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Calculated Radio Frequency Emissions Report

Sturbridge W MA

92 Stallion Hill Road, Sturbridge, MA 01518

January 15, 2024

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1. Introduction

The purpose of this report is to investigate compliance with applicable FCC regulations for the proposed installation of Verizon's antenna arrays to be mounted at 125' AGL on a proposed monopole located at 92 Stallion Hill Road, MA. The coordinates of the proposed facility are 42° 06' 31" N, 72° 06' 44.6" W.

Verizon is proposing the following:

1) Install eight (8) multi-band antennas (two (2) antennas per sector, four sectors) to support its 4G LTE and 5G NR network;
2) Install three (3) C-band antennas (one (1) antenna per sector, three sectors) to support its 5G NR network;

This report considers the antenna configuration[1] for Verizon's proposed installation to calculate the resulting % Maximum Permissible Exposure (MPE).

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 C 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 C 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.

[1] As referenced to Verizon's Radio Frequency Design Sheet updated 10/30/2023 and Zoning Drawings prepared by Vertex Towers (Rev. 0, dated 11/01/23).

3. RF Exposure Calculation Methods

The results displayed in the following figures were generated using the following formula as outlined in FCC bulletin OET 65:

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

Where:

EIRP = Effective Isotropic Radiated Power

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

H = Horizontal Distance from antenna

V = Vertical Distance from radiation center of antenna

Off Beam Loss is determined by the selected antenna patterns

GRF = Ground reflection factor of 2.0

These calculations assume that the antennas are operating at full power and 100 percent capacity, and that all antenna channels are transmitting simultaneously. Obstructions (trees, buildings, etc.) that would normally attenuate the signal are not considered. The calculations assume even terrain in the area of study and do not account for 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 signal levels will be from the final installation.

4. Antenna Inventory

Table 1 below outlines Verizon's proposed antenna configuration for the site. The associated data sheets and antenna patterns for these specific antenna models are included in Attachment C.

Operator	Sector / Azimuth	TX Freq (MHz)	Power at Antenna (Watts)	Ant Gain (dBi)	Power EIRP (Watts)	Antenna Model	Beam Width	Mech. Tilt	Length (ft)	Antenna Centerline Height (ft)
Verizon	Alpha / 50°	700	160	16.8	7658	NHH-45B-R2B	48	0	6	125
		850	160	17.5	8997		43	0		
		1900	160	19.9	15636		43	0		
		2100	240	20.3	25716		41	0		
	Alpha / 75°	3700	320	25.5	113540	MT6413-77A	-	0	2.46	125
	Beta / 140°	700	160	16.8	7658	NHH-45B-R2B	48	0	6	125
		850	160	17.5	8997		43	0		
		1900	160	19.9	15636		43	0		
		2100	240	20.3	25716		41	0		
	Beta / 195°	3700	320	25.5	113540	MT6413-77A	-	0	2.46	125
	Gamma / 230°	700	160	16.8	7658	NHH-45B-R2B	48	0	6	125
		850	160	17.5	8997		43	0		
		1900	160	19.9	15636		43	0		
		2100	240	20.3	25716		41	0		
	Delta / 320°	700	160	16.8	7658	NHH-45B-R2B	48	0	6	125
		850	160	17.5	8997		43	0		
		1900	160	19.9	15636		43	0		
		2100	240	20.3	25716		41	0		
	Delta / 315°	3700	320	25.5	113540	MT6413-77A	-	0	2.46	125

Table 1: Proposed Antenna Inventory[2][3]

[2] Antenna heights are in reference to Verizon's Radio Frequency Design Sheet updated 10/30/2023 and Zoning Drawings prepared by Vertex Towers (Rev. 0, dated 11/01/23).

[3] Transmit power assumes 0 dB of cable loss.

5. Calculated % MPE Results

The calculated % MPE results for the proposed antenna configuration are shown in Figure 1 below. Each frequency band and technology is calculated as well as the resulting cumulative percent of MPE. For completeness, the calculations for this analysis range from 0 feet horizontal distance (directly below the antennas) to a value of 3,000 feet horizontal distance from the site. In addition to the other worst-case scenario considerations that were previously mentioned, the power density calculations to each horizontal distance point away from the antennas was completed using a local maximum off beam antenna gain (within ± 5 degrees of the true mathematical angle) to incorporate a realistic worst-case scenario.

