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Calculated Radio Frequency Exposure Report

AT&T / Verizon / T-Mobile / Sprint

173.5 West Rocks Road, Norwalk, CT 06851

October 21, 2019

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1. Introduction

The purpose of this report is to investigate compliance with applicable FCC regulations for the antenna arrays to be mounted on the proposed monopole at 173.5 West Rocks Road in Norfolk, CT. The coordinates of the proposed tower are 41° 8' 36.63" N, 73° 25' 8.28" W.

AT&T, Verizon, T-Mobile, and Sprint are proposed to locate the following equipment:

- AT&T – Six (6) multi-band antennas (two per sector) to support its LTE network;
- Verizon – Nine (9) multi-band antennas (three per sector) to support its LTE and CDMA networks;
- T-Mobile – Three (3) antennas (one per sector) to support its LTE, UMTS, and GSM networks;
- Sprint – Six (6) antennas (two per sector) to support its LTE and CDMA networks.

This report considers the planned antenna configurations as provided by each operator to calculate the % MPE (Maximum Permissible Exposure) of the proposed installation.

2. FCC Guidelines for Evaluating RF Radiation Exposure Limits

In 1985, the FCC established rules to regulate radio frequency (RF) exposure from FCC licensed antenna facilities. In 1996, the FCC updated these rules, which were further amended in August 1997 by OET Bulletin 65 Edition 97-01. These new rules include Maximum Permissible Exposure (MPE) limits for transmitters operating between 300 kHz and 100 GHz. The FCC MPE limits are based upon those recommended by the National Council on Radiation Protection and Measurements (NCRP), developed by the Institute of Electrical and Electronics Engineers, Inc., (IEEE) and adopted by the American National Standards Institute (ANSI).

The FCC general population/uncontrolled limits set the maximum exposure to which most people may be subjected. General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

Public exposure to radio frequencies is regulated and enforced in units of milliwatts per square centimeter (mW/cm^2). The general population exposure limits for the various frequency ranges are defined in the attached "FCC Limits for Maximum Permissible Exposure (MPE)" in Attachment B of this report.

Higher exposure limits are permitted under the occupational/controlled exposure category, but only for persons who are exposed as a consequence of their employment and who have been made fully aware of the potential for exposure, and they must be able to exercise control over their exposure. General population/uncontrolled limits are five times more stringent than the levels that are acceptable for occupational, or radio frequency trained individuals. Attachment B contains excerpts from OET Bulletin 65 and defines the Maximum Exposure Limit.

Finally, it should be noted that the MPE limits adopted by the FCC for both general population/uncontrolled exposure and for occupational/controlled exposure incorporate a substantial margin of safety and have been established to be well below levels generally accepted as having the potential to cause adverse health effects.

3. RF Exposure Calculation Methods

The power density calculation results were generated using the following formula as outlined in FCC bulletin OET 65, and Connecticut Siting Council recommendations:

$$\text{Power Density} = \left(\frac{1.6^2 \times 1.64 \times \text{ERP}}{4\pi \times R^2}\right) \text{X Off Beam Loss}$$

Where:

EIRP = Effective Isotropic Radiated Power = 1.64 x ERP

R = Radial Distance = $\sqrt{(H^2 + V^2)}$

H = Horizontal Distance from antenna

V = Vertical Distance from radiation center of antenna

Ground reflection factor of 1.6

Off Beam Loss is determined by the selected antenna pattern

These calculations assume that the antennas are operating at 100 percent capacity and full power, and that all antenna channels are transmitting simultaneously. Obstructions (trees, buildings, etc.) that would normally attenuate the signal are not taken into account. The calculations assume even terrain in the area of study and do not consider actual terrain elevations which could attenuate the signal. As a result, the calculated power density and corresponding % MPE levels reported below are much higher than the actual levels will be from the final installation.

