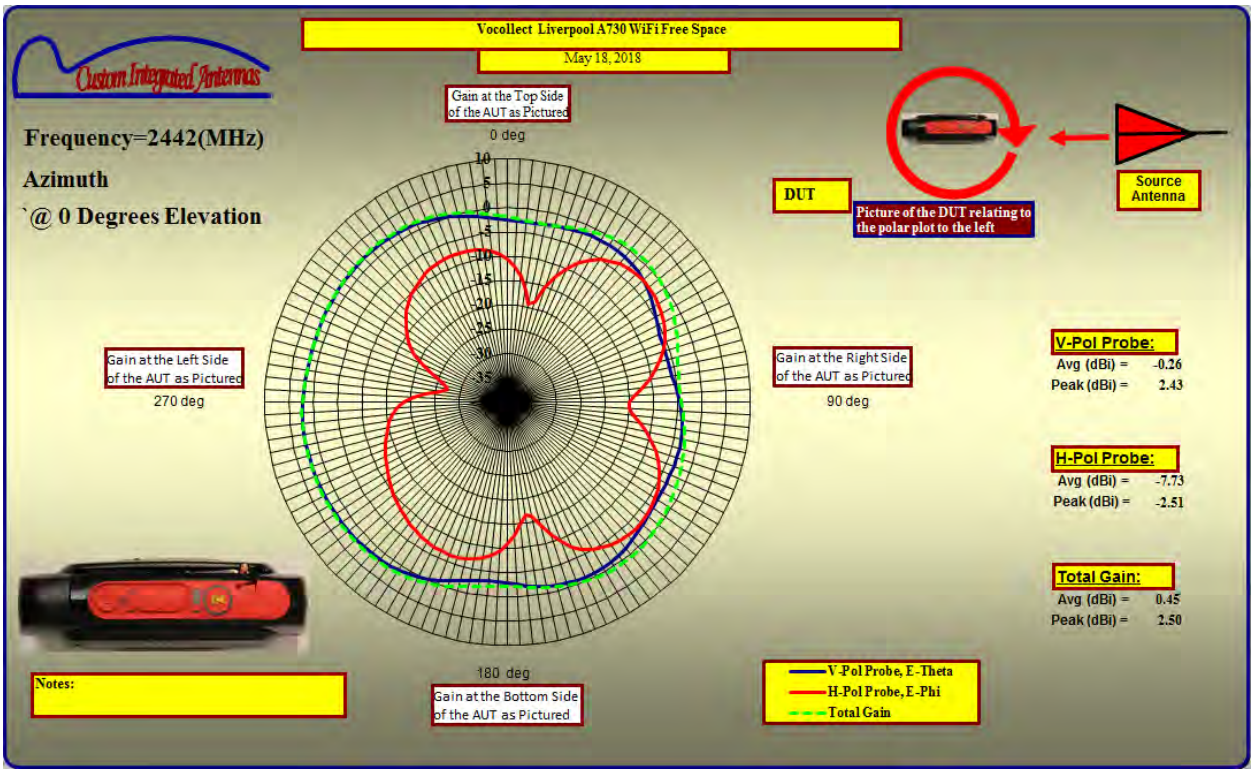


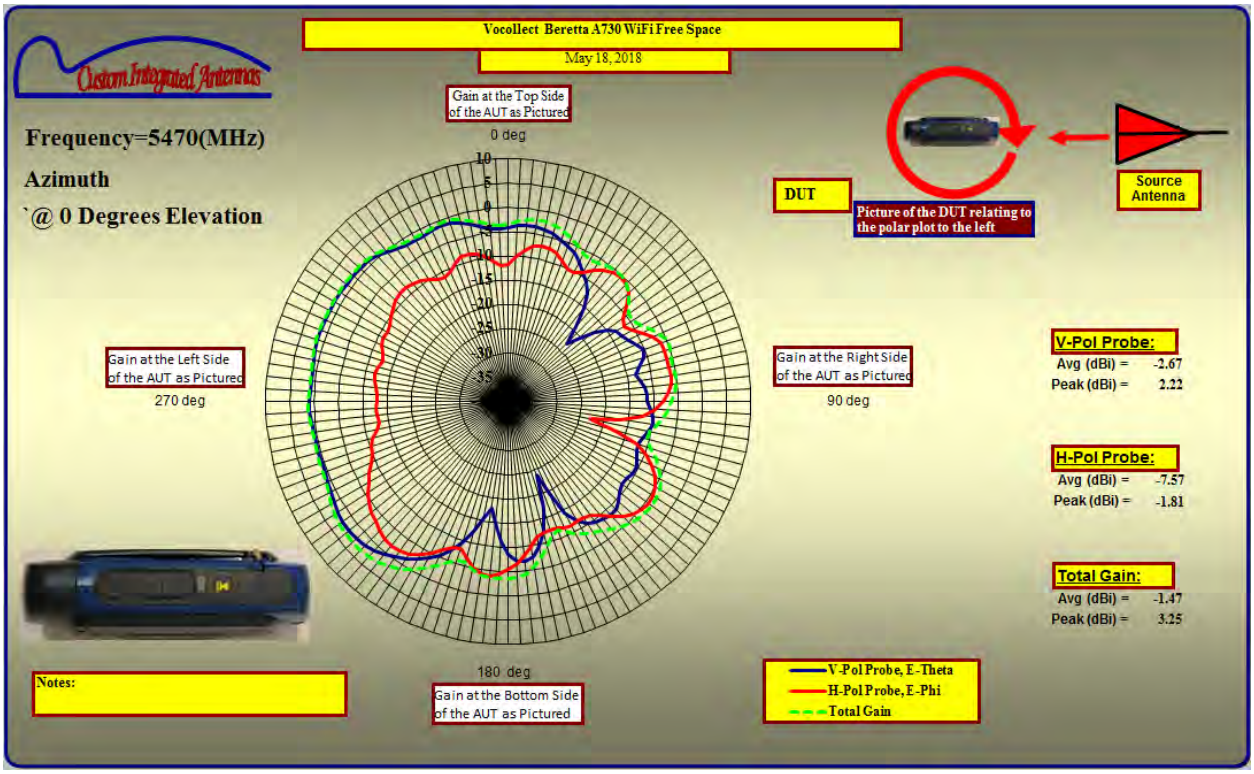
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

