7136 S Yale Ave
Suite 501
Tulsa, OK 74133

o 918.664.4581
f 918.664.3066

www.iHeartMedia.com
www.iHeartRadio.com
#iheartradio

November 17, 2021

*VIA EMAIL*

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

RE: IHM LICENSES, LLC (FRN No. 0014042816)
Application for New License on FCC Form 302-AM
WWRL (AM), 1600 kHz, New York, NY; Facility ID No. 68906

Dear Ms. Dortch:

On behalf of IHM LICENSES, LLC, the licensee of the above-referenced station, enclosed is copy of an application for New License submitted on FCC Form 302-AM.

Also enclosed is Form 159, Remittance Advice, with credit card payment of the $1905.00 filing fee.

Please contact the undersigned with any communications concerning this application.

Respectfully submitted,
IHM LICENSES, LLC

By: _____
Troy Langham
VP, Technical Regulatory Affairs

cc: Public Inspection File

# Online Payment Information

| | |
|---|---|
| Total Amount | $1,905.00 |
| Payer FRN | 0014042816 |
| Payer Name | |
| Remittance ID | 3687700 |
| Treasury Tracking ID | 26U2C8U8 |

Thank you for your payment!

Federal Communications Commission
Washington, D. C. 20554

Approved by OMB
3060-0627
Expires 01/31/98

FOR FCC USE ONLY

# FCC 302-AM
# APPLICATION FOR AM BROADCAST STATION LICENSE

(Please read instructions before filling out form.

FOR COMMISSION USE ONLY

FILE NO.

## SECTION I - APPLICANT FEE INFORMATION

1. PAYOR NAME (Last, First, Middle Initial)

iHM Licenses, LLC

MAILING ADDRESS (Line 1) (Maximum 35 characters)
7136 S Yale Ave

MAILING ADDRESS (Line 2) (Maximum 35 characters)
Suite 501

| CITY | STATE OR COUNTRY (if foreign address) | ZIP CODE |
|---|---|---|
| Tulsa | OK | 74136 |

| TELEPHONE NUMBER (include area code) | CALL LETTERS | OTHER FCC IDENTIFIER (If applicable) |
|---|---|---|
| 918-664-4581 | WWRL | 68906 |

2. A. Is a fee submitted with this application? [✓] Yes [ ] No

B. If No, indicate reason for fee exemption (see 47 C.F.R. Section

[ ] Governmental Entity [ ] Noncommercial educational licensee [ ] Other (Please explain):

C. If Yes, provide the following information:

Enter in Column (A) the correct Fee Type Code for the service you are applying for. Fee Type Codes may be found in the "Mass Media Services Fee Filing Guide." Column (B) lists the Fee Multiple applicable for this application. Enter fee amount due in Column (C).

| (A) FEE TYPE CODE | (B) FEE MULTIPLE | (C) FEE DUE FOR FEE TYPE CODE IN COLUMN (A) | FOR FCC USE ONLY |
|---|---|---|---|
| M M R | 0 0 0 1 | $ 645.00 | |

To be used only when you are requesting concurrent actions which result in a requirement to list more than one Fee Type Code.

| (A) | (B) | (C) | FOR FCC USE ONLY |
|---|---|---|---|
| M O R | 0 0 0 1 | $ 1260.00 | |

ADD ALL AMOUNTS SHOWN IN COLUMN C,
AND ENTER THE TOTAL HERE.
THIS AMOUNT SHOULD EQUAL YOUR ENCLOSED REMITTANCE.

| TOTAL AMOUNT REMITTED WITH THIS APPLICATION | FOR FCC USE ONLY |
|---|---|
| $ 1905.00 | |

| SECTION II - APPLICANT INFORMATION | | |
|---|---|---|
| 1. NAME OF APPLICANT<br>iHM Licenses, LLC | | |
| MAILING ADDRESS<br>7136 S Yale Ave, Suite 501 | | |
| CITY<br>Tulsa | STATE<br>OK | ZIP CODE<br>74136 |

2. This application is for:

☑ Commercial ☐ Noncommercial

☑ AM Directional ☐ AM Non-Directional

| Call letters | Community of License | Construction Permit File No. | Modification of Construction Permit File No(s). | Expiration Date of Last Construction Permit |
|---|---|---|---|---|
| WWRL | New York, NY | | | |

3. Is the station now operating pursuant to automatic program test authority in accordance with 47 C.F.R. Section 73.1620?

☑ Yes ☐ No

If No, explain in an Exhibit.

Exhibit No.

4. Have all the terms, conditions, and obligations set forth in the above described construction permit been fully met?

☐ Yes ☐ No

If No, state exceptions in an Exhibit.

Exhibit No. N/A

5. Apart from the changes already reported, has any cause or circumstance arisen since the grant of the underlying construction permit which would result in any statement or representation contained in the construction permit application to be now incorrect?

☐ Yes ☐ No

If Yes, explain in an Exhibit.

Exhibit No. N/A

6. Has the permittee filed its Ownership Report (FCC Form 323) or ownership certification in accordance with 47 C.F.R. Section 73.3615(b)?

☐ Yes ☐ No

☐ Does not apply

If No, explain in an Exhibit.

Exhibit No.

7. Has an adverse finding been made or an adverse final action been taken by any court or administrative body with respect to the applicant or parties to the application in a civil or criminal proceeding, brought under the provisions of any law relating to the following: any felony; mass media related antitrust or unfair competition; fraudulent statements to another governmental unit; or discrimination?

☐ Yes ☑ No

If the answer is Yes, attach as an Exhibit a full disclosure of the persons and matters involved, including an identification of the court or administrative body and the proceeding (by dates and file numbers), and the disposition of the litigation. Where the requisite information has been earlier disclosed in connection with another application or as required by 47 U.S.C. Section 1.65(c), the applicant need only provide: (i) an identification of that previous submission by reference to the file number in the case of an application, the call letters of the station regarding which the application or Section 1.65 information was filed, and the date of filing; and (ii) the disposition of the previously reported matter.

Exhibit No.

8. Does the applicant, or any party to the application, have a petition on file to migrate to the expanded band (1605-1705 kHz) or a permit or license either in the existing band or expanded band that is held in combination (pursuant to the 5 year holding period allowed) with the AM facility proposed to be modified herein?

☐ Yes ☑ No

If Yes, provide particulars as an Exhibit.

Exhibit No.

The APPLICANT hereby waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because use of the same, whether by license or otherwise, and requests and authorization in accordance with this application. (See Section 304 of the Communications Act of 1934, as amended).

The APPLICANT acknowledges that all the statements made in this application and attached exhibits are considered material representations and that all the exhibits are a material part hereof and are incorporated herein as set out in full in

## CERTIFICATION

1. By checking Yes, the applicant certifies, that, in the case of an individual applicant, he or she is not subject to a denial of federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. Section 862, or, in the case of a non-individual applicant (e.g., corporation, partnership or other unincorporated association), no party to the application is subject to a denial of federal benefits that includes FCC benefits pursuant to that section. For the definition of a "party" for these purposes, see 47 C.F.R. Section 1.2002(b).

☑ Yes ☐ No

2. I certify that the statements in this application are true, complete, and correct to the best of my knowledge and belief, and are made in good faith.

| Name | Signature | |
|---|---|---|
| Troy G Langham | Troy Langham<br>Digitally signed by Troy Langham<br>DN: cn=Troy Langham, o, ou, email=Troylangham@iheartmedia.com, c=US<br>Date: 2021.11.17 07:19:40 -06'00' | |
| Title<br>VP, Technical Regulatory Affairs | Date<br>11/16/2021 | Telephone Number<br>918-664-4581 |

**WILLFUL FALSE STATEMENTS ON THIS FORM ARE PUNISHABLE BY FINE AND/OR IMPRISONMENT (U.S. CODE, TITLE 18, SECTION 1001), AND/OR REVOCATION OF ANY STATION LICENSE OR CONSTRUCTION**

FCC NOTICE TO INDIVIDUALS REQUIRED BY THE PRIVACY ACT AND THE PAPERWORK REDUCTION ACT

The solicitation of personal information requested in this application is authorized by the Communications Act of 1934, as amended. The Commission will use the information provided in this form to determine whether grant of the application is in the public interest. In reaching that determination, or for law enforcement purposes, it may become necessary to refer personal information contained in this form to another government agency. In addition, all information provided in this form will be available for public inspection. If information requested on the form is not provided, the application may be returned without action having been taken upon it or its processing may be delayed while a request is made to provide the missing information. Your response is required to obtain the requested authorization.

Public reporting burden for this collection of information is estimated to average 639 hours and 53 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, can be sent to the Federal Communications Commission, Records Management Branch, Paperwork Reduction Project (3060-0627), Washington, D. C. 20554. Do NOT send completed forms to this address.

THE FOREGOING NOTICE IS REQUIRED BY THE PRIVACY ACT OF 1974, P.L. 93-579, DECEMBER 31, 1974, 5 U.S.C. 552a(e)(3), AND THE PAPERWORK REDUCTION ACT OF 1980, P.L. 96-511, DECEMBER 11, 1980, 44 U.S.C. 3507.