4. Calculation Results

Table 1 below outlines the power density information for the proposed installation. All proposed antennas are directional in nature; therefore, the majority of the RF power is focused out towards the horizon. As a result, there will be less RF power directed below the antennas relative to the horizon, and consequently lower power density levels around the base of the tower. Please refer to Attachments C, D, E, and F for the vertical patterns of the proposed AT&T, Verizon, T-Mobile, and Sprint antennas, respectively. The calculated results in Table 1 include a nominal 10 dB off-beam pattern loss to account for the lower relative gain below the antennas.

Carrier	Antenna Height (Feet)	Operating Frequency (MHz)	Number of Trans.	ERP Per Transmitter (Watts)	Power Density (mw/cm^2)	Limit	% MPE
AT&T LTE	126	739	1	3156	0.0079	0.4927	1.60%
AT&T LTE	126	763	1	3541	0.0088	0.5087	1.74%
AT&T LTE	126	1900	1	5877	0.0147	1.0000	1.47%
AT&T LTE	126	2100	1	9890	0.0247	1.0000	2.47%
AT&T LTE	126	2300	1	6443	0.0161	1.0000	1.61%
Verizon LTE	116	751	1	2183	0.0065	0.5007	1.30%
Verizon LTE	116	875	1	2450	0.0073	0.5833	1.25%
Verizon CDMA	116	875	3	474	0.0042	0.5833	0.73%
Verizon LTE	116	1900	1	4668	0.0139	1.0000	1.39%
Verizon LTE	116	2100	1	5484	0.0163	1.0000	1.63%
T-Mobile LTE	106	627	1	1578	0.0057	0.4180	1.36%
T-Mobile LTE	106	731	1	865	0.0031	0.4873	0.64%
T-Mobile GSM	106	1900	1	551	0.0020	1.0000	0.20%
T-Mobile LTE	106	1900	1	1469	0.0053	1.0000	0.53%
T-Mobile UMTS	106	2100	1	1726	0.0062	1.0000	0.62%
T-Mobile LTE	106	2100	1	1726	0.0062	1.0000	0.62%
Sprint LTE/CDMA	96	865	1	4325	0.0192	0.5767	3.33%
Sprint LTE/CDMA	96	1900	1	6923	0.0307	1.0000	3.07%
Sprint LTE	96	2500	1	2422	0.0108	1.0000	1.08%
						Total	**26.62%**

Table 1: Proposed Tower % MPE [1] [2]

[1] In the case where antenna models are not uniform across all 3 sectors for the same frequency band, the antenna model with the highest gain was used for the calculations to present a worse-case scenario.

[2] Antenna heights listed are in reference to the All Points Technology site drawings dated 10/11//2019 (Rev. 0).

5. Conclusion

The above analysis concludes that RF exposure at ground level from the proposed tower will be below the maximum power density limits as outlined by the FCC in the OET Bulletin 65 Ed. 97-01. Using the conservative calculation methods discussed herein, the highest expected percent of Maximum Permissible Exposure at ground level from the proposed installation is **26.62% of the FCC General Population/Uncontrolled limit**.

As noted previously, the calculated % MPE levels are more conservative (higher) than the actual levels will be from the finished installation.

6. Statement of Certification

I certify to the best of my knowledge that the statements in this report are true and accurate. The calculations follow guidelines set forth in FCC OET Bulletin 65 Edition 97-01, ANSI/IEEE Std. C95.1, and ANSI/IEEE Std. C95.3.