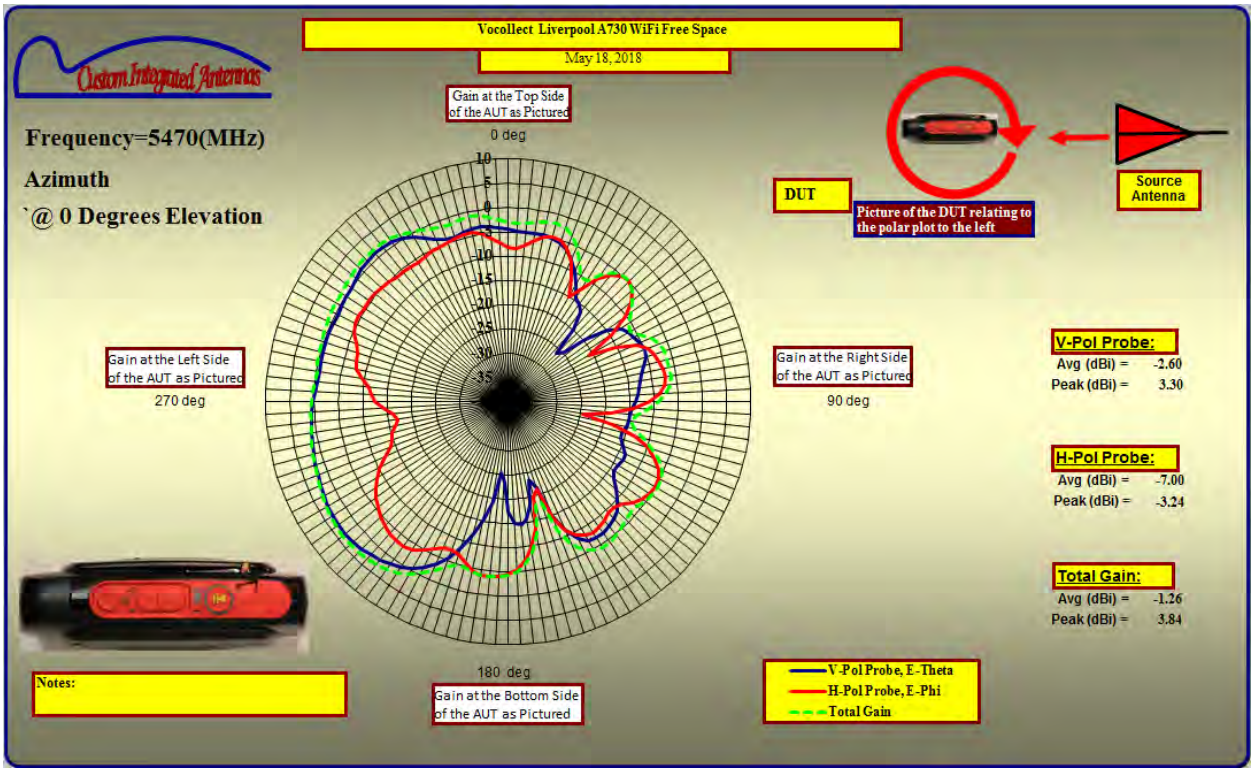
3.6 A730 WiFi Comparison

3.6.1 Free Space