Consulting Engineers
CTJC
CARL T. JONES CORPORATION

**ENGINEERING EXHIBIT**
**IN SUPPORT OF AN**
**APPLICATION FOR STATION LICENSE**
**STATION WWRL – NEW YORK, NEW YORK**
**1600 kHz - 25 kW-D, 5 kW-N, U, DA-2**
**FACILITY ID: 68906**

Applicant: IHM Licenses, LLC

NOVEMBER, 2021

7901 Yarnwood Court
Springfield, VA 22153-2899

tel: (703) 569-7704
fax: (703) 569-6417

email: info@ctjc.com
**www.ctjc.com**

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SECTION III OF FCC FORM 302-AM

ENGINEERING STATEMENT OF JAMES D. SADLER

FIGURE

**SECTION III - LICENSE APPLICATION ENGINEERING DATA**

Name of Applicant
IHM Licenses, LLC

PURPOSE OF AUTHORIZATION APPLIED FOR: (check one)

☑ Station License BMML- ☐ Direct Measurement of Power

1. Facilities authorized in construction permit

| Call Sign | File No. of Construction Permit (if applicable) | Frequency (kHz) | Hours of Operation | Power in kilowatts | |
|---|---|---|---|---|---|
| | | | | Night | Day |
| WWRL | | 1600 | Unlimited | 5 | 25 |

2. Station location

| State | City or Town |
|---|---|
| New York | New York |

3. Transmitter location

| State | County | City or Town | Street address (or other identification) |
|---|---|---|---|
| NY | Hudson | Secaucus | 50 Radio Avenue |

4. Main studio location

| State | County | City or Town | Street address (or other identification) |
|---|---|---|---|
| NY | New York | New York | 32 Avenue of Americas |

5. Remote control point location (specify only if authorized directional antenna)

| State | County | City or Town | Street address (or other identification) |
|---|---|---|---|
| NY | New York | New York | 32 Avenue of Americas |

6. Has type-approved stereo generating equipment been installed? ☐ Yes ☑ No

7. Does the sampling system meet the requirements of 47 C.F.R. Section 73.68? ☑ Yes ☐ No ☐ Not Applicable

Attach as an Exhibit a detailed description of the sampling system as installed. Exhibit No. Eng Stmt

8. Operating constants:

| RF common point or antenna current (in amperes) without modulation for night system | RF common point or antenna current (in amperes) without modulation for day system |
|---|---|
| 10.39 | 22.95 |

| Measured antenna or common point resistance (in ohms) at operating frequency | | Measured antenna or common point reactance (in ohms) at operating frequency | |
|---|---|---|---|
| Night | Day | Night | Day |
| 50 | 50 | +j 0 | +j 0 |

Antenna indications for directional operation

| Towers | Antenna monitor Phase reading(s) in degrees | | Antenna monitor sample current ratio(s) | | Antenna base currents | |
|---|---|---|---|---|---|---|
| | Night | Day | Night | Day | Night | Day |
| 1 (NE) | -7.8 | +38.1 | 0.954 | 0.653 | --- | --- |
| 2 (SE) | 0.0 | 0.0 | 1.000 | 1.000 | --- | --- |
| 3 (SW) | +125.4 | +105.3 | 0.693 | 1.134 | --- | --- |
| 4 (NW) | +129.3 | +112.4 | 0.581 | 0.184 | --- | --- |
| | | | | | | |
| | | | | | | |

Manufacturer and type of antenna monitor: Potomac Instruments, Model 1901-4

**SECTION III - Page 2**

9. Description of antenna system ((f directional antenna is used, the information requested below should be given for each element of the array. Use separate sheets if necessary.)

| Type Radiator | Overall height in meters of radiator above base insulator, or above base, if grounded. | Overall height in meters above ground (without obstruction lighting) | Overall height in meters above ground (include obstruction lighting) | If antenna is either top loaded or sectionalized, describe fully in an Exhibit. |
|---|---|---|---|---|
| Uniform cross-section guyed tower | 94 | 95 | 96 | Exhibit No. Eng Stmt |

Excitation ☑ Series ☐ Shunt

Geographic coordinates to nearest second. For directional antenna give coordinates of center of array. For single vertical radiator give tower location.

| North Latitude | West Longitude |
|---|---|
| 40 ° 47 ' 44 " | 74 ° 03 ' 18 " |

If not fully described above, attach as an Exhibit further details and dimensions including any other antenna mounted on tower and associated isolation circuits. Exhibit No. Eng Stmt

Also, if necessary for a complete description, attach as an Exhibit a sketch of the details and dimensions of ground system. Exhibit No. No Change

10. In what respect, if any, does the apparatus constructed differ from that described in the application for construction permit or in the permit?

N/A

11. Give reasons for the change in antenna or common point resistance.

N/A

I certify that I represent the applicant in the capacity indicated below and that I have examined the foregoing statement of technical information and that it is true to the best of my knowledge and belief.

| Name (Please Print or Type) | Signature (check appropriate box below) |
|---|---|
| James D. Sadler | |
| Address (include ZIP Code)<br>Carl T. Jones Corporation<br>7901 Yarnwood Ct<br>Springfield, VA 22153 | Date<br>November 12, 2021<br>Telephone No. (Include Area Code)<br>(703) 569-7704 |

☐ Technical Director

☐ Registered Professional Engineer

☐ Chief Operator

☑ Technical Consultant

☐ Other (specify)

Consulting Engineers
CTJC
CARL T. JONES CORPORATION

**ENGINEERING STATEMENT OF JAMES D. SADLER**
**IN SUPPORT OF AN**
**APPLICATION FOR STATION LICENSE**
**STATION WWRL – NEW YORK, NEW YORK**
**1600 kHz - 25 kW-D, 5 kW-N, U, DA-2**
**FACILITY ID: 68906**

Applicant: IHM Licenses, LLC

I am a Technical Consultant, an employee in the firm of Carl T. Jones Corporation, with offices located in Springfield, Virginia. My education and experience are a matter of record with the Federal Communications Commission.

## 1.0 GENERAL

This office has been authorized by IHM Licenses, LLC ("IHM"), licensee of AM Station WWRL, to prepare this engineering statement, FCC Form 302-AM, Section III, and the associated figures and appendices in support of an Application for License. Station WWRL is licensed for operation on 1600 kilohertz at a power of 25 kilowatts during daytime hours and 5 kilowatt during nighttime hours. The station operates using all 4 towers with a different antenna pattern day and night (DA-2).

Computer modeling and sample system verification techniques, as described in Section 47 CFR 73.151(c) of the Commission's Rules and Regulations, were used to verify the performance of the WWRL daytime and nighttime directional antenna

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systems. The specific measurement and modeling techniques used in performing the proof of performance on the WWRL directional patterns are described in detail in this engineering statement. Impedance measurement data, sample system verification measurement data and model derived operating parameters are tabulated in the figures attached to this engineering statement. Finally, all pertinent computer model input and output files are contained in the attached Appendices A, B, and C.

## 2.0 IMPEDANCE MEASUREMENTS, COMPUTER MODELING AND SAMPLE SYSTEM VERIFICATION

The proof of performance contained herein is based on the computer modeling and sample system verification procedures described in Section 47 CFR 73.151(c) of the FCC's Rules and Regulations. The WWRL antenna array consists of four base insulated, steel, series-fed, guyed towers with identical cross-sections and a 40-inch face width. All four towers are top loaded with the uppermost 25.6 meters of the top guy wires to achieve an apparent electrical radiator height of 215 degrees (180.4 degrees vertical height plus 34.6 degrees of apparent top loading). The sampling system employs identical toroidal current transformers located at the output of the antenna matching network and prior to the series filter and detuning networks for nearby stations operating on 710 kHz and 1050 kHz at the base of each tower.

A detailed description of the impedance measurements, the computer models employed, and the sample system verification measurements, is contained below.

## 2.1 INDIVIDUAL TOWER IMPEDANCE MEASUREMENTS

Impedance measurements were performed at the base of each tower, by the undersigned, at the J-Plug located in the output branch of the antenna matching network. This measurement location corresponds to the input to the filter and detuning network and is immediately adjacent to the location of the sampling system toroidal current transformer. The impedance measurements were performed using a Hewlett-Packard Model 8753C network analyzer; an ENI, Model 240L, power amplifier; and a Tunwall Radio directional coupler. The impedance of each tower was measured with the other three towers open-circuited at the same ATU output J-Plug location that was used to perform the impedance measurement. The measured impedances are tabulated in Figure 2.

## 2.2 INDIVIDUAL TOWER COMPUTER MODELS

A Method of Moments ("MoM") computer model was developed to model each element in the array using Expert MiniNEC Broadcast Professional (Version 23.0). A wire model was developed for each tower in the array that is comprised of 21 segments for the tower and 5 segments for the top-loading. To replicate the individual measured base impedances to within FCC specified tolerances, each tower's physical height was adjusted in the MiniNEC model and series inductances and shunt capacitance were employed in a separate circuit model. The top-loading was lengthened proportionally to the tower height. The actual equivalent physical radius was used in all computer

models contained in this application. Details of the modeled individual tower adjusted heights are contained in Figure 1.

The values of the shunt capacitances, measured series inductances, and lumped series inductances used in the circuit model are contained in the table of Figure 2[1]. A comparison of the measured individual tower impedances, the modeled individual tower impedances, and the adjusted modeled (circuit model) individual tower impedances is also contained in the table of Figure 2. The percentage difference between the adjusted modeled tower height and the actual physical tower height and the magnitude of the lumped series inductances that were used in the circuit models are all within the tolerances set forth in the Rules.

As demonstrated by the data contained in Figure 2, the adjusted modeled individual tower resistance and reactance for each tower is well within ± 2 ohms and ± 4 percent tolerance of the corresponding measured individual tower resistance and reactance. The text files containing all pertinent input and output data associated with the individual tower models are contained in Appendix A.

## 2.3 DIRECTIONAL ANTENNA COMPUTER MODEL AND ANTENNA MONITOR PARAMETERS

The theoretical daytime and nighttime directional field parameters and the licensed tower spacings and orientations were used in combination with the adjusted

[1] The networks at the base of each tower contain a series inductor located at the output of the filter network. The values of these inductors were measured and included in the circuit model.

individual tower models to produce the daytime and nighttime directional antenna computer models. From the directional computer model, tower currents were derived for each wire segment of each antenna.

The new daytime and nighttime directional array operating parameters were determined from the modeled base currents and are tabulated in Figure 3. The text files containing all pertinent input and output data associated with the daytime and nighttime directional antenna computer models are contained in Appendix B and C.

## 2.4 SAMPLE SYSTEM DESCRIPTION AND VERIFICATION MEASUREMENTS

The WWRL antenna sampling system is comprised of: 1) Delta Electronics, Model TCT-3, toroidal current transformers mounted in an identical manner in the output branch of each tower's impedance matching network; 2) approximate equal lengths of 1/2-inch, foam dielectric, coaxial cable and varied lengths of Andrew, ½-inch, superflexible, foam dielectric coaxial cable, on both ends of the cable between each toroidal current transformer and the antenna monitor located in the transmitter building; and 3) a Potomac Instruments, Model AM-1901-4, antenna monitor. Each sample line between the ATU building and the transmitter building, including excess lengths, is installed such that each cable is subjected to the same environmental conditions.

The sample lines were verified to be equal in length by measuring the open-circuit series resonate frequency closest to the carrier frequency. The characteristic impedance was verified by measuring the impedance at frequencies corresponding to odd multiples of 1/8 wavelength immediately above and below the open circuit series

resonant frequency closest to the carrier frequency, while the line was open-circuited at the sample element end of the line. The characteristic impedance was calculated by the following formula:

$$Z = \sqrt{\sqrt{R_1^2 + X_1^2} \times \sqrt{R_2^2 + X_2^2}}$$

*where:*

***Z** = Characteristic impedance and*

***R₁** + **j** **X₁** and **R₂** + **j** **X₂** are the measured impedances at ± 45 degrees offset frequencies.*

A tabulation of the measured sample line lengths and the characteristic impedance of each line is contained in Figure 4. All sample line verification measurements were performed by the undersigned using a Hewlett-Packard, Model 8753C, network analyzer; an ENI, Model 240L, power amplifier; and a Tunwall Radio directional coupler. As demonstrated by the measured values in Figure 4, the measured sample line lengths are within 1 electrical degree with respect to each other and the measured characteristic impedances are well within 2 ohms of each other, as required by Section 47 CFR 73.151(c)(2)(I) of the FCC Rules and Regulations.