Keith Vellante

October 21, 2019

Date

Report Prepared By: Keith Vellante
Director of RF Services
C Squared Systems, LLC

Attachment A: References

OET Bulletin 65 - Edition 97-01 - August 1997 Federal Communications Commission Office of Engineering & Technology

IEEE C95.1-2005, IEEE Standard Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz IEEE-SA Standards Board

IEEE C95.3-2002 (R2008), IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz-300 GHz IEEE-SA Standards Board

Attachment B: FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure[3]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	$(900/f^2)$*	6
30-300	61.4	0.163	1.0	6
300-1500	-	-	f/300	6
1500-100,000	-	-	5	6

(B) Limits for General Population/Uncontrolled Exposure[4]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	$(180/f^2)$*	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	f/1500	30
1500-100,000	-	-	1.0	30

f = frequency in MHz * Plane-wave equivalent power density

Table 2: FCC Limits for Maximum Permissible Exposure (MPE)

[3] Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure

[4] General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure

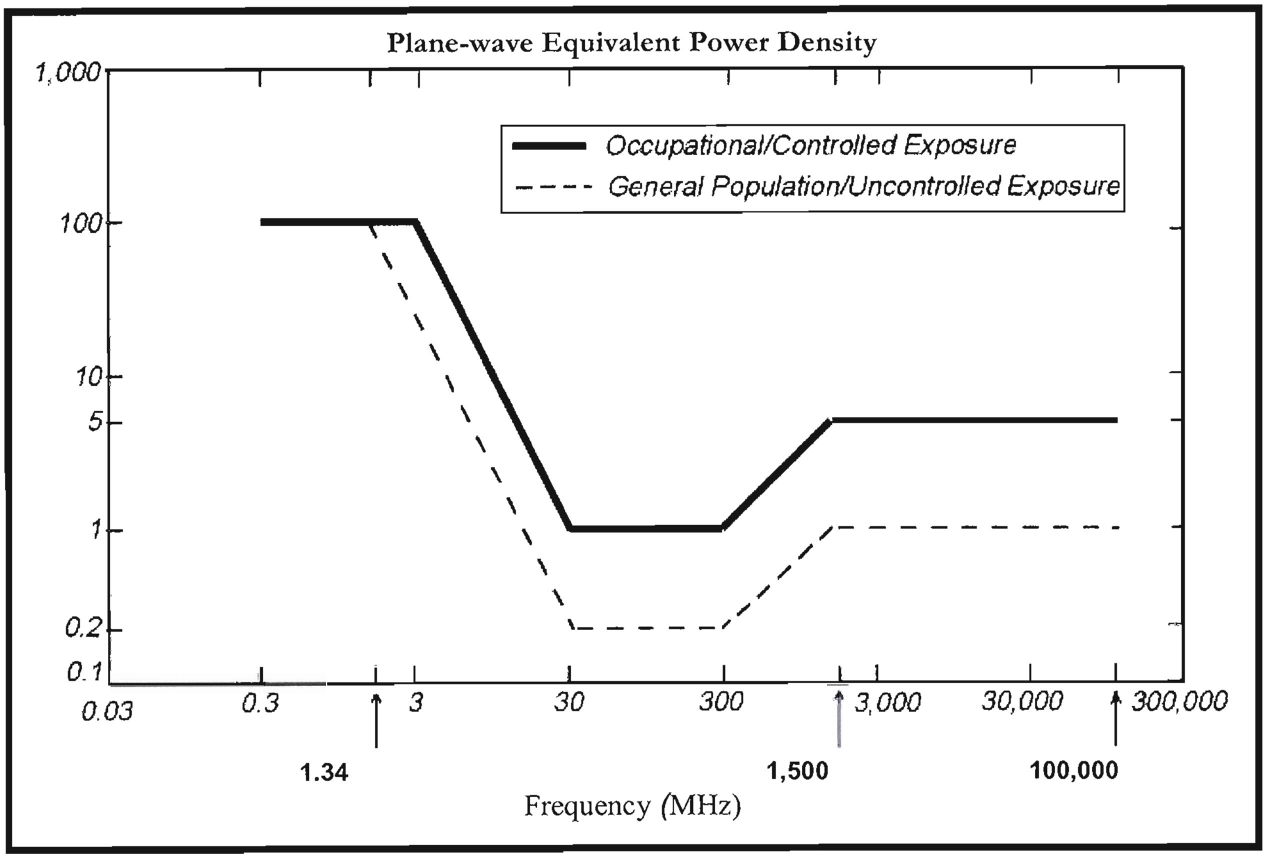
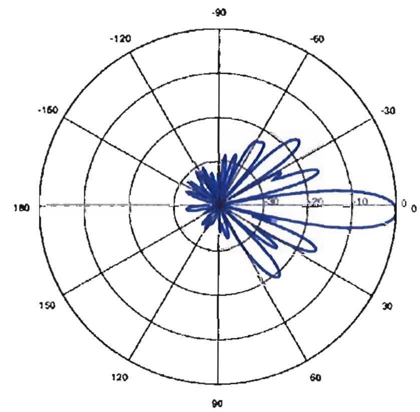