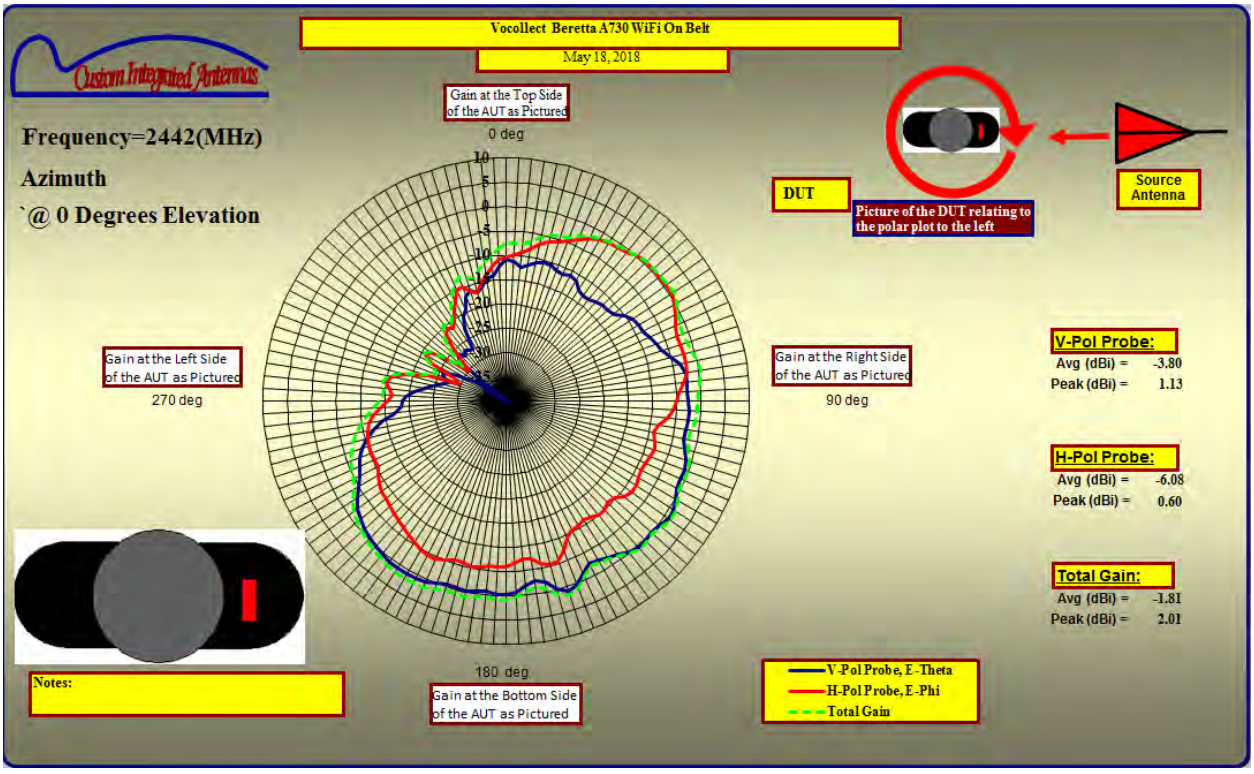


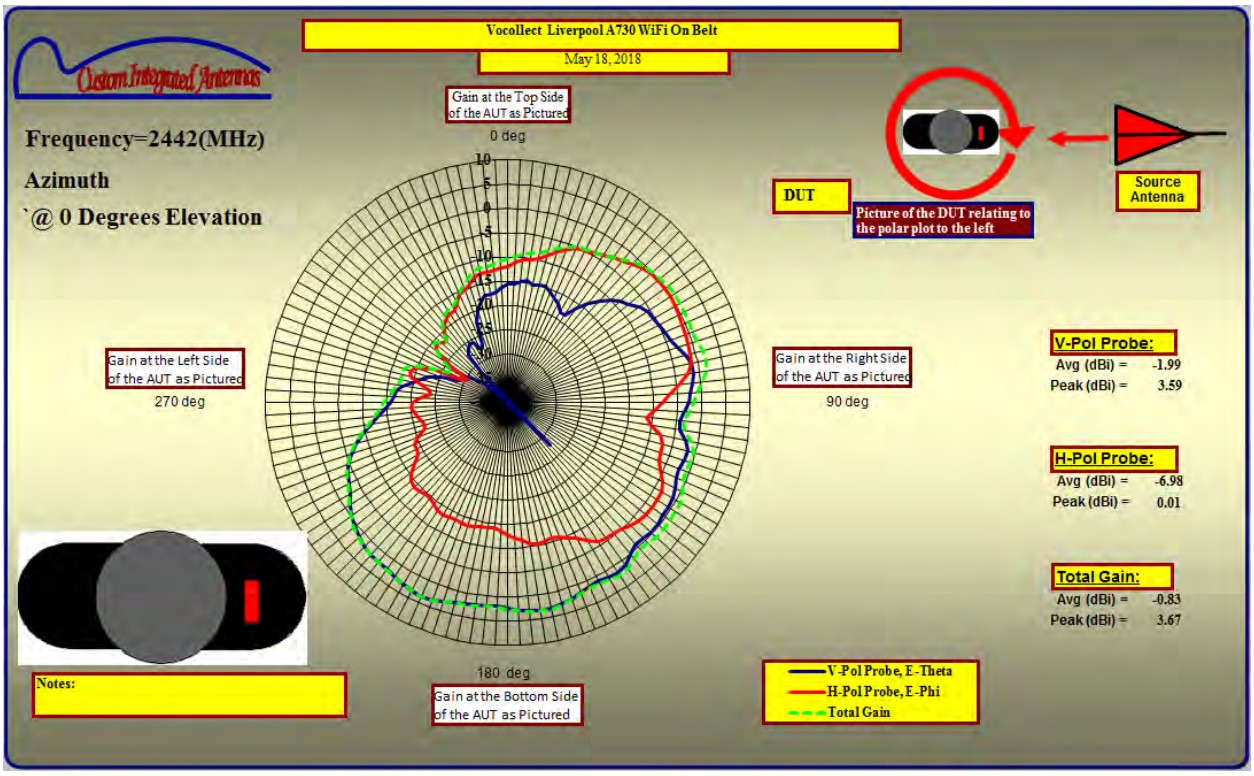


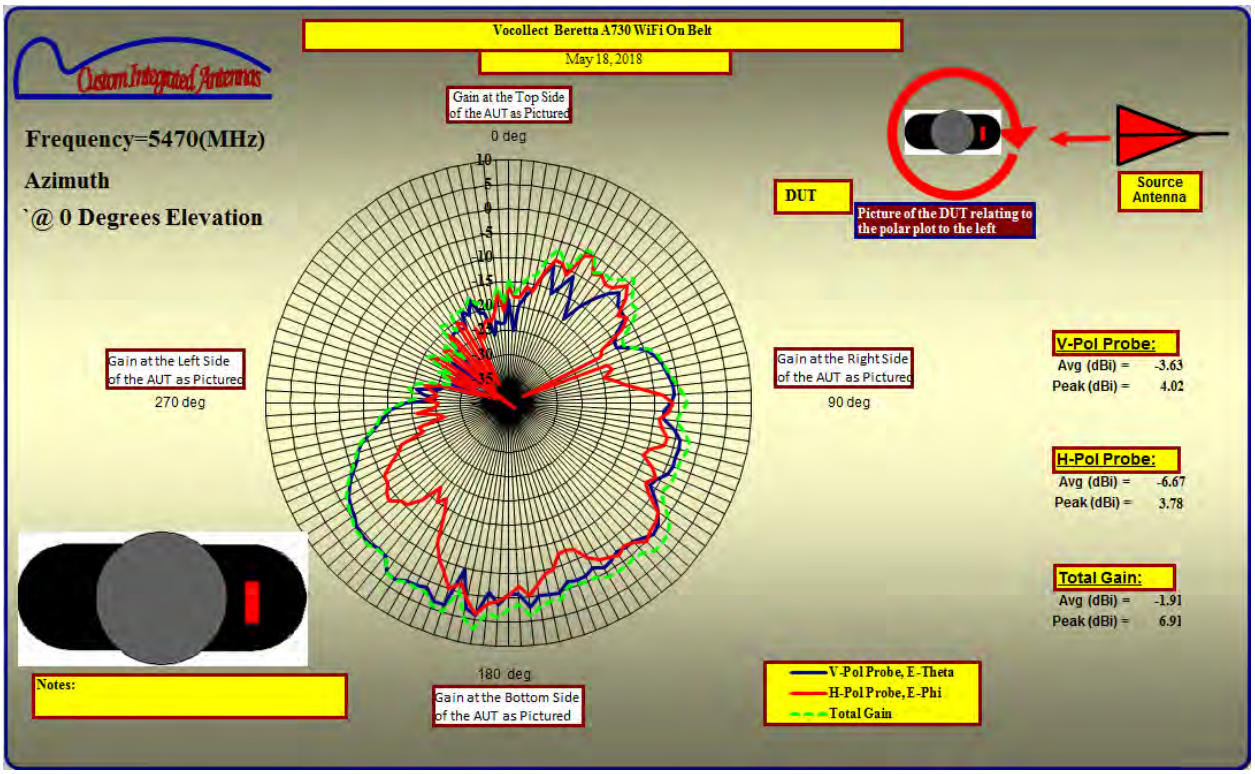