An impedance measurement was performed at the input to each sample line, at the antenna monitor end of the line, with the toroidal current transformer connected. The measurement was performed at the WWRL operating frequency of 1600 kilohertz. The measured sample line impedances with the current transformers connected are tabulated in Figure 4 under the heading “Reference Impedance Sample Transformer

Connected." The toroidal current transformers were purchased brand new from the manufacturer immediately prior to installation and therefore additional testing of the transformers was not necessary. Toroidal current transformer serial numbers are contained in Figure 5.

The antenna monitor that is employed by WWRL is a Potomac Instruments, Model 1901-4. The monitor was calibrated by Potomac Instruments on September 15, 2021, immediately prior to installation at WWRL.

## 3.0 COMMON POINT IMPEDANCE AND COMMON POINT CURRENT

The networks associated with the daytime and nighttime directional antenna system were adjusted for proper impedance transformation and the common point impedance matching network was set for Z = 50 +j 0 Ohms. The transmitter output power level was adjusted for a daytime common point current of 22.95 amperes and a nighttime common point current of 10.39 amperes, corresponding to daytime and nighttime input powers of 26,325 Watts and 5,400 Watts, respectively.

## 4.0 REFERENCE FIELD STRENGTH MEASUREMENTS

Reference field strength measurements were performed on the WWRL daytime and nighttime directional antenna patterns on the 129° radial bearing, corresponding to the major lobe of the two patterns[2]. In addition, reference field strength measurements

[2] The actual daytime and nighttime main lobe maxima are located on the 131° and 126° radial bearings, respectively. The 129° radial was selected and measured for both patterns to reduce the total number radials for the two patterns.

were performed on the 21°, 55°, 202°, 259°, and 333° radial bearings, corresponding to the daytime directional pattern minima and on the 14°, 55°, 203°, 227°, 276°, and 318° radial bearings, corresponding to the nighttime directional pattern minima[3]. Three reference field strength measurements were performed on each of the selected radial bearings.

The measurements were performed by Mr. Dan Cavegn, a senior field technician with Carl T. Jones Corporation, and the undersigned. A single meter was used to perform the measurements, a Potomac Instruments, Model FIM-41, Serial Number 2185, last calibrated by the manufacturer in January, 2021.

The measured field strength value for each established reference point location is tabulated in Figure 6, Sheets 1 through 5. The tabulations contained in Figure 6 also include for each reference location; GPS coordinates (NAD83), distance from the WWRL array center, and a description of measurement location.

## SUMMARY

It is submitted that the WWRL daytime and nighttime directional antenna patterns performance has been verified using computer modeling and sample system verification procedures in accordance with Section 47 CFR 73.151(c) of the Commission's Rules and Regulations. It is believed that the daytime and nighttime directional antenna patterns, as adjusted, fully comply with the terms of the station's FCC Authorization and

[3] The actual daytime minima radial bearing of 54° and nighttime minima radial bearing of 56° were both selected and measured on the 55° radial bearing to reduce the total number radials for the two patterns. In a similar fashion, the daytime minima radial bearing of 202° was measured on the nighttime minima radial bearing of 203°.

all applicable FCC Rules and Regulations. It is requested that a superseding license be issued to IHM reflecting the new MoM model derived daytime and nighttime operating parameters as contained herein.

This engineering statement, FCC Form 302-AM, Section III, and the attached figures and appendices were prepared by the undersigned or under the direct supervision of the undersigned and are believed to be true and correct.

Dated: November 12, 2021

James D. Sadler

Figure 1

# TOWER MODEL HEIGHT AND RADIUS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

| Tower | Physical Height (degrees) | Modeled Height (degrees) | Percent of Physical Height | Modeled Radius (degrees) | Percent of Equivalent Radius |
|---|---|---|---|---|---|
| 1 | 180.4 | 186.93 | 103.6 | 0.4851 | 100.0 |
| 2 | 180.4 | 190.54 | 105.6 | 0.4851 | 100.0 |
| 3 | 180.4 | 187.84 | 104.1 | 0.4851 | 100.0 |
| 4 | 180.4 | 177.90 | 98.6 | 0.4851 | 100.0 |

## MEASURED AND MODELED IMPEDANCES

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

| Tower | Measured Tower Base Impedance[1] | Modeled Tower Base Impedance | Shunt Capacitance (pF) | Modeled plus Shunt Reactance | Measured Series Inductance (uH) | Lumped Series Inductance (uH) | Total Adjusted Tower Base Impedance |
|---|---|---|---|---|---|---|---|
| 1 | 28.60 -j 5.6 | 30.56 -j 185.28 | 15.0 | 28.92 -j 180.37 | 12.88 | 4.51 | 28.92 -j 5.55 |
| 2 | 25.69 -j 15.6 | 27.12 -j 169.27 | 15.0 | 25.79 -j 165.16 | 10.93 | 3.95 | 25.79 -j 15.57 |
| 3 | 28.64 -j 2.1 | 29.79 -j 181.45 | 15.0 | 28.22 -j 176.74 | 12.64 | 4.73 | 28.22 -j 2.12 |
| 4 | 45.32 +j 4.8 | 49.02 -j 232.86 | 15.0 | 45.75 -j 225.29 | 15.35 | 7.54 | 45.75 +j 4.83 |

[1] Measured at output of matching network with other towers open-circuited

Figure 2

# ANTENNA MONITOR PARAMETERS AND COMMON POINT DATA

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

| DAYTIME | | |
|---|---|---|
| | Modeled Parameters | |
| **Tower** | **Ratio** | **Phase (deg)** |
| 1 | 0.653 | 38.1 |
| 2 | 1.000 | 0.0 |
| 3 | 1.134 | 105.3 |
| 4 | 0.184 | 112.4 |
| Common Point Impedance = 50 +j 0 ohms<br>Common Point Current = 22.95 amperes<br>Antenna Input Power = 26,325 Watts | | |

| NIGHTTIME | | |
|---|---|---|
| | Modeled Parameters | |
| **Tower** | **Ratio** | **Phase (deg)** |
| 1 | 0.954 | 7.8 |
| 2 | 1.000 | 0.0 |
| 3 | 0.693 | 125.4 |
| 4 | 0.581 | 129.3 |
| Common Point Impedance = 50 +j 0 ohms<br>Common Point Current = 10.39 amperes<br>Antenna Input Power = 5,400 Watts | | |

# SAMPLE LINE VERIFICATION MEASUREMENTS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

| Tower | Open Circuit Series Resonant Frequency[1] (kHz) | Open Circuit Measured Line Length[2] (degrees) | Resonant Frequency -45 degree Offset Frequency (kHz) | Resonant Frequency -45 degree Offset Impedance (Ohms) | Resonant Frequency +45 degree Offset Frequency (kHz) | Resonant Frequency +45 degree Offset Impedance (Ohms) | Calculated Characteristic Impedance (Ohms) | Reference Impedance Sample Toroid Connected[2] (Ohms) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1883.40 | 382.3 | 1695.1 | 5.33 -j 50.10 | 2071.7 | 6.71 +j 50.70 | 50.76 | 52.04 +j 0.97 |
| 2 | 1883.40 | 382.3 | 1695.1 | 5.28 -j 48.73 | 2071.7 | 6.90 +j 50.02 | 49.75 | 53.52 -j 1.78 |
| 3 | 1883.20 | 382.3 | 1694.9 | 7.26 -j 50.37 | 2071.5 | 9.00 +j 50.38 | 51.03 | 52.09 +j 0.96 |
| 4 | 1882.80 | 382.4 | 1694.5 | 5.31 -j 50.12 | 2071.1 | 6.64 +j 50.52 | 50.68 | 52.07 +j 0.98 |

[1] At this frequency, the sample line electrical length is equal to 450°.
[2] At carrier frequency (1600 kHz)

Figure 4

Figure 5

# SAMPLE DEVICE DATA

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

| Sample Toroid Number | Type | Serial Number |
|---|---|---|
| 1 | Delta Electronics, TCT-3 | 18477 |
| 2 | Delta Electronics, TCT-3 | 18478 |
| 3 | Delta Electronics, TCT-3 | 18479 |
| 4 | Delta Electronics, TCT-3 | 18480 |

# REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

**14 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 8.04 | - - - | 22 | 40° 51' 56.3" | 74° 01' 48.2" | The point is located on the curb adjacent to the steps on the south side of #103 2nd St (west of #38 Central Ave), Ridgefield Park, NJ. |
| 2 | 8.82 | - - - | 16.4 | 40° 52' 20.8" | 74° 01' 40.2" | The point is located on the sidewalk at the front door for #73 Elmwood Ave, Bogota, NJ. |
| 3 | 9.86 | - - - | 15.9 | 40° 52' 53.4" | 74° 01' 29.5" | The point is located in the center of the street in line with fire hydrant north of #500 Leonia Ave, Bogata, NJ. |

**21 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 6.37 | 53 | - - - | 40° 50' 56.2" | 74° 01' 34.7" | The point is located at the curb on the northeast corner of Ridgefield Ave and College Pl near #47 College Pl, Ridgefield Park, NJ. |
| 2 | 7.07 | 43 | - - - | 40° 51' 17.5" | 74° 01' 23.9" | The point is located on the sidewalk at the front door of #86 Cedar St, Ridgefield Park, NJ. |
| 3 | 7.75 | 27.1 | - - - | 40° 51' 37.9" | 74° 01' 13.6" | The point is located sidewalk at the front door of #75 Union Pl, Ridgefield Park, NJ. |

# REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

**55 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 3.49 | 250 | 42 | 40° 48' 49.2" | 74° 01' 10.3" | The point is located adjacent to fire hydrant on the southwest corner of street and entrance to #8501 West Side Ave, North Bergen, NJ. |
| 2 | 4.78 | 56 | 25.5 | 40° 49' 12.0" | 74° 00' 24.1" | The point is located 10 ft west of the center of garage door for #183 Battaglia Ln, Fairview Borough, NJ. |
| 3 | 4.97 | 69 | 26.2 | 40° 49' 15.7" | 74° 00' 17.9" | The point is located on curb east side of main perimeter road in line with "STONE" headstone, Mount Moriah Cemetary, Fairview, NJ. |