Figure 1: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: AT&T Antenna Data Sheets and Electrical Patterns

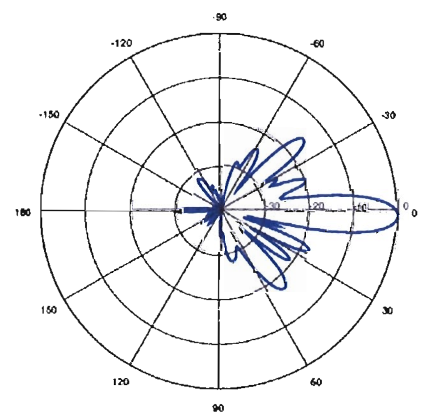
739 MHz

Manufacturer:	CCI
Model #:	DMP65R-BU8D
Frequency Band:	698-798 MHz
Gain:	12.95 dBd
Vertical Beamwidth:	9.5°
Horizontal Beamwidth:	75°
Polarization:	±45°
Dimensions (L x W x D):	96.0" x 20.7" x 7.7"



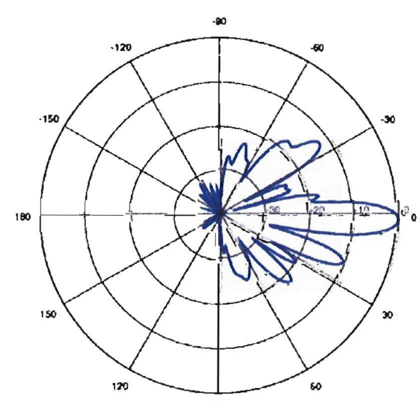
763 MHz

Manufacturer:	CCI
Model #:	TPA65R-BU8D
Frequency Band:	698-806 MHz
Gain:	13.35 dBd
Vertical Beamwidth:	9.5°
Horizontal Beamwidth:	73°
Polarization:	±45°
Dimensions (L x W x D):	96.0" x 21.0" x 7.8"



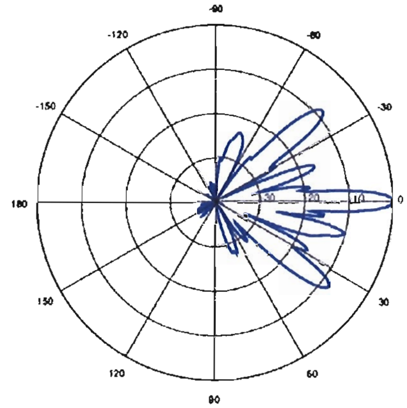
885 MHz (UMTS)

Manufacturer:	CCI
Model #:	TPA65R-BU8D
Frequency Band:	824-896 MHz
Gain:	14.25 dBd
Vertical Beamwidth:	7.9°
Horizontal Beamwidth:	64°
Polarization:	±45°
Dimensions (L x W x D):	96.0" x 21.0" x 7.8"