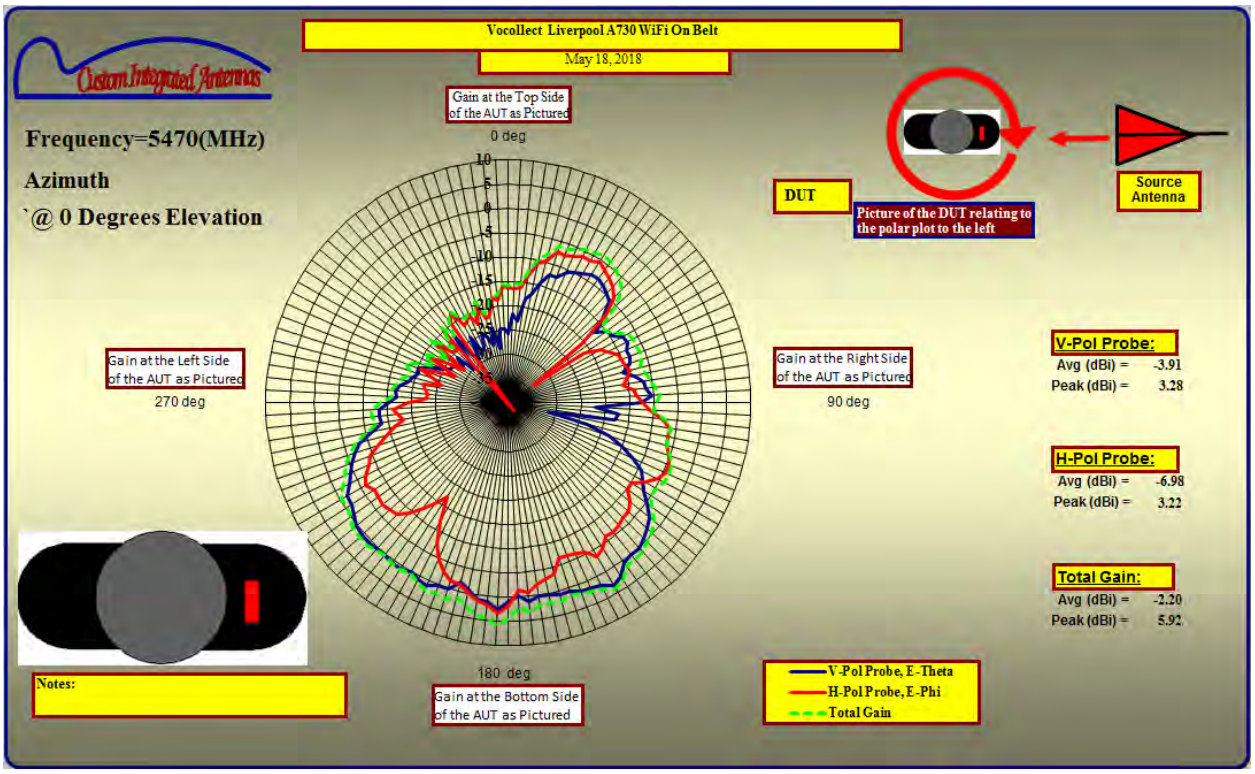
Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