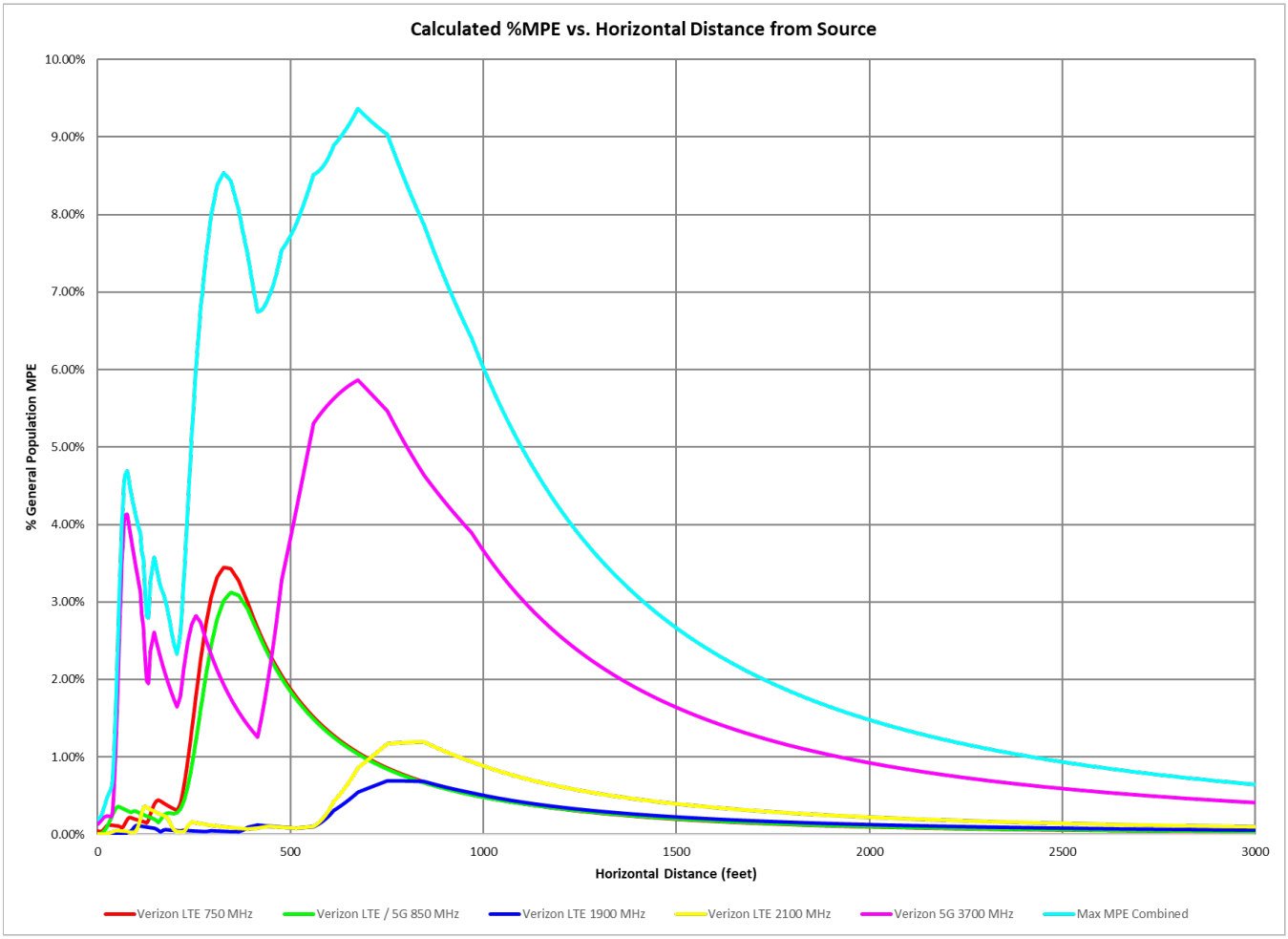


Figure 1: Graph of General Population % MPE vs. Distance

The highest percent of MPE (**9.37%** of the General Population limit) is calculated to occur at a horizontal distance of 675 feet from antennas. Please note that the percent of MPE calculations close to the site consider off beam loss, which is determined from the vertical pattern of the antennas used. Therefore, RF power density levels may increase as the distance from the site increases. At distances of approximately 1000 feet and beyond, one would now be in the main beam of the antenna patterns and off beam loss is no longer considered. Beyond this point, power density levels vary solely based on distance from the site and the percent of MPE decreases significantly as distance from the site increases.