**129 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 0.95 | 3950 | 1490 | 40° 47' 24.1" | 74° 02' 40.6" | The point is located on the ADA sidewalk ramp pad adjacent to stop sign southeast corner of Buffalo Wild Wings, Secaucus, NJ. |
| 2 | 2.12 | 1225 | 465 | 40° 47' 00.4" | 74° 02' 01.5" | The point is located on the sidewalk at the front door of #1811 44th St, North Bergen, NJ. |
| 3 | 2.50 | 700 | 247 | 40° 46' 52.7" | 74° 01' 49.1" | The point is located on the sidewalk and center of garage door #4306 Meadowview Ave, North Bergen, NJ. |

# REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

**203 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 2.28 | 305 | 34.5 | 40° 46' 35.9" | 74° 03' 50.2" | The point is located on the sidewalk adjacent to bus stop sign at front door of #520 Secaucus Rd, Secaucus, NJ. |
| 2 | 2.60 | 365 | 50 | 40° 46' 26.3" | 74° 03' 55.7" | The point is located is located on the curb east of rear entrance to PSEG, north side of Jefferson Ave, Secaucus, NJ. |
| 3 | 3.23 | 233 | 36.8 | 40° 46' 07.3" | 74° 04' 06.1" | The point is located in the center of the alleyway between transformer #672 and Utility Pole #2418, #79 County Ave, Secaucus, |

**227 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 1.01 | - - - | 232 | 40° 47' 21.4" | 74° 03' 43.7" | The point is located on the sidewalk and the center of driveway at #703 1st St, Secaucus, NJ. |
| 2 | 2.47 | - - - | 8 | 40° 46' 49.4" | 74° 04' 29.4" | The point is located on the north edge of Secaucus Rd in front of Bus Stop #21655 near intersection with Hartz Way, Secaucus, NJ. |
| 3 | 3.58 | - - - | 25.1 | 40° 46' 24.8" | 74° 05' 04.2" | The point is located on the sidewalk at the storm drain on southwest side of road opposite #24 Castle Rd, Secaucus, NJ. |

# REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

**259 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 6.16 | 76 | - - - | 40° 47' 05.7" | 74° 07' 30.6" | The point is located on the sidewalk opposite front door at #4 Silvia Pl, North Arlington, NJ. |
| 2 | 7.48 | 55 | - - - | 40° 46' 57.8" | 74° 08' 26.0" | The point is located on the sidewalk adjacent to fire hydrant in front of #147 Pleasant Pl, Kearny, NJ. |
| 3 | 7.93 | 25.2 | - - - | 40° 46' 54.8" | 74° 08' 45.1" | The point is located on the southwest corner of W Bennett Ave and Jefferson Ave near #45 Jefferson Ave, Kearny, NJ. |

**276 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 5.47 | - - - | 17.3 | 40° 48' 02.0" | 74° 07' 04.7" | The point is located on the sidewalk at the door for #601 1st St (eastside of #730 Kingsland Ave), Lyndhurst, NJ. |
| 2 | 6.32 | - - - | 14.9 | 40° 48' 04.7" | 74° 07' 40.9" | The point is located on the sidewalk at driveway for #492 Wilson Ave, Lyndhurst, NJ. |
| 3 | 7.14 | - - - | 18.6 | 40° 48' 08.0" | 74° 08' 15.8" | The point is located adjacent to park bench ("Gary Trabucco") north end of parking lot, Riverside County Park, North Arlington, NJ. |

# REFERENCE FIELD STRENGTH MEASUREMENTS

STATION WWRL - NEW YORK, NEW YORK
1600 kHz - 25 kW-D, 5 kW-N, U, DA-2
NOVEMBER, 2021

**318 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 5.04 | - - - | 24 | 40° 49' 44.8" | 74° 05' 36.7" | The point is located on the sidewalk north side of street opposite front door #128 Stanley St, East Rutherford, NJ. |
| 2 | 5.75 | - - - | 12.6 | 40° 50' 01.7" | 74° 05' 57.1" | The point is located on the sidewalk at front door for #129 Everett Pl, East Rutherford, NJ. |
| 3 | 7.07 | - - - | 3.87 | 40° 50' 33.4" | 74° 06' 34.8" | The point is located on the sidewalk at front door for #69 Bobbink Terr, East Rutherford, NJ. |

**333 Degree Radial**

| Point Number | Distance (km) | Daytime Field (mV/m) | Nighttime Field (mV/m) | Geographic Coordinates (NAD83) | | Description |
|---|---|---|---|---|---|---|
| | | | | Latitude | Longitude | |
| 1 | 5.67 | 181 | - - - | 40° 50' 27.2" | 74° 05' 02.5" | The point is located on the sidewalk and the center of the driveway for #741 8th St, Carlstadt, NJ. |
| 2 | 6.27 | 191 | - - - | 40° 50' 44.4" | 74° 05' 14.4" | The point is located on the sidewalk at park entrance path north of #102 2nd St, Wood-Ridge, NJ. |
| 3 | 6.96 | 142 | - - - | 40° 51' 04.4" | 74° 05' 27.9" | The point is located on the sidewalk at front door for #185 10th St, Wood-Ridge, NJ. |

# APPENDIX A

# INDIVIDUAL TOWER MODEL

IMPEDANCE – TOWER #1
normalization = 50.

| freq (MHz) | resist (ohms) | react (ohms) | imped (ohms) | phase (deg) | VSWR | S11 dB | S12 dB |
|---|---|---|---|---|---|---|---|
| source = 1; node 1, sector 1 | | | | | | | |
| 1.6 | 30.56 | -185.28 | 187.78 | 279.4 | 24.674 | -.70445 | -8.2468 |

GEOMETRY – TOWER #1
Dimensions in meters
Environment: perfect ground

| wire | caps | X | Y | Z | radius | segs |
|---|---|---|---|---|---|---|
| 1 | none | 0 | 0 | 0 | .4851 | 21 |
| | | 0 | 0 | 97.29 | | |
| 2 | none | 0 | 12.5 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 3 | none | 10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 4 | none | -10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 5 | none | -80.2 | -56.2 | 0 | .4851 | 21 |
| | | -80.2 | -56.2 | 99.17 | | |
| 6 | none | -80.2 | -43.7 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 7 | none | -69.4 | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 8 | none | -91. | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 9 | none | -58.7 | -97.8 | 0 | .4851 | 21 |
| | | -58.7 | -97.8 | 97.76 | | |
| 10 | none | -58.7 | -85.3 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 11 | none | -47.9 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 12 | none | -69.5 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 13 | none | 21.3 | -41.8 | 0 | .4851 | 21 |
| | | 21.3 | -41.8 | 92.59 | | |
| 14 | none | 21.3 | -29.3 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 15 | none | 32.1 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 16 | none | 10.5 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |

Number of wires = 16
current nodes = 144

| Individual wires | minimum wire | minimum value | maximum wire | maximum value |
|---|---|---|---|---|
| segment length | 13 | 4.40905 | 6 | 5.32883 |
| segment/radius ratio | 13 | 9.08895 | 6 | 106.577 |
| radius | 2 | .05 | 1 | .4851 |

ELECTRICAL DESCRIPTION – TOWER #1
Frequencies (MHz)

| no. | frequency lowest | step | no. of steps | segment length (wavelengths) minimum | maximum |
|---|---|---|---|---|---|
| 1 | 1.6 | 0 | 1 | .0235306 | .0284394 |

Sources

| source | node | sector | magnitude | phase | type |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1. | 0 | voltage |

Lumped loads

| load | node | resistance (ohms) | reactance (ohms) | inductance (mH) | capacitance (uF) | passive circuit |
|---|---|---|---|---|---|---|
| 1 | 1 | .01 | 0 | 0 | 0 | 0 |
| 2 | 37 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 3 | 73 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 4 | 109 | .01 | 0 | 0 | 1.5E-11 | 0 |

IMPEDANCE – TOWER #2
normalization = 50.

| freq (MHz) | resist (ohms) | react (ohms) | imped (ohms) | phase (deg) | VSWR | S11 dB | S12 dB |
|---|---|---|---|---|---|---|---|
| source = 1; node 37, sector 1 | | | | | | | |
| 1.6 | 27.124 | -169.27 | 171.43 | 279.1 | 23.469 | -.74064 | -8.0468 |

GEOMETRY – TOWER #2
Dimensions in meters
Environment: perfect ground

| wire | caps | X | Y | Z | radius | segs |
|---|---|---|---|---|---|---|
| 1 | none | 0 | 0 | 0 | .4851 | 21 |
| | | 0 | 0 | 97.29 | | |
| 2 | none | 0 | 12.5 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 3 | none | 10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 4 | none | -10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 5 | none | -80.2 | -56.2 | 0 | .4851 | 21 |
| | | -80.2 | -56.2 | 99.17 | | |
| 6 | none | -80.2 | -43.7 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 7 | none | -69.4 | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 8 | none | -91. | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 9 | none | -58.7 | -97.8 | 0 | .4851 | 21 |
| | | -58.7 | -97.8 | 97.76 | | |
| 10 | none | -58.7 | -85.3 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 11 | none | -47.9 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 12 | none | -69.5 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 13 | none | 21.3 | -41.8 | 0 | .4851 | 21 |
| | | 21.3 | -41.8 | 92.59 | | |
| 14 | none | 21.3 | -29.3 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 15 | none | 32.1 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 16 | none | 10.5 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |

Number of wires = 16
current nodes = 144

| Individual wires | minimum wire | minimum value | maximum wire | maximum value |
|---|---|---|---|---|
| segment length | 13 | 4.40905 | 6 | 5.32883 |
| segment/radius ratio | 13 | 9.08895 | 6 | 106.577 |
| radius | 2 | .05 | 1 | .4851 |

ELECTRICAL DESCRIPTION – TOWER #2
Frequencies (MHz)

| no. | frequency lowest | step | no. of steps | segment length (wavelengths) minimum | maximum |
|---|---|---|---|---|---|
| 1 | 1.6 | 0 | 1 | .0235306 | .0284394 |

Sources

| source | node | sector | magnitude | phase | type |
|---|---|---|---|---|---|
| 1 | 37 | 1 | 1. | 0 | voltage |

Lumped loads

| load | node | resistance (ohms) | reactance (ohms) | inductance (mH) | capacitance (uF) | passive circuit |
|---|---|---|---|---|---|---|
| 1 | 1 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 2 | 37 | .01 | 0 | 0 | 0 | 0 |
| 3 | 73 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 4 | 109 | .01 | 0 | 0 | 1.5E-11 | 0 |

IMPEDANCE – TOWER #3
normalization = 50.