3.6.2 On Belt


Vocollect Beretta A730 WiFi On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
DUT
Picture of the DUT relating to the polar plot to the left
Source Antenna
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
180 deg
Gain at the Bottom Side of the AUT as Pictured
V-Pol Probe:
Avg (dBi) = -3.80
Peak (dBi) = 1.13
H-Pol Probe:
Avg (dBi) = -6.08
Peak (dBi) = 0.60
Total Gain:
Avg (dBi) = -1.81
Peak (dBi) = 2.01
Notes:
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain


Vocollect Liverpool A730 WiFi On Belt
May 18, 2018
Frequency=2442(MHz)
Azimuth
`@ 0 Degrees Elevation
Gain at the Top Side of the AUT as Pictured
0 deg
DUT
Picture of the DUT relating to the polar plot to the left
Source Antenna
Gain at the Left Side of the AUT as Pictured
270 deg
Gain at the Right Side of the AUT as Pictured
90 deg
180 deg
Gain at the Bottom Side of the AUT as Pictured
V-Pol Probe:
Avg (dBi) = -1.99
Peak (dBi) = 3.59
H-Pol Probe:
Avg (dBi) = -6.98
Peak (dBi) = 0.01
Total Gain:
Avg (dBi) = -0.83
Peak (dBi) = 3.67
Notes:
V-Pol Probe, E-Theta
H-Pol Probe, E-Phi
Total Gain





Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265
Tel: (512) 638-2643

4 Tabular Data

A710 Bluetooth in Free Space

Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A710 Bluetooth Free Space	Liverpool A710 Bluetooth Free Space		Beretta A710 Bluetooth Free Space	Liverpool A710 Bluetooth Free Space		Beretta A710 Bluetooth Free Space	Liverpool A710 Bluetooth Free Space
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-5.81	-7.07	2.400	26.53%	20.93%	2.400	0.17	-0.33
2.412	-5.81	-6.97	2.412	26.04%	21.55%	2.412	0.25	-0.26
2.437	-5.72	-6.86	2.437	25.48%	21.98%	2.437	0.91	-0.49
2.442	-5.73	-6.83	2.442	25.23%	22.05%	2.442	1.01	-0.43
2.462	-5.99	-7.15	2.462	23.08%	20.03%	2.462	0.90	-1.34
2.484	-6.16	-7.34	2.484	21.97%	18.54%	2.484	0.71	-2.25
2.500	-6.33	-7.58	2.500	21.17%	17.22%	2.500	0.49	-2.89

A720 Bluetooth in Free Space

Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A720 Bluetooth Free Space	Liverpool A720 Bluetooth Free Space		Beretta A720 Bluetooth Free Space	Liverpool A720 Bluetooth Free Space		Beretta A720 Bluetooth Free Space	Liverpool A720 Bluetooth Free Space
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-7.83	-7.17	2.400	22.61%	20.13%	2.400	-0.83	-3.47
2.412	-7.59	-6.97	2.412	23.98%	20.89%	2.412	-0.43	-3.26
2.437	-7.16	-6.71	2.437	26.04%	21.75%	2.437	0.13	-3.20
2.442	-7.14	-6.64	2.442	26.07%	21.98%	2.442	0.16	-3.02
2.462	-7.05	-6.69	2.462	25.84%	21.30%	2.462	0.06	-2.87
2.484	-6.98	-6.54	2.484	25.07%	21.67%	2.484	-0.06	-2.52
2.500	-7.00	-6.49	2.500	24.22%	21.70%	2.500	-0.39	-2.49

A730 Bluetooth in Free Space

Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A730 Bluetooth Free Space	Liverpool A730 Bluetooth Free Space		Beretta A730 Bluetooth Free Space	Liverpool A730 Bluetooth Free Space		Beretta A730 Bluetooth Free Space	Liverpool A730 Bluetooth Free Space
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-6.42	-6.78	2.400	26.65%	19.90%	2.400	-0.22	-2.70
2.412	-6.14	-6.73	2.412	28.48%	20.01%	2.412	0.04	-2.83
2.437	-5.77	-6.83	2.437	30.79%	19.72%	2.437	-0.10	-2.74
2.442	-5.71	-6.80	2.442	31.09%	19.80%	2.442	-0.15	-2.77
2.462	-5.77	-7.06	2.462	30.07%	18.65%	2.462	0.09	-2.76
2.484	-5.97	-7.03	2.484	28.36%	18.82%	2.484	-0.06	-2.44
2.500	-6.13	-6.96	2.500	27.21%	18.98%	2.500	-0.24	-2.52