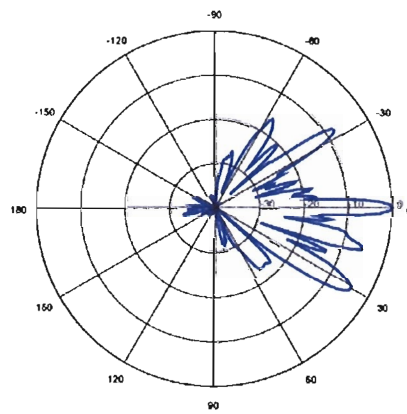
1900 MHz

Manufacturer:	CCI
Model #:	DMP65R-BU8D
Frequency Band:	1850-1990 MHz
Gain:	15.65 dBd
Vertical Beamwidth:	5.1°
Horizontal Beamwidth:	68°
Polarization:	±45°
Dimensions (L x W x D):	96.0" x 20.7" x 7.7"



2300 MHz

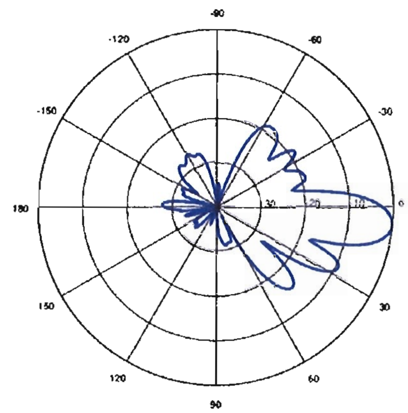
Manufacturer:	CCI
Model #:	TPA65R-BU8D
Frequency Band:	2300-2400 MHz
Gain:	16.05 dBd
Vertical Beamwidth:	4.1°
Horizontal Beamwidth:	60°
Polarization:	±45°
Dimensions (L x W x D):	96.0" x 21.0" x 7.8"



Attachment D: Verizon Wireless Antenna Data Sheets and Electrical Patterns

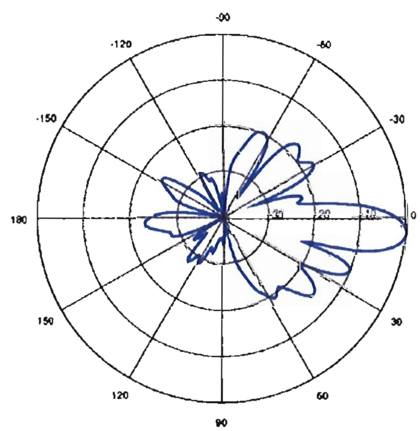
751 MHz

Manufacturer:	Quintel
Model #:	QS6656-3
Frequency Band:	698-806 MHz
Gain:	11.35 dBd
Vertical Beamwidth:	12.5°
Horizontal Beamwidth:	69°
Polarization:	±45°
Dimensions (L x W x D):	72.0" x 12.0" x 9.6"



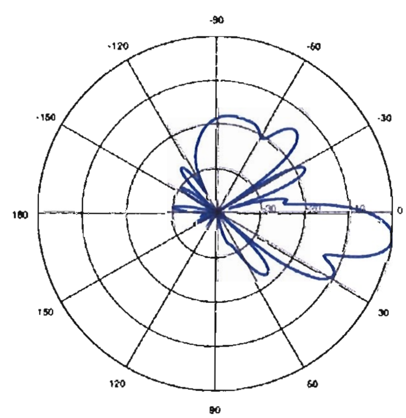
875 MHz

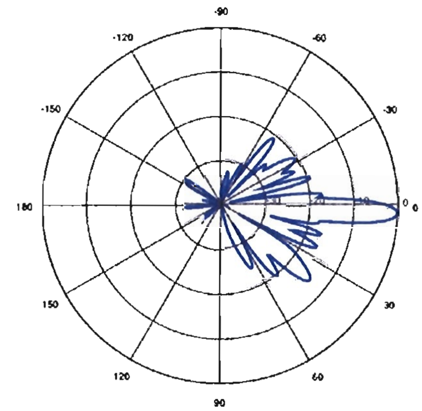
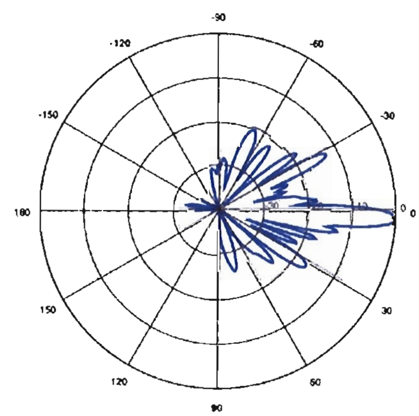
Manufacturer:	Quintel
Model #:	QS6656-3
Frequency Band:	814-894 MHz
Gain:	11.85 dBd
Vertical Beamwidth:	10.5°
Horizontal Beamwidth:	63°
Polarization:	±45°
Dimensions (L x W x D):	72.0" x 12.0" x 9.6"