Table 2 below lists percent of MPE values as well as the associated parameters that were included in the calculations. As stated in Section 3, all calculations assume that the antennas are operating at 100 percent capacity, and that all antenna channels are transmitting simultaneously. Obstructions (trees, buildings etc.) that would normally attenuate the signal are not taken into account. Additionally, a six-foot height offset was considered in this analysis to account for average human height standing at ground level. As a result, the calculated % MPE levels are significantly higher than the actual signal levels will be from the final installation. The results presented in Figure 1 and Table 2 assume level ground elevation from the base of the site out to the horizontal distances calculated.

Carrier	Number of Transmitters	Power out of Base Station Per Transmitter (Watts)	Antenna Height (Feet)	Distance to the Base of Antennas (Feet)	Power Density (mW/cm^2)	Limit (mW/cm^2)	% MPE
Verizon 5G 3700 MHz	1	320.0	125.0	675	0.058637	1.000	5.86%
Verizon LTE / 5G 850 MHz	1	160.0	125.0	675	0.005889	0.567	1.04%
Verizon LTE 1900 MHz	1	160.0	125.0	675	0.005461	1.000	0.55%
Verizon LTE 2100 MHz	1	240.0	125.0	675	0.008604	1.000	0.86%
Verizon LTE 750 MHz	1	160.0	125.0	675	0.005285	0.500	1.06%
						Total	**9.37%**

Table 2: Maximum Percent of General Population Exposure Values [4][5]

[4] Frequencies listed are representative of the operating band and are not the specific operating frequency.

[5] The total % MPE listed is a summation of each unrounded contribution. Therefore, summing each rounded value may not reflect the total value listed in the table.

6. Conclusion

The above analysis concludes that RF exposure levels from the proposed site will be well below the maximum permissible levels as outlined by the FCC in the OET Bulletin 65 Ed. 97-01. Using the conservative calculation methods and parameters detailed above, the maximum cumulative percent of MPE in consideration of all transmitters is calculated to be **9.37% of the FCC limit (General Population/Uncontrolled)**. This maximum cumulative percent of MPE value is calculated to occur 675 feet away from the site.

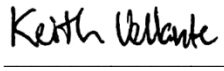
7. Statement of Certification

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 ANSI/IEEE Std. C95.1, ANSI/IEEE Std. C95.3, and FCC OET Bulletin 65 Edition 97-01.

January 12, 2024

Report Prepared By: Ram Acharya
RF Engineer
C Squared Systems, LLC

Date



January 15, 2024

Reviewed/Approved By: Keith Vellante
Director – RF Services
C Squared Systems, LLC

Date

Attachment A: References

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

IEEE C95.1-2019, IEEE Standard Safety Levels With Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz IEEE-SA Standards Board

IEEE C95.3-2021, IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields With Respect to Human Exposure to Such Fields, 0 Hz to 300 GHz IEEE-SA Standards Board

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

(A) Limits for Occupational/Controlled Exposure[6]

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[7]

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 3: FCC Limits for Maximum Permissible Exposure

[6] 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.

[7] 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.