A710 WiFi in Free Space								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A710 WiFi Free Space	Liverpool A710 WiFi Free Space		Beretta A710 WiFi Free Space	Liverpool A710 WiFi Free Space		Beretta A710 WiFi Free Space	Liverpool A710 WiFi Free Space
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-3.36	-3.00	2.400	67.39%	70.06%	2.400	2.44	2.83
2.412	-3.37	-2.95	2.412	68.52%	70.82%	2.412	2.69	2.84
2.437	-3.39	-2.92	2.437	70.63%	71.88%	2.437	3.06	2.84
2.442	-3.34	-2.88	2.442	71.70%	72.70%	2.442	3.13	2.93
2.462	-3.59	-3.17	2.462	69.02%	68.93%	2.462	3.15	2.87
2.484	-3.69	-3.28	2.484	68.98%	68.51%	2.484	3.28	3.02
2.500	-3.78	-3.38	2.500	68.72%	68.04%	2.500	3.20	2.97
4.900	-3.15	-3.58	4.900	63.53%	60.02%	4.900	2.91	2.70
4.975	-2.97	-3.30	4.975	68.05%	65.98%	4.975	3.08	3.33
5.150	-3.14	-3.17	5.150	71.78%	70.24%	5.150	3.79	4.30
5.260	-3.10	-3.06	5.260	71.40%	70.27%	5.260	3.84	4.25
5.470	-3.07	-3.10	5.470	74.23%	73.73%	5.470	5.04	4.90
5.650	-3.19	-3.16	5.650	72.73%	74.07%	5.650	4.54	5.13
5.785	-2.64	-2.96	5.785	81.33%	79.17%	5.785	5.42	5.29
5.875	-2.86	-3.14	5.875	77.44%	75.96%	5.875	4.79	5.12

A720 WiFi in Free Space								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A720 WiFi Free Space	Liverpool A720 WiFi Free Space		Beretta A720 WiFi Free Space	Liverpool A720 WiFi Free Space		Beretta A720 WiFi Free Space	Liverpool A720 WiFi Free Space
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-3.00	-3.27	2.400	68.79%	69.34%	2.400	-0.83	2.51
2.412	-2.98	-3.20	2.412	69.51%	70.66%	2.412	-0.43	2.68
2.437	-2.98	-3.12	2.437	70.75%	72.81%	2.437	0.13	2.79
2.442	-2.95	-3.05	2.442	71.40%	73.93%	2.442	0.16	2.92
2.462	-3.20	-3.27	2.462	68.25%	70.96%	2.462	0.06	2.93
2.484	-3.31	-3.35	2.484	67.36%	70.92%	2.484	-0.06	3.20
2.500	-3.37	-3.44	2.500	67.06%	70.64%	2.500	-0.39	3.12
4.900	-3.62	-3.82	4.900	59.55%	59.70%	4.900	-3.09	3.02
4.975	-3.40	-3.50	4.975	64.20%	65.46%	4.975	-3.02	3.37
5.150	-3.24	-3.29	5.150	69.28%	70.53%	5.150	-2.08	4.19
5.260	-3.06	-3.18	5.260	71.13%	71.29%	5.260	-2.28	4.35
5.470	-3.18	-3.09	5.470	71.88%	74.97%	5.470	-0.65	4.96
5.650	-3.42	-3.22	5.650	69.54%	74.34%	5.650	-0.86	5.17
5.785	-3.04	-2.99	5.785	78.42%	79.20%	5.785	-0.48	4.83
5.875	-3.41	-3.10	5.875	74.10%	76.18%	5.875	-0.24	5.07

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

A730 WiFi in Free Space								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A730 WiFi Free Space	Liverpool A730 WiFi Free Space		Beretta A730 WiFi Free Space	Liverpool A730 WiFi Free Space		Beretta A730 WiFi Free Space	Liverpool A730 WiFi Free Space
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-2.83	-3.24	2.400	70.51%	70.10%	2.400	2.96	2.40
2.412	-2.83	-3.22	2.412	70.88%	71.06%	2.412	2.97	2.54
2.437	-2.88	-3.16	2.437	71.37%	73.25%	2.437	3.17	2.76
2.442	-2.84	-3.13	2.442	72.16%	74.04%	2.442	3.29	2.90
2.462	-3.12	-3.42	2.462	68.97%	70.57%	2.462	2.99	2.75
2.484	-3.22	-3.52	2.484	69.22%	70.32%	2.484	2.91	2.79
2.500	-3.32	-3.65	2.500	69.54%	69.25%	2.500	2.93	2.62
4.900	-3.79	-4.01	4.900	58.56%	56.83%	4.900	3.28	2.63
4.975	-3.46	-3.61	4.975	64.05%	63.79%	4.975	3.28	3.42
5.150	-3.26	-3.31	5.150	68.56%	70.51%	5.150	4.04	4.71
5.260	-3.20	-3.19	5.260	69.01%	71.44%	5.260	4.63	4.42
5.470	-3.17	-3.16	5.470	72.00%	73.73%	5.470	5.44	4.87
5.650	-3.41	-3.25	5.650	68.92%	72.06%	5.650	4.83	4.42
5.785	-2.97	-2.99	5.785	76.00%	75.96%	5.785	5.45	5.00
5.875	-3.16	-3.22	5.875	73.76%	72.67%	5.875	5.45	5.12

A710 Bluetooth On Belt								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A710 Bluetooth On Belt	Liverpool A710 Bluetooth On Belt		Beretta A710 Bluetooth On Belt	Liverpool A710 Bluetooth On Belt		Beretta A710 Bluetooth On Belt	Liverpool A710 Bluetooth On Belt
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-10.98	-13.20	2.400	12.99%	9.27%	2.400	-1.28	-3.49
2.412	-10.90	-12.90	2.412	13.30%	9.87%	2.412	-1.25	-3.07
2.437	-10.65	-12.04	2.437	14.25%	11.89%	2.437	-0.55	-2.10
2.442	-10.66	-11.88	2.442	14.25%	12.32%	2.442	-0.36	-1.65
2.462	-10.85	-11.65	2.462	13.80%	12.79%	2.462	-0.15	-1.24
2.484	-11.04	-11.31	2.484	13.42%	13.67%	2.484	-0.35	-0.50
2.500	-11.29	-11.36	2.500	12.99%	13.60%	2.500	-0.01	-0.24