875 MHz (CDMA)

Manufacturer:	Commscope
Model #:	LNX-6514DS
Frequency Band:	806-896 MHz
Gain:	13.75 dBd
Vertical Beamwidth:	11.2°
Horizontal Beamwidth:	64°
Polarization:	±45°
Dimensions (L x W x D):	72.9" x 11.9" x 7.1"

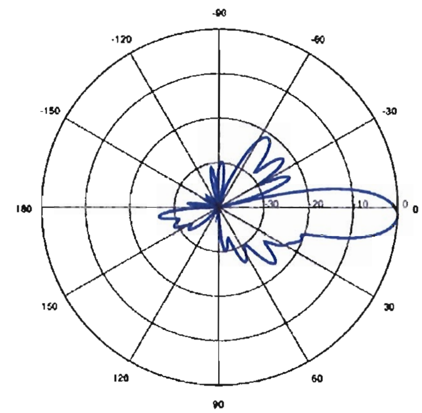


1900 MHz Manufacturer: Quintel Model #: QS6656-3 Frequency Band: 1850-1990 MHz Gain: 14.65 dBd Vertical Beamwidth: 5.9° Horizontal Beamwidth: 70° Polarization: ±45° Dimensions (L x W x D): 72.0" x 12.0" x 9.6"	
2100 MHz Manufacturer: Quintel Model #: QS6656-3 Frequency Band: 2110-2180 MHz Gain: 15.35 dBd Vertical Beamwidth: 5.2° Horizontal Beamwidth: 62° Polarization: ±45° Dimensions (L x W x D): 72.0" x 12.0" x 9.6"	

Attachment E: T-Mobile Antenna Data Sheets and Electrical Patterns

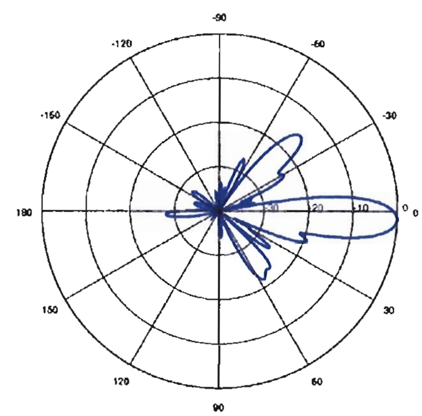
627 MHz

Manufacturer:	RFS
Model #:	APXVAARR24
Frequency Band:	617-698 MHz
Gain:	12.95 dBd
Vertical Beamwidth:	11.4°
Horizontal Beamwidth:	65°
Polarization:	±45°
Dimensions (L x W x D):	95.9" x 24.0" x 8.7"



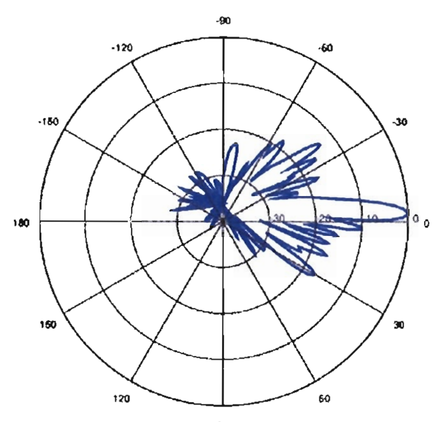
731 MHz

Manufacturer:	RFS
Model #:	APXVAARR24
Frequency Band:	698-746 MHz
Gain:	13.35 dBd
Vertical Beamwidth:	10.4°
Horizontal Beamwidth:	62°
Polarization:	±45°
Dimensions (L x W x D):	95.9" x 24.0" x 8.7"