| freq (MHz) | resist (ohms) | react (ohms) | imped (ohms) | phase (deg) | VSWR | S11 dB | S12 dB |
|---|---|---|---|---|---|---|---|
| source = 1; node 73, sector 1 | | | | | | | |
| 1.6 | 29.789 | -181.45 | 183.88 | 279.3 | 24.337 | -.7142 | -8.1919 |

GEOMETRY – TOWER #3
Dimensions in meters
Environment: perfect ground

| wire | caps | X | Y | Z | radius | segs |
|---|---|---|---|---|---|---|
| 1 | none | 0 | 0 | 0 | .4851 | 21 |
| | | 0 | 0 | 97.29 | | |
| 2 | none | 0 | 12.5 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 3 | none | 10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 4 | none | -10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 5 | none | -80.2 | -56.2 | 0 | .4851 | 21 |
| | | -80.2 | -56.2 | 99.17 | | |
| 6 | none | -80.2 | -43.7 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 7 | none | -69.4 | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 8 | none | -91. | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 9 | none | -58.7 | -97.8 | 0 | .4851 | 21 |
| | | -58.7 | -97.8 | 97.76 | | |
| 10 | none | -58.7 | -85.3 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 11 | none | -47.9 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 12 | none | -69.5 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 13 | none | 21.3 | -41.8 | 0 | .4851 | 21 |
| | | 21.3 | -41.8 | 92.59 | | |
| 14 | none | 21.3 | -29.3 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 15 | none | 32.1 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 16 | none | 10.5 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |

Number of wires = 16
current nodes = 144

| Individual wires | minimum wire | minimum value | maximum wire | maximum value |
|---|---|---|---|---|
| segment length | 13 | 4.40905 | 6 | 5.32883 |
| segment/radius ratio | 13 | 9.08895 | 6 | 106.577 |
| radius | 2 | .05 | 1 | .4851 |

ELECTRICAL DESCRIPTION – TOWER #3
Frequencies (MHz)

| no. | frequency lowest | step | no. of steps | segment length (wavelengths) minimum | maximum |
|---|---|---|---|---|---|
| 1 | 1.6 | 0 | 1 | .0235306 | .0284394 |

Sources

| source | node | sector | magnitude | phase | type |
|---|---|---|---|---|---|
| 1 | 73 | 1 | 1. | 0 | voltage |

Lumped loads

| load | node | resistance (ohms) | reactance (ohms) | inductance (mH) | capacitance (uF) | passive circuit |
|---|---|---|---|---|---|---|
| 1 | 1 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 2 | 37 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 3 | 73 | .01 | 0 | 0 | 0 | 0 |
| 4 | 109 | .01 | 0 | 0 | 1.5E-11 | 0 |

IMPEDANCE – TOWER #4
normalization = 50.

| freq (MHz) | resist (ohms) | react (ohms) | imped (ohms) | phase (deg) | VSWR | S11 dB | S12 dB |
|---|---|---|---|---|---|---|---|
| source = 1; node 109, sector 1 | | | | | | | |
| 1.6 | 49.018 | -232.86 | 237.96 | 281.9 | 24.082 | -.72178 | -8.1497 |

GEOMETRY – TOWER #4
Dimensions in meters
Environment: perfect ground

| wire | caps | X | Y | Z | radius | segs |
|---|---|---|---|---|---|---|
| 1 | none | 0 | 0 | 0 | .4851 | 21 |
| | | 0 | 0 | 97.29 | | |
| 2 | none | 0 | 12.5 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 3 | none | 10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 4 | none | -10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 5 | none | -80.2 | -56.2 | 0 | .4851 | 21 |
| | | -80.2 | -56.2 | 99.17 | | |
| 6 | none | -80.2 | -43.7 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 7 | none | -69.4 | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 8 | none | -91. | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 9 | none | -58.7 | -97.8 | 0 | .4851 | 21 |
| | | -58.7 | -97.8 | 97.76 | | |
| 10 | none | -58.7 | -85.3 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 11 | none | -47.9 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 12 | none | -69.5 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 13 | none | 21.3 | -41.8 | 0 | .4851 | 21 |
| | | 21.3 | -41.8 | 92.59 | | |
| 14 | none | 21.3 | -29.3 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 15 | none | 32.1 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 16 | none | 10.5 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |

Number of wires = 16
current nodes = 144

| Individual wires | minimum wire | minimum value | maximum wire | maximum value |
|---|---|---|---|---|
| segment length | 13 | 4.40905 | 6 | 5.32883 |
| segment/radius ratio | 13 | 9.08895 | 6 | 106.577 |
| radius | 2 | .05 | 1 | .4851 |

ELECTRICAL DESCRIPTION – TOWER #4
Frequencies (MHz)

| no. | frequency lowest | step | no. of steps | segment length (wavelengths) minimum | maximum |
|---|---|---|---|---|---|
| 1 | 1.6 | 0 | 1 | .0235306 | .0284394 |

Sources

| source | node | sector | magnitude | phase | type |
|---|---|---|---|---|---|
| 1 | 109 | 1 | 1. | 0 | voltage |

Lumped loads

| load | node | resistance (ohms) | reactance (ohms) | inductance (mH) | capacitance (uF) | passive circuit |
|---|---|---|---|---|---|---|
| 1 | 1 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 2 | 37 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 3 | 73 | .01 | 0 | 0 | 1.5E-11 | 0 |
| 4 | 109 | .01 | 0 | 0 | 0 | 0 |

# APPENDIX B

# DAYTIME DIRECTIONAL ARRAY MODEL

IMPEDANCE – DAYTIME OPERATION
normalization = 50.

| freq (MHz) | resist (ohms) | react (ohms) | imped (ohms) | phase (deg) | VSWR | S11 dB | S12 dB |
|---|---|---|---|---|---|---|---|
| source = 1; node 1, sector 1 | | | | | | | |
| 1.6 | 49.92 | -206.67 | 212.61 | 283.6 | 19.06 | -.91226 | -7.2248 |
| source = 2; node 37, sector 1 | | | | | | | |
| 1.6 | 46.416 | -147.41 | 154.55 | 287.5 | 11.281 | -1.544 | -5.2405 |
| source = 3; node 73, sector 1 | | | | | | | |
| 1.6 | 10.359 | -201.25 | 201.52 | 272.9 | 83.22 | -.20876 | -13.285 |
| source = 4; node 109, sector 1 | | | | | | | |
| 1.6 | -24.774 | -466.18 | 466.83 | 267. | **** | **** | **** |

GEOMETRY – DAYTIME OPERATION
Dimensions in meters
Environment: perfect ground

| wire | caps | X | Y | Z | radius | segs |
|---|---|---|---|---|---|---|
| 1 | none | 0 | 0 | 0 | .4851 | 21 |
| | | 0 | 0 | 97.29 | | |
| 2 | none | 0 | 12.5 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 3 | none | 10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 4 | none | -10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 5 | none | -80.2 | -56.2 | 0 | .4851 | 21 |
| | | -80.2 | -56.2 | 99.17 | | |
| 6 | none | -80.2 | -43.7 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 7 | none | -69.4 | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 8 | none | -91. | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 9 | none | -58.7 | -97.8 | 0 | .4851 | 21 |
| | | -58.7 | -97.8 | 97.76 | | |
| 10 | none | -58.7 | -85.3 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 11 | none | -47.9 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 12 | none | -69.5 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 13 | none | 21.3 | -41.8 | 0 | .4851 | 21 |
| | | 21.3 | -41.8 | 92.59 | | |
| 14 | none | 21.3 | -29.3 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 15 | none | 32.1 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 16 | none | 10.5 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |

Number of wires = 16
current nodes = 144

| Individual wires | minimum wire | minimum value | maximum wire | maximum value |
|---|---|---|---|---|
| segment length | 13 | 4.40905 | 6 | 5.32883 |
| segment/radius ratio | 13 | 9.08895 | 6 | 106.577 |
| radius | 2 | .05 | 1 | .4851 |

ELECTRICAL DESCRIPTION – DAYTIME OPERATION
Frequencies (MHz)

| no. | frequency lowest | step | no. of steps | segment length (wavelengths) minimum | maximum |
|---|---|---|---|---|---|
| 1 | 1.6 | 0 | 1 | .0235306 | .0284394 |

Sources

| source | node | sector | magnitude | phase | type |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 3,447.37 | 74.2 | voltage |
| 2 | 37 | 1 | 3,871.22 | 40. | voltage |
| 3 | 73 | 1 | 5,681.17 | 131.1 | voltage |
| 4 | 109 | 1 | 2,053.8 | 132.4 | voltage |

Lumped loads

| load | node | resistance (ohms) | reactance (ohms) | inductance (mH) | capacitance (uF) | passive circuit |
|---|---|---|---|---|---|---|
| 1 | 1 | .01 | 0 | 0 | 0 | 0 |
| 2 | 37 | .01 | 0 | 0 | 0 | 0 |
| 3 | 73 | .01 | 0 | 0 | 0 | 0 |
| 4 | 109 | .01 | 0 | 0 | 0 | 0 |

RMS CURRENT – DAYTIME OPERATION
Frequency = 1.6 MHz
Input power = 25,000. watts
Efficiency = 99.97 %
coordinates in meters