A720 Bluetooth On Belt								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A720 Bluetooth On Belt	Liverpool A720 Bluetooth On Belt		Beretta A720 Bluetooth On Belt	Liverpool A720 Bluetooth On Belt		Beretta A720 Bluetooth On Belt	Liverpool A720 Bluetooth On Belt
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-12.08	-13.20	2.400	9.75%	9.27%	2.400	-2.11	-0.83
2.412	-11.81	-12.90	2.412	10.16%	9.87%	2.412	-1.90	-0.43
2.437	-11.28	-12.04	2.437	11.05%	11.89%	2.437	-1.52	0.13
2.442	-11.21	-11.88	2.442	11.16%	12.32%	2.442	-1.39	0.16
2.462	-11.03	-11.65	2.462	11.44%	12.79%	2.462	-1.07	0.06
2.484	-10.97	-11.31	2.484	11.58%	13.67%	2.484	-0.91	-0.06
2.500	-11.05	-11.36	2.500	11.60%	13.60%	2.500	-0.89	-0.39

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

A730 Bluetooth On Belt								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A730 Bluetooth On Belt	Liverpool A730 Bluetooth On Belt		Beretta A730 Bluetooth On Belt	Liverpool A730 Bluetooth On Belt		Beretta A730 Bluetooth On Belt	Liverpool A730 Bluetooth On Belt
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-10.83	-11.55	2.400	15.78%	12.52%	2.400	3.14	-1.77
2.412	-10.58	-11.53	2.412	16.85%	12.60%	2.412	3.28	-1.97
2.437	-10.16	-11.48	2.437	18.86%	12.87%	2.437	3.33	-2.07
2.442	-10.07	-11.47	2.442	19.24%	12.89%	2.442	2.95	-2.16
2.462	-10.08	-11.83	2.462	19.12%	11.87%	2.462	2.45	-2.13
2.484	-10.20	-11.87	2.484	18.55%	11.46%	2.484	1.73	-2.14
2.500	-10.34	-11.97	2.500	18.10%	10.94%	2.500	1.19	-2.24

A710 WiFi On Belt								
Average Gain (dBi)			Efficiency (%)			Peak Gain (dBi)		
	Beretta A710 WiFi On Belt	Liverpool A710 WiFi On Belt		Beretta A710 WiFi On Belt	Liverpool A710 WiFi On Belt		Beretta A710 WiFi On Belt	Liverpool A710 WiFi On Belt
1			1			1		
Frequency (GHz)	E Total. dB	E Total. dB	Frequency (GHz)	Efficiency	Efficiency	Frequency (GHz)	E Total. dB	E Total. dB
2.400	-5.97	-5.82	2.400	49.48%	51.53%	2.400	4.73	4.29
2.412	-5.92	-5.75	2.412	49.64%	52.18%	2.412	4.44	4.27
2.437	-5.86	-5.57	2.437	50.29%	54.11%	2.437	4.32	4.69
2.442	-5.85	-5.53	2.442	50.54%	54.49%	2.442	4.32	4.65
2.462	-6.13	-5.74	2.462	48.29%	51.91%	2.462	4.33	4.30
2.484	-6.25	-5.85	2.484	48.41%	51.11%	2.484	4.62	4.26
2.500	-6.37	-6.00	2.500	47.94%	49.63%	2.500	4.89	4.00
4.900	-8.52	-10.19	4.900	32.16%	23.03%	4.900	4.57	3.32
4.975	-8.14	-10.10	4.975	34.65%	23.06%	4.975	4.57	3.05
5.150	-7.44	-8.53	5.150	40.86%	33.45%	5.150	5.84	4.69
5.260	-6.95	-7.70	5.260	46.07%	40.35%	5.260	6.22	5.59
5.470	-6.11	-6.78	5.470	54.29%	49.17%	5.470	6.50	6.11
5.650	-5.91	-6.66	5.650	54.49%	48.73%	5.650	6.81	6.93
5.785	-5.38	-6.41	5.785	59.51%	50.71%	5.785	6.90	7.28
5.875	-5.70	-6.48	5.875	56.19%	49.76%	5.875	6.53	7.31

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

A720 WiFi On Belt

Average Gain (dBi)

	Beretta A720 WiFi On Belt	Liverpool A720 WiFi On Belt
1	Flawed Data	
Frequency (GHz)	E Total. dB	E Total. dB
2.400	-33.02	-6.08
2.412	-32.92	-6.03
2.437	-32.69	-5.90
2.442	-32.77	-5.86
2.462	-32.74	-6.04
2.484	-33.37	-5.95
2.500	-33.54	-5.98
4.900	-26.61	-8.47
4.975	-26.61	-7.96
5.150	-28.26	-7.32
5.260	-28.72	-7.25
5.470	-28.45	-6.98
5.650	-26.22	-7.08
5.785	-24.32	-7.02
5.875	-23.93	-7.14

Efficiency (%)