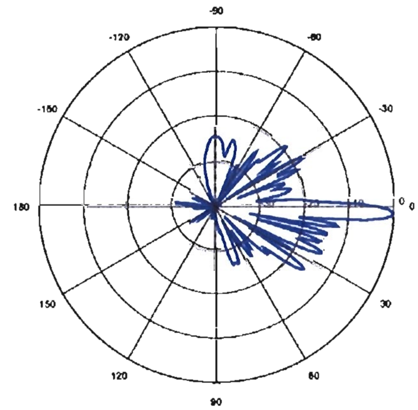
1900 MHz

Manufacturer:	RFS
Model #:	APXVAARR24
Frequency Band:	1850-1990 MHz
Gain:	15.65 dBd
Vertical Beamwidth:	4.7°
Horizontal Beamwidth:	59°
Polarization:	±45°
Dimensions (L x W x D):	95.9" x 24.0" x 8.7"



2100 MHz

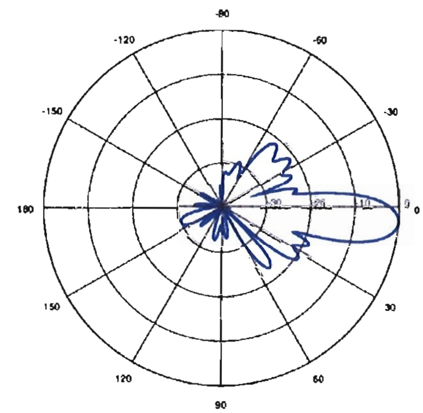
Manufacturer:	RFS
Model #:	APXVAARR24
Frequency Band:	1920-2200 MHz
Gain:	16.35 dBd
Vertical Beamwidth:	4.3°
Horizontal Beamwidth:	59°
Polarization:	±45°
Dimensions (L x W x D):	95.9" x 24.0" x 8.7"



Attachment F: Sprint Antenna Data Sheets and Electrical Patterns

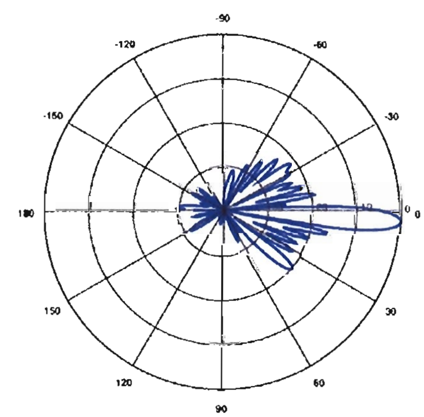
865 MHz

Manufacturer:	RFS
Model #:	APXVSPP18-C
Frequency Band:	806-869 MHz
Gain:	13.35 dBd
Vertical Beamwidth:	11.5°
Horizontal Beamwidth:	65°
Polarization:	±45°
Dimensions (L x W x D):	72.0” x 11.8” x 7.0”



1900 MHz

Manufacturer:	RFS
Model #:	APXVSPP18-C
Frequency Band:	1850-1995 MHz
Gain:	15.85 dBd
Vertical Beamwidth:	5.5°
Horizontal Beamwidth:	65°
Polarization:	±45°
Dimensions (L x W x D):	72.0” x 11.8” x 7.0”



2500 MHz

Manufacturer:	NOKIA
Model #:	AAHC
Frequency Band:	824-896 MHz
Gain:	13.05 dBd
Vertical Beamwidth:	9.0°
Horizontal Beamwidth:	65°
Polarization:	±45°
Dimensions (L x W x D):	25.6” x 19.7” x 9.6”