| current no. | X | Y | Z | mag (amps) | phase (deg) | real (amps) | imaginary (amps) |
|---|---|---|---|---|---|---|---|
| GND | 0 | 0 | 0 | 11.4652 | 150.6 | -9.98881 | 5.62799 |
| 2 | 0 | 0 | 4.63286 | 8.33544 | 145.4 | -6.86479 | 4.72803 |
| 3 | 0 | 0 | 9.26572 | 6.26631 | 139.3 | -4.75126 | 4.0856 |
| 4 | 0 | 0 | 13.8986 | 4.3856 | 128.3 | -2.72102 | 3.43941 |
| 5 | 0 | 0 | 18.5314 | 2.87262 | 104.7 | -.728186 | 2.7788 |
| 6 | 0 | 0 | 23.1643 | 2.43908 | 59.7 | 1.23043 | 2.10598 |
| 7 | 0 | 0 | 27.7971 | 3.44728 | 24.5 | 3.1368 | 1.42976 |
| 8 | 0 | 0 | 32.43 | 5.02289 | 8.7 | 4.96479 | .761738 |
| 9 | 0 | 0 | 37.0629 | 6.68629 | 1. | 6.68531 | .114589 |
| 10 | 0 | 0 | 41.6957 | 8.28423 | 356.5 | 8.2692 | -.498824 |
| 11 | 0 | 0 | 46.3286 | 9.74762 | 353.7 | 9.68914 | -1.06616 |
| 12 | 0 | 0 | 50.9614 | 11.0344 | 351.8 | 10.9212 | -1.57618 |
| 13 | 0 | 0 | 55.5943 | 12.1162 | 350.4 | 11.9467 | -2.01927 |
| 14 | 0 | 0 | 60.2271 | 12.9758 | 349.4 | 12.7542 | -2.38809 |
| 15 | 0 | 0 | 64.86 | 13.6081 | 348.6 | 13.342 | -2.67823 |
| 16 | 0 | 0 | 69.4929 | 14.0233 | 348.1 | 13.7225 | -2.88911 |
| 17 | 0 | 0 | 74.1257 | 14.2467 | 347.7 | 13.922 | -3.02434 |
| 18 | 0 | 0 | 78.7586 | 14.3042 | 347.5 | 13.9666 | -3.08949 |
| 19 | 0 | 0 | 83.3914 | 14.2008 | 347.4 | 13.8609 | -3.08834 |
| 20 | 0 | 0 | 88.0243 | 13.9265 | 347.5 | 13.5944 | -3.02349 |
| 21 | 0 | 0 | 92.6571 | 13.4729 | 347.6 | 13.1575 | -2.89794 |
| J1 | 0 | 0 | 97.29 | 12.9123 | 347.8 | 12.6202 | -2.73099 |
| END | 0 | 12.5 | 74.21 | 0 | 0 | 0 | 0 |
| 22 | 0 | 10. | 78.826 | 1.23257 | 169.2 | -1.21084 | .230445 |
| 23 | 0 | 7.5 | 83.442 | 2.26219 | 168.8 | -2.21882 | .440874 |
| 24 | 0 | 5. | 88.058 | 3.1475 | 168.3 | -3.0821 | .638253 |
| 25 | 0 | 2.5 | 92.674 | 3.872 | 167.8 | -3.78524 | .815061 |
| 2J2 | 0 | 0 | 97.29 | 4.37649 | 167.5 | -4.27212 | .95009 |
| END | 10.8 | -6.25 | 74.21 | 0 | 0 | 0 | 0 |
| 27 | 8.64 | -5. | 78.826 | 1.1665 | 168.5 | -1.14325 | .231713 |
| 28 | 6.48 | -3.75 | 83.442 | 2.14877 | 168. | -2.10191 | .446283 |
| 29 | 4.32 | -2.5 | 88.058 | 3.00048 | 167.5 | -2.92964 | .648171 |
| 30 | 2.16 | -1.25 | 92.674 | 3.70434 | 167.1 | -3.61053 | .828362 |
| 2J2 | 0 | 0 | 97.29 | 4.20035 | 166.7 | -4.08808 | .964671 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| END | -10.8 | -6.25 | 74.21 | 0 | 0 | 0 | 0 |
| 32 | -8.64 | -5. | 78.826 | 1.23014 | 171.9 | -1.21789 | .173189 |
| 33 | -6.48 | -3.75 | 83.442 | 2.25059 | 171.1 | -2.22358 | .347592 |
| 34 | -4.32 | -2.5 | 88.058 | 3.12448 | 170.4 | -3.08053 | .522164 |
| 35 | -2.16 | -1.25 | 92.674 | 3.83881 | 169.7 | -3.77698 | .686236 |
| 2J2 | 0 | 0 | 97.29 | 4.33752 | 169.2 | -4.26003 | .816228 |
| GND | -80.2 | -56.2 | 0 | 17.712 | 112.5 | -6.77756 | 16.364 |
| 38 | -80.2 | -56.2 | 4.72238 | 14.1826 | 108.2 | -4.42034 | 13.4762 |
| 39 | -80.2 | -56.2 | 9.44476 | 11.7116 | 104. | -2.83693 | 11.3628 |
| 40 | -80.2 | -56.2 | 14.1671 | 9.29914 | 98.2 | -1.33227 | 9.20321 |
| 41 | -80.2 | -56.2 | 18.8895 | 6.96879 | 88.9 | .130073 | 6.96757 |
| 42 | -80.2 | -56.2 | 23.6119 | 4.92058 | 71.6 | 1.55452 | 4.66858 |
| 43 | -80.2 | -56.2 | 28.3343 | 3.7503 | 38.6 | 2.93007 | 2.34082 |
| 44 | -80.2 | -56.2 | 33.0567 | 4.24008 | .4 | 4.23999 | .0282127 |
| 45 | -80.2 | -56.2 | 37.7791 | 5.89967 | 337.9 | 5.46549 | -2.22136 |
| 46 | -80.2 | -56.2 | 42.5014 | 7.89957 | 326.5 | 6.58778 | -4.35941 |
| 47 | -80.2 | -56.2 | 47.2238 | 9.8886 | 320.1 | 7.58931 | -6.33931 |
| 48 | -80.2 | -56.2 | 51.9462 | 11.7215 | 316.2 | 8.45481 | -8.11851 |
| 49 | -80.2 | -56.2 | 56.6686 | 13.3216 | 313.5 | 9.17274 | -9.66057 |
| 50 | -80.2 | -56.2 | 61.391 | 14.6434 | 311.7 | 9.73616 | -10.9379 |
| 51 | -80.2 | -56.2 | 66.1133 | 15.6644 | 310.4 | 10.1456 | -11.9348 |
| 52 | -80.2 | -56.2 | 70.8357 | 16.3847 | 309.5 | 10.4113 | -12.6516 |
| 53 | -80.2 | -56.2 | 75.5581 | 16.8273 | 308.8 | 10.5543 | -13.1059 |
| 54 | -80.2 | -56.2 | 80.2805 | 17.0195 | 308.5 | 10.5937 | -13.3206 |
| 55 | -80.2 | -56.2 | 85.0029 | 16.9673 | 308.4 | 10.5294 | -13.3049 |
| 56 | -80.2 | -56.2 | 89.7252 | 16.6618 | 308.4 | 10.3484 | -13.0586 |
| 57 | -80.2 | -56.2 | 94.4476 | 16.0979 | 308.6 | 10.0394 | -12.5839 |
| J5 | -80.2 | -56.2 | 99.17 | 15.3682 | 308.9 | 9.65365 | -11.9577 |
| END | -80.2 | -43.7 | 75.64 | 0 | 0 | 0 | 0 |
| 58 | -80.2 | -46.2 | 80.346 | 1.41554 | 136.6 | -1.02919 | .971869 |
| 59 | -80.2 | -48.7 | 85.052 | 2.61765 | 135.4 | -1.8636 | 1.83822 |
| 60 | -80.2 | -51.2 | 89.758 | 3.67117 | 134.2 | -2.55945 | 2.63186 |
| 61 | -80.2 | -53.7 | 94.464 | 4.55393 | 133.1 | -3.10999 | 3.32659 |
| 2J2 | -80.2 | -56.2 | 99.17 | 5.18735 | 132.1 | -3.4796 | 3.84721 |
| END | -69.4 | -62.45 | 75.64 | 0 | 0 | 0 | 0 |
| 63 | -71.56 | -61.2 | 80.346 | 1.33706 | 129. | -.842037 | 1.03861 |
| 64 | -73.72 | -59.95 | 85.052 | 2.49447 | 128.1 | -1.53989 | 1.96243 |
| 65 | -75.88 | -58.7 | 89.758 | 3.52421 | 127.4 | -2.13821 | 2.80145 |
| 66 | -78.04 | -57.45 | 94.464 | 4.39801 | 126.7 | -2.629 | 3.52574 |
| 2J2 | -80.2 | -56.2 | 99.17 | 5.03142 | 126.2 | -2.97457 | 4.05797 |
| END | -91. | -62.45 | 75.64 | 0 | 0 | 0 | 0 |
| 68 | -88.84 | -61.2 | 80.346 | 1.39164 | 131.5 | -.922641 | 1.04182 |
| 69 | -86.68 | -59.95 | 85.052 | 2.58498 | 130.6 | -1.68176 | 1.96311 |
| 70 | -84.52 | -58.7 | 89.758 | 3.63833 | 129.7 | -2.32466 | 2.79883 |
| 71 | -82.36 | -57.45 | 94.464 | 4.52542 | 128.9 | -2.84299 | 3.52091 |
| 2J2 | -80.2 | -56.2 | 99.17 | 5.16333 | 128.3 | -3.19948 | 4.05256 |
| GND | -58.7 | -97.8 | 0 | 19.9347 | 218.1 | -15.6798 | -12.31 |
| 74 | -58.7 | -97.8 | 4.65524 | 14.55 | 217. | -11.6209 | -8.7554 |
| 75 | -58.7 | -97.8 | 9.31048 | 10.8409 | 215.4 | -8.83672 | -6.27993 |
| 76 | -58.7 | -97.8 | 13.9657 | 7.23721 | 212.1 | -6.13172 | -3.84437 |
| 77 | -58.7 | -97.8 | 18.621 | 3.72315 | 202.1 | -3.44859 | -1.40323 |
| 78 | -58.7 | -97.8 | 23.2762 | 1.30265 | 127.1 | -.786006 | 1.0388 |
| 79 | -58.7 | -97.8 | 27.9314 | 3.90648 | 62.1 | 1.82933 | 3.45169 |
| 80 | -58.7 | -97.8 | 32.5867 | 7.25215 | 53. | 4.35976 | 5.79535 |
| 81 | -58.7 | -97.8 | 37.2419 | 10.4957 | 49.9 | 6.76343 | 8.02588 |
| 82 | -58.7 | -97.8 | 41.8971 | 13.5264 | 48.3 | 8.99801 | 10.0994 |
| 83 | -58.7 | -97.8 | 46.5524 | 16.2759 | 47.4 | 11.0235 | 11.9744 |
| 84 | -58.7 | -97.8 | 51.2076 | 18.6894 | 46.8 | 12.8039 | 13.6144 |
| 85 | -58.7 | -97.8 | 55.8629 | 20.724 | 46.3 | 14.3102 | 14.99 |
| 86 | -58.7 | -97.8 | 60.5181 | 22.3512 | 46. | 15.5224 | 16.082 |
| 87 | -58.7 | -97.8 | 65.1733 | 23.562 | 45.8 | 16.4335 | 16.8851 |
| 88 | -58.7 | -97.8 | 69.8286 | 24.3731 | 45.6 | 17.0541 | 17.4128 |
| 89 | -58.7 | -97.8 | 74.4838 | 24.8285 | 45.5 | 17.4132 | 17.6984 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 90 | -58.7 | -97.8 | 79.1391 | 24.9739 | 45.4 | 17.5414 | 17.7762 |
| 91 | -58.7 | -97.8 | 83.7943 | 24.8186 | 45.3 | 17.4445 | 17.6537 |
| 92 | -58.7 | -97.8 | 88.4495 | 24.3469 | 45.3 | 17.1113 | 17.3198 |
| 93 | -58.7 | -97.8 | 93.1048 | 23.5458 | 45.4 | 16.5329 | 16.765 |
| J9 | -58.7 | -97.8 | 97.76 | 22.5437 | 45.5 | 15.7992 | 16.0811 |
| END | -58.7 | -85.3 | 74.57 | 0 | 0 | 0 | 0 |
| 94 | -58.7 | -87.8 | 79.208 | 2.12198 | 228.3 | -1.41125 | -1.58466 |
| 95 | -58.7 | -90.3 | 83.846 | 3.90267 | 228. | -2.60988 | -2.90162 |
| 96 | -58.7 | -92.8 | 88.484 | 5.44161 | 227.7 | -3.66167 | -4.02534 |
| 97 | -58.7 | -95.3 | 93.122 | 6.70925 | 227.4 | -4.54493 | -4.93535 |
| 2J2 | -58.7 | -97.8 | 97.76 | 7.6 | 227. | -5.18049 | -5.56081 |
| END | -47.9 | -104.05 | 74.57 | 0 | 0 | 0 | 0 |
| 99 | -50.06 | -102.8 | 79.208 | 2.08638 | 225.1 | -1.47356 | -1.47703 |
| 100 | -52.22 | -101.55 | 83.846 | 3.84251 | 224.9 | -2.72247 | -2.71165 |
| 101 | -54.38 | -100.3 | 88.484 | 5.36498 | 224.7 | -3.81277 | -3.77435 |
| 102 | -56.54 | -99.05 | 93.122 | 6.62326 | 224.5 | -4.72069 | -4.64571 |
| 2J2 | -58.7 | -97.8 | 97.76 | 7.51035 | 224.4 | -5.36578 | -5.25488 |
| END | -69.5 | -104.05 | 74.57 | 0 | 0 | 0 | 0 |
| 104 | -67.34 | -102.8 | 79.208 | 2.05563 | 225.9 | -1.43172 | -1.47505 |
| 105 | -65.18 | -101.55 | 83.846 | 3.79203 | 225.7 | -2.65034 | -2.71205 |
| 106 | -63.02 | -100.3 | 88.484 | 5.30189 | 225.5 | -3.71885 | -3.77892 |
| 107 | -60.86 | -99.05 | 93.122 | 6.55317 | 225.3 | -4.61326 | -4.65423 |
| 2J2 | -58.7 | -97.8 | 97.76 | 7.43759 | 225.1 | -5.25289 | -5.26545 |
| GND | 21.3 | -41.8 | 0 | 3.11087 | 225.5 | -2.18186 | -2.21744 |
| 110 | 21.3 | -41.8 | 4.40905 | 1.25596 | 229.4 | -.817755 | -.953258 |
| 111 | 21.3 | -41.8 | 8.8181 | .131401 | 282.1 | .0276017 | -.128469 |
| 112 | 21.3 | -41.8 | 13.2271 | 1.01625 | 39.5 | .783645 | .647039 |
| 113 | 21.3 | -41.8 | 17.6362 | 2.02984 | 43.3 | 1.47621 | 1.39321 |
| 114 | 21.3 | -41.8 | 22.0452 | 2.9894 | 45. | 2.11424 | 2.1134 |
| 115 | 21.3 | -41.8 | 26.4543 | 3.89015 | 46.1 | 2.69822 | 2.80231 |
| 116 | 21.3 | -41.8 | 30.8633 | 4.72414 | 46.9 | 3.22572 | 3.4514 |
| 117 | 21.3 | -41.8 | 35.2724 | 5.48205 | 47.6 | 3.69352 | 4.05102 |
| 118 | 21.3 | -41.8 | 39.6814 | 6.15455 | 48.2 | 4.09839 | 4.59149 |
| 119 | 21.3 | -41.8 | 44.0905 | 6.73323 | 48.8 | 4.43773 | 5.06389 |
| 120 | 21.3 | -41.8 | 48.4995 | 7.21133 | 49.2 | 4.70993 | 5.46076 |
| 121 | 21.3 | -41.8 | 52.9086 | 7.58453 | 49.6 | 4.9148 | 5.77666 |
| 122 | 21.3 | -41.8 | 57.3176 | 7.85191 | 49.9 | 5.05404 | 6.00909 |
| 123 | 21.3 | -41.8 | 61.7267 | 8.01737 | 50.2 | 5.13209 | 6.15953 |
| 124 | 21.3 | -41.8 | 66.1357 | 8.09132 | 50.4 | 5.1571 | 6.23489 |
| 125 | 21.3 | -41.8 | 70.5448 | 8.09037 | 50.6 | 5.14061 | 6.24726 |
| 126 | 21.3 | -41.8 | 74.9538 | 8.02955 | 50.6 | 5.0925 | 6.20807 |
| 127 | 21.3 | -41.8 | 79.3629 | 7.91169 | 50.7 | 5.01408 | 6.11996 |
| 128 | 21.3 | -41.8 | 83.7719 | 7.73051 | 50.7 | 4.90025 | 5.97899 |
| 129 | 21.3 | -41.8 | 88.181 | 7.47854 | 50.6 | 4.74501 | 5.78043 |
| J13 | 21.3 | -41.8 | 92.59 | 7.19233 | 50.5 | 4.57032 | 5.55354 |
| END | 21.3 | -29.3 | 70.62 | 0 | 0 | 0 | 0 |
| 130 | 21.3 | -31.8 | 75.014 | .675945 | 233.5 | -.401924 | -.543469 |
| 131 | 21.3 | -34.3 | 79.408 | 1.22826 | 233.7 | -.727953 | -.9893 |
| 132 | 21.3 | -36.8 | 83.802 | 1.69433 | 233.7 | -1.00269 | -1.36579 |
| 133 | 21.3 | -39.3 | 88.196 | 2.06905 | 233.7 | -1.22458 | -1.66774 |
| 2J2 | 21.3 | -41.8 | 92.59 | 2.32529 | 233.7 | -1.37819 | -1.87285 |
| END | 32.1 | -48.05 | 70.62 | 0 | 0 | 0 | 0 |
| 135 | 29.94 | -46.8 | 75.014 | .697869 | 225.7 | -.487249 | -.49961 |
| 136 | 27.78 | -45.55 | 79.408 | 1.2685 | 226.1 | -.880059 | -.913561 |
| 137 | 25.62 | -44.3 | 83.802 | 1.74874 | 226.4 | -1.20522 | -1.26711 |
| 138 | 23.46 | -43.05 | 88.196 | 2.13236 | 226.8 | -1.45938 | -1.55472 |
| 2J2 | 21.3 | -41.8 | 92.59 | 2.39158 | 227.2 | -1.62606 | -1.75373 |
| END | 10.5 | -48.05 | 70.62 | 0 | 0 | 0 | 0 |
| 140 | 12.66 | -46.8 | 75.014 | .743454 | 230.1 | -.476742 | -.570474 |
| 141 | 14.82 | -45.55 | 79.408 | 1.33904 | 230.3 | -.854511 | -1.03094 |
| 142 | 16.98 | -44.3 | 83.802 | 1.83244 | 230.6 | -1.16393 | -1.4153 |
| 143 | 19.14 | -43.05 | 88.196 | 2.22183 | 230.8 | -1.40544 | -1.72084 |
| 2J2 | 21.3 | -41.8 | 92.59 | 2.48308 | 230.9 | -1.56607 | -1.92695 |