	Beretta A720 WiFi On Belt	Liverpool A720 WiFi On Belt
1	Flawed Data	
Frequency (GHz)	Efficiency	Efficiency
2.400	0.10%	54.05%
2.412	0.10%	54.73%
2.437	0.10%	56.95%
2.442	0.10%	57.45%
2.462	0.10%	55.40%
2.484	0.09%	55.83%
2.500	0.09%	55.25%
4.900	0.50%	35.08%
4.975	0.50%	38.17%
5.150	0.33%	44.42%
5.260	0.30%	46.76%
5.470	0.32%	49.28%
5.650	0.50%	46.80%
5.785	0.72%	47.41%
5.875	0.81%	45.28%

Peak Gain (dBi)

	Beretta A720 WiFi On Belt	Liverpool A720 WiFi On Belt
1	Flawed Data	
Frequency (GHz)	E Total. dB	E Total. dB
2.400	-21.78	4.70
2.412	-22.02	4.39
2.437	-21.82	4.30
2.442	-21.01	4.12
2.462	-20.87	3.92
2.484	-21.87	4.06
2.500	-22.55	4.08
4.900	-14.01	6.23
4.975	-14.32	6.22
5.150	-14.97	6.02
5.260	-16.40	6.32
5.470	-15.16	5.46
5.650	-13.80	5.74
5.785	-12.52	6.39
5.875	-11.84	6.27

A730 WiFi On Belt

Average Gain (dBi)

	Beretta A730 WiFi On Belt	Liverpool A730 WiFi On Belt
1		
Frequency (GHz)	E Total. dB	E Total. dB
2.400	-6.09	-5.85
2.412	-6.14	-5.76
2.437	-6.11	-5.56
2.442	-6.04	-5.53
2.462	-6.19	-5.78
2.484	-6.19	-5.94
2.500	-6.30	-6.21
4.900	-8.34	-7.61
4.975	-7.99	-7.34
5.150	-7.73	-7.52
5.260	-7.32	-7.65
5.470	-6.80	-7.66
5.650	-6.75	-7.80
5.785	-6.20	-7.17
5.875	-6.30	-7.02

Efficiency (%)

	Beretta A730 WiFi On Belt	Liverpool A730 WiFi On Belt
1		
Frequency (GHz)	Efficiency	Efficiency
2.400	46.46%	52.13%
2.412	46.65%	52.79%
2.437	48.24%	54.61%
2.442	49.11%	54.89%
2.462	47.96%	51.62%
2.484	48.44%	50.15%
2.500	47.76%	47.94%
4.900	33.62%	39.16%
4.975	36.61%	42.23%
5.150	39.72%	43.30%
5.260	43.76%	42.63%
5.470	50.79%	43.17%
5.650	50.30%	39.50%
5.785	54.38%	42.85%
5.875	51.26%	43.15%

Peak Gain (dBi)

	Beretta A730 WiFi On Belt	Liverpool A730 WiFi On Belt
1		
Frequency (GHz)	E Total. dB	E Total. dB
2.400	3.27	4.19
2.412	3.53	4.49
2.437	3.72	4.34
2.442	3.60	4.21
2.462	3.78	3.79
2.484	3.89	3.36
2.500	3.89	3.18
4.900	6.18	5.37
4.975	5.78	5.56
5.150	6.29	5.88
5.260	7.24	6.38
5.470	8.24	6.27
5.650	8.27	5.73
5.785	8.02	4.95
5.875	6.69	5.26

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643

5 Conclusions

Although care was taken to make each DUT look exactly the same in the chamber, very small variations in positioning, test cable lengths, test cable types, screw torque, internal coaxial and flex cable routing, etc., can all cause minor fluctuations in antenna performance. For "On Belt" measurements, the position of the DUT on the belt (side, front, back, low on the hip, high on the waist, … of the human test subject) and how the human test subject stands, holds their arms, etc. all impact the measurement as well. In short the human test subject creates a large moving absorber in close proximity to the antenna and variations are inevitable.

With those variations in mind, in general the WiFi and Bluetooth antennas in Liverpool exhibited less average gain than their Beretta counterparts. If the variations were random, we might see random variations in the data, but consistently Liverpool was slightly lower than Beretta. For Bluetooth, this reduction in average gain was generally on the order of 1 dB or so. For WiFi, the reduction was on the order of 0.3 dB or so.

The overall reduction in average gain for Liverpool is likely attributable to the physical changes necessary for this version of the product, i.e., component changes. One thing that stands out is the color change. It is worthy of note that darker colors tend to have higher carbon content, which leads to increased absorption of RF energy. *FYI: Carbon is used in RF absorber material in anechoic chambers for this reason.* That said, it is more likely the reduction in gain is due to physical changes to the product, rather than just the color, although the color may be a contributor as well. If the color were the primary reason for reduction then 2.4 GHz WiFi would have the same reduction as Bluetooth and that is not the case.

Overall, the updates to the product didn't do a lot of harm to the antennas and it is unlikely most customers would notice a difference in everyday use. For all practical purposes, the effort to keep the antenna performance as close to the same as Beretta as possible should be deemed a success. To expect perfection (no change) would be naive.

NOTE: Occasionally a customer may get to know specific fringe coverage locations and the new product may not communicate in these areas. In that case complaints may surface. However, in the same way in locations were communication was not possible before, it may be possible with the new product. Any time changes are made to a product, the antenna pattern changes. This is one reason why the FCC and other regulatory bodies require verification of products with significant changes.

Timothy Milam 1322 Butcher Hollow, PO Box 116, Van Lear, KY 41265 Tel: (512) 638-2643