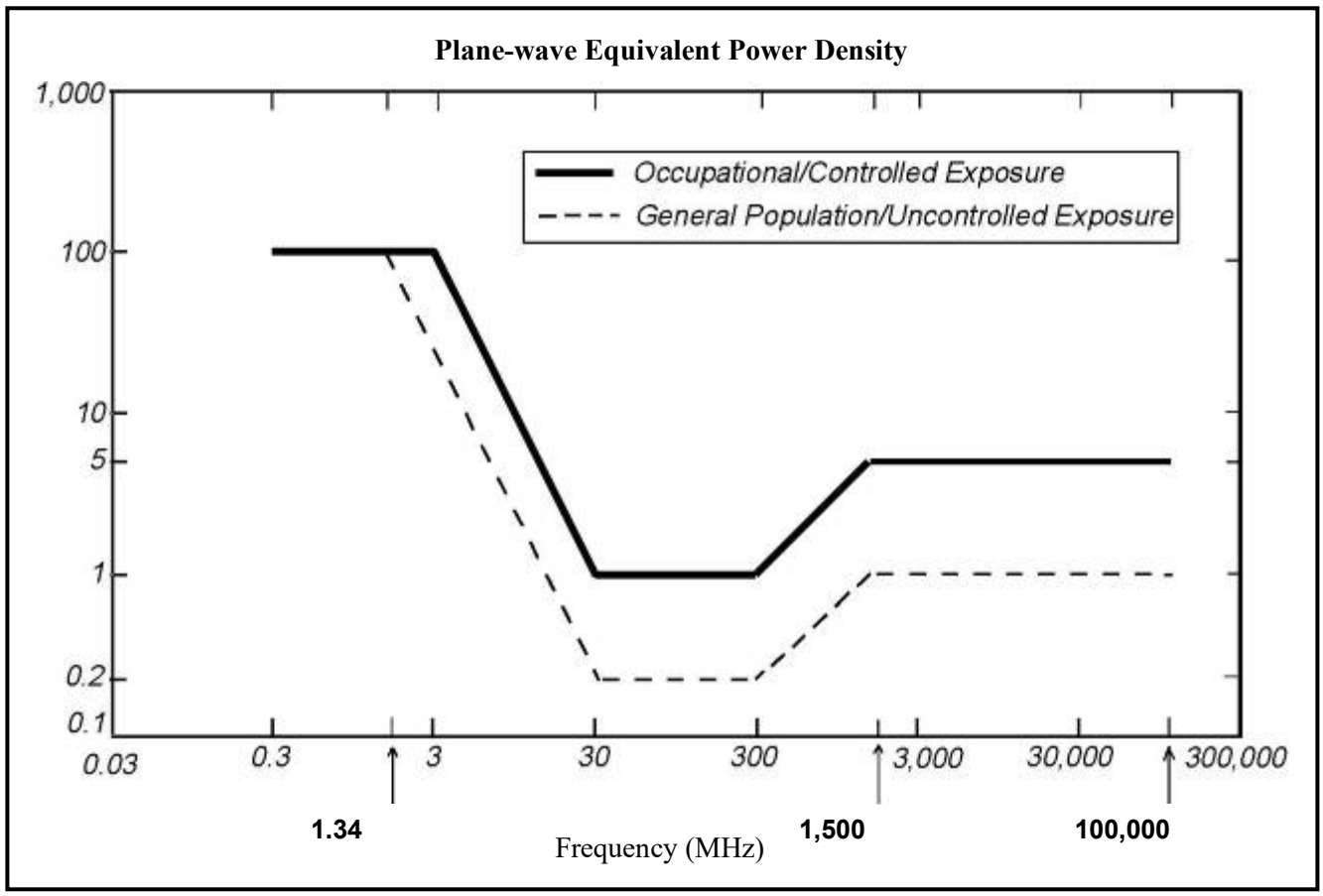
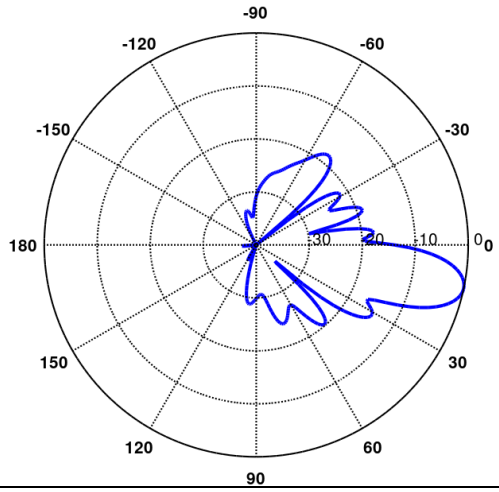


Figure 2: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: Verizon Antenna Model Data Sheets and Electrical Patterns