# APPENDIX C

# NIGHTTIME DIRECTIONAL ARRAY MODEL

IMPEDANCE – NIGHTTIME OPERATION
normalization = 50.

| freq (MHz) | resist (ohms) | react (ohms) | imped (ohms) | phase (deg) | VSWR | S11 dB | S12 dB |
|---|---|---|---|---|---|---|---|
| source = 1; node 1, sector 1 | | | | | | | |
| 1.6 | 39.762 | -179.08 | 183.45 | 282.5 | 18.129 | -.9592 | -7.0295 |
| source = 2; node 37, sector 1 | | | | | | | |
| 1.6 | 38.335 | -157.1 | 161.71 | 283.7 | 14.88 | -1.1692 | -6.2705 |
| source = 3; node 73, sector 1 | | | | | | | |
| 1.6 | -8.843 | -203.06 | 203.25 | 267.5 | **** | **** | **** |
| source = 4; node 109, sector 1 | | | | | | | |
| 1.6 | -10.389 | -273.98 | 274.18 | 267.8 | **** | **** | **** |

GEOMETRY – NIGHTTIME OPERATION
Dimensions in meters
Environment: perfect ground

| wire | caps | X | Y | Z | radius | segs |
|---|---|---|---|---|---|---|
| 1 | none | 0 | 0 | 0 | .4851 | 21 |
| | | 0 | 0 | 97.29 | | |
| 2 | none | 0 | 12.5 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 3 | none | 10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 4 | none | -10.8 | -6.25 | 74.21 | .05 | 5 |
| | | 0 | 0 | 97.29 | | |
| 5 | none | -80.2 | -56.2 | 0 | .4851 | 21 |
| | | -80.2 | -56.2 | 99.17 | | |
| 6 | none | -80.2 | -43.7 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 7 | none | -69.4 | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 8 | none | -91. | -62.45 | 75.64 | .05 | 5 |
| | | -80.2 | -56.2 | 99.17 | | |
| 9 | none | -58.7 | -97.8 | 0 | .4851 | 21 |
| | | -58.7 | -97.8 | 97.76 | | |
| 10 | none | -58.7 | -85.3 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 11 | none | -47.9 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 12 | none | -69.5 | -104.05 | 74.57 | .05 | 5 |
| | | -58.7 | -97.8 | 97.76 | | |
| 13 | none | 21.3 | -41.8 | 0 | .4851 | 21 |
| | | 21.3 | -41.8 | 92.59 | | |
| 14 | none | 21.3 | -29.3 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 15 | none | 32.1 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |
| 16 | none | 10.5 | -48.05 | 70.62 | .05 | 5 |
| | | 21.3 | -41.8 | 92.59 | | |

Number of wires = 16
current nodes = 144

| Individual wires | minimum wire | minimum value | maximum wire | maximum value |
|---|---|---|---|---|
| segment length | 13 | 4.40905 | 6 | 5.32883 |
| segment/radius ratio | 13 | 9.08895 | 6 | 106.577 |
| radius | 2 | .05 | 1 | .4851 |

ELECTRICAL DESCRIPTION – NIGHTTIME OPERATION

Frequencies (MHz)

| no. | frequency lowest | step | no. of steps | segment length (wavelengths) minimum | maximum |
|---|---|---|---|---|---|
| 1 | 1.6 | 0 | 1 | .0235306 | .0284394 |