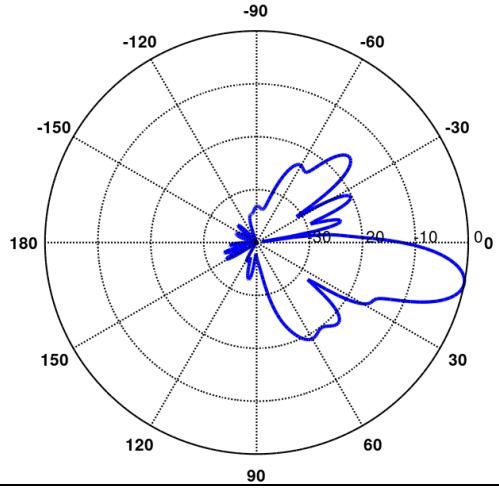
750 MHz

Manufacturer:	COMMSCOPE
Model #:	NHH-45B-2RB
Frequency Band:	698-806 MHz
Gain:	16.8 dBi
Vertical Beamwidth:	12.5°
Horizontal Beamwidth:	48°
Polarization:	±45°
Dimensions (L x W x D):	72.0” x 17.9” x 7.0”



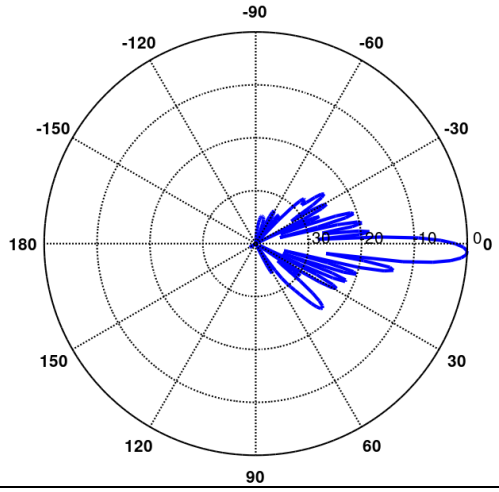
850 MHz

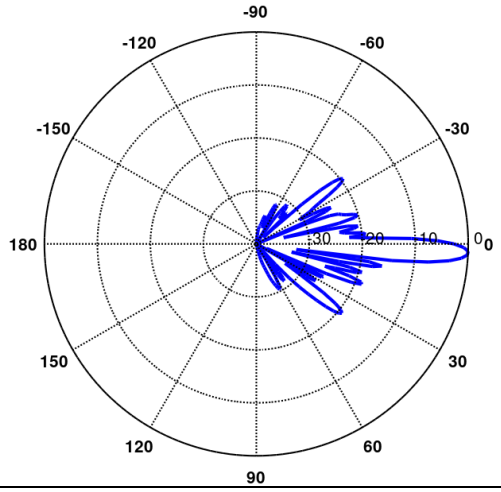
Manufacturer:	COMMSCOPE
Model #:	NHH-45B-2RB
Frequency Band:	806 - 896 MHz
Gain:	17.5 dBi
Vertical Beamwidth:	11.4°
Horizontal Beamwidth:	43°
Polarization:	±45°
Dimensions (L x W x D):	72.0” x 17.9” x 7.0”



1900 MHz

Manufacturer:	COMMSCOPE
Model #:	NHH-45B-2RB
Frequency Band:	1850-1990 MHz
Gain:	19.9 dBi
Vertical Beamwidth:	5.4°
Horizontal Beamwidth:	43°
Polarization:	±45°
Dimensions (L x W x D):	72.0” x 17.9” x 7.0”



2100 MHz Manufacturer: COMMSCOPE Model #: NHH-45B-2RB Frequency Band: 1920-2200 MHz Gain: 20.3 dBi Vertical Beamwidth: 5° Horizontal Beamwidth: 41° Polarization: ±45° Dimensions (L x W x D): 72.0” x 17.9” x 7.0”	
3700 MHz Manufacturer: SAMSUNG Model #: MT6413-77A Frequency Band: 3700-3980 MHz Gain: 25.5 dBi Vertical Beamwidth: N/A° Horizontal Beamwidth: N/A° Polarization: N/A° Dimensions (L x W x D): 29.53” x 15.75” x 5.51”	N/A