Sources

| source | node | sector | magnitude | phase | type |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 2,136.01 | 78.2 | voltage |
| 2 | 37 | 1 | 1,979.67 | 71.5 | voltage |
| 3 | 73 | 1 | 1,712.85 | 181.1 | voltage |
| 4 | 109 | 1 | 1,917.14 | 185.3 | voltage |

Lumped loads

| load | node | resistance (ohms) | reactance (ohms) | inductance (mH) | capacitance (uF) | passive circuit |
|---|---|---|---|---|---|---|
| 1 | 1 | .01 | 0 | 0 | 0 | 0 |
| 2 | 37 | .01 | 0 | 0 | 0 | 0 |
| 3 | 73 | .01 | 0 | 0 | 0 | 0 |
| 4 | 109 | .01 | 0 | 0 | 0 | 0 |

RMS CURRENT – NIGHTTIME OPERATION
Frequency = 1.6 MHz
Input power = 5,000. watts
Efficiency = 99.96 %
coordinates in meters

| current no. | X | Y | Z | mag (amps) | phase (deg) | real (amps) | imaginary (amps) |
|---|---|---|---|---|---|---|---|
| GND | 0 | 0 | 0 | 8.23345 | 155.6 | -7.50035 | 3.39623 |
| 2 | 0 | 0 | 4.63286 | 6.26978 | 151.7 | -5.52293 | 2.96773 |
| 3 | 0 | 0 | 9.26572 | 4.93338 | 147.6 | -4.16603 | 2.64244 |
| 4 | 0 | 0 | 13.8986 | 3.65895 | 141.1 | -2.84613 | 2.29945 |
| 5 | 0 | 0 | 18.5314 | 2.4707 | 128.4 | -1.53577 | 1.9354 |
| 6 | 0 | 0 | 23.1643 | 1.57109 | 98.6 | -.234849 | 1.55344 |
| 7 | 0 | 0 | 27.7971 | 1.56008 | 48. | 1.04296 | 1.16021 |
| 8 | 0 | 0 | 32.43 | 2.40328 | 18.5 | 2.27864 | .763901 |
| 9 | 0 | 0 | 37.0629 | 3.47129 | 6.2 | 3.45115 | .373417 |
| 10 | 0 | 0 | 41.6957 | 4.53932 | 360. | 4.53932 | -2.24E-03 |
| 11 | 0 | 0 | 46.3286 | 5.53456 | 356.3 | 5.5232 | -.35434 |
| 12 | 0 | 0 | 50.9614 | 6.42072 | 354. | 6.38515 | -.674863 |
| 13 | 0 | 0 | 55.5943 | 7.17503 | 352.3 | 7.11095 | -.956807 |
| 14 | 0 | 0 | 60.2271 | 7.78335 | 351.2 | 7.69113 | -1.19459 |
| 15 | 0 | 0 | 64.86 | 8.24003 | 350.3 | 8.12289 | -1.38448 |
| 16 | 0 | 0 | 69.4929 | 8.54929 | 349.7 | 8.41216 | -1.52507 |
| 17 | 0 | 0 | 74.1257 | 8.72555 | 349.3 | 8.5743 | -1.61755 |
| 18 | 0 | 0 | 78.7586 | 8.78467 | 349.1 | 8.6255 | -1.66467 |
| 19 | 0 | 0 | 83.3914 | 8.73064 | 349. | 8.56964 | -1.66897 |
| 20 | 0 | 0 | 88.0243 | 8.55966 | 349. | 8.40248 | -1.63282 |
| 21 | 0 | 0 | 92.6571 | 8.26868 | 349.1 | 8.12041 | -1.55882 |
| J1 | 0 | 0 | 97.29 | 7.90397 | 349.4 | 7.76833 | -1.45802 |
| END | 0 | 12.5 | 74.21 | 0 | 0 | 0 | 0 |
| 22 | 0 | 10. | 78.826 | .730185 | 173.1 | -.724947 | .0873029 |
| 23 | 0 | 7.5 | 83.442 | 1.34839 | 172.4 | -1.33662 | .177768 |
| 24 | 0 | 5. | 88.058 | 1.88783 | 171.7 | -1.86821 | .271444 |
| 25 | 0 | 2.5 | 92.674 | 2.33695 | 171.1 | -2.3086 | .362921 |
| 2J2 | 0 | 0 | 97.29 | 2.65603 | 170.5 | -2.61959 | .438451 |
| END | 10.8 | -6.25 | 74.21 | 0 | 0 | 0 | 0 |
| 27 | 8.64 | -5. | 78.826 | .715439 | 168.8 | -.701837 | .138843 |
| 28 | 6.48 | -3.75 | 83.442 | 1.32589 | 168.3 | -1.29855 | .26788 |
| 29 | 4.32 | -2.5 | 88.058 | 1.86148 | 167.9 | -1.82026 | .389537 |
| 30 | 2.16 | -1.25 | 92.674 | 2.30922 | 167.5 | -2.25482 | .498295 |
| 2J2 | 0 | 0 | 97.29 | 2.62821 | 167.2 | -2.56328 | .580607 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| END | -10.8 | -6.25 | 74.21 | 0 | 0 | 0 | 0 |
| 32 | -8.64 | -5. | 78.826 | .718152 | 173.4 | -.713435 | .0821707 |
| 33 | -6.48 | -3.75 | 83.442 | 1.32751 | 172.5 | -1.31624 | .172618 |
| 34 | -4.32 | -2.5 | 88.058 | 1.86046 | 171.7 | -1.84099 | .268436 |
| 35 | -2.16 | -1.25 | 92.674 | 2.30537 | 171. | -2.27673 | .362297 |
| 2J2 | 0 | 0 | 97.29 | 2.62246 | 170.4 | -2.58546 | .438958 |
| GND | -80.2 | -56.2 | 0 | 8.65633 | 147.8 | -7.32145 | 4.61826 |
| 38 | -80.2 | -56.2 | 4.72238 | 6.81408 | 144.1 | -5.51885 | 3.99674 |
| 39 | -80.2 | -56.2 | 9.44476 | 5.52274 | 140.4 | -4.25412 | 3.52181 |
| 40 | -80.2 | -56.2 | 14.1671 | 4.26096 | 134.9 | -3.00553 | 3.02036 |
| 41 | -80.2 | -56.2 | 18.8895 | 3.04151 | 125.1 | -1.75002 | 2.48761 |
| 42 | -80.2 | -56.2 | 23.6119 | 1.98964 | 104.3 | -.490138 | 1.92832 |
| 43 | -80.2 | -56.2 | 28.3343 | 1.55065 | 60.7 | .758846 | 1.35229 |
| 44 | -80.2 | -56.2 | 33.0567 | 2.12183 | 21.3 | 1.97658 | .771567 |
| 45 | -80.2 | -56.2 | 37.7791 | 3.14703 | 3.6 | 3.14071 | .199264 |
| 46 | -80.2 | -56.2 | 42.5014 | 4.24338 | 355.3 | 4.22881 | -.351308 |
| 47 | -80.2 | -56.2 | 47.2238 | 5.29112 | 350.6 | 5.21956 | -.867252 |
| 48 | -80.2 | -56.2 | 51.9462 | 6.2388 | 347.6 | 6.09393 | -1.33664 |
| 49 | -80.2 | -56.2 | 56.6686 | 7.05656 | 345.6 | 6.83636 | -1.74907 |
| 50 | -80.2 | -56.2 | 61.391 | 7.72583 | 344.3 | 7.436 | -2.09625 |
| 51 | -80.2 | -56.2 | 66.1133 | 8.238 | 343.3 | 7.88891 | -2.37273 |
| 52 | -80.2 | -56.2 | 70.8357 | 8.59537 | 342.6 | 8.20003 | -2.5768 |
| 53 | -80.2 | -56.2 | 75.5581 | 8.81153 | 342.1 | 8.38416 | -2.71088 |
| 54 | -80.2 | -56.2 | 80.2805 | 8.90205 | 341.8 | 8.457 | -2.77952 |
| 55 | -80.2 | -56.2 | 85.0029 | 8.87023 | 341.7 | 8.42143 | -2.78576 |
| 56 | -80.2 | -56.2 | 89.7252 | 8.71127 | 341.7 | 8.27187 | -2.73171 |
| 57 | -80.2 | -56.2 | 94.4476 | 8.42216 | 341.9 | 8.00423 | -2.62012 |
| J5 | -80.2 | -56.2 | 99.17 | 8.05096 | 342.1 | 7.66313 | -2.46866 |
| END | -80.2 | -43.7 | 75.64 | 0 | 0 | 0 | 0 |
| 58 | -80.2 | -46.2 | 80.346 | .737188 | 167.7 | -.720153 | .157562 |
| 59 | -80.2 | -48.7 | 85.052 | 1.36178 | 166.7 | -1.32524 | .313344 |
| 60 | -80.2 | -51.2 | 89.758 | 1.90743 | 165.8 | -1.84899 | .468554 |
| 61 | -80.2 | -53.7 | 94.464 | 2.36274 | 164.9 | -2.2813 | .614989 |
| 2J2 | -80.2 | -56.2 | 99.17 | 2.68784 | 164.2 | -2.58614 | .732357 |
| END | -69.4 | -62.45 | 75.64 | 0 | 0 | 0 | 0 |
| 63 | -71.56 | -61.2 | 80.346 | .720697 | 163.1 | -.689481 | .209812 |
| 64 | -73.72 | -59.95 | 85.052 | 1.33824 | 162.3 | -1.27518 | .405988 |
| 65 | -75.88 | -58.7 | 89.758 | 1.88182 | 161.7 | -1.78655 | .591155 |
| 66 | -78.04 | -57.45 | 94.464 | 2.33762 | 161.1 | -2.21187 | .756378 |
| 2J2 | -80.2 | -56.2 | 99.17 | 2.6638 | 160.7 | -2.51382 | .881203 |
| END | -91. | -62.45 | 75.64 | 0 | 0 | 0 | 0 |
| 68 | -88.84 | -61.2 | 80.346 | .736102 | 164. | -.707665 | .202621 |
| 69 | -86.68 | -59.95 | 85.052 | 1.36377 | 163.3 | -1.30641 | .391367 |
| 70 | -84.52 | -58.7 | 89.758 | 1.91424 | 162.7 | -1.82727 | .570452 |
| 71 | -82.36 | -57.45 | 94.464 | 2.37424 | 162. | -2.25866 | .731756 |
| 2J2 | -80.2 | -56.2 | 99.17 | 2.70204 | 161.6 | -2.56317 | .855097 |
| GND | -58.7 | -97.8 | 0 | 5.95907 | 273.6 | .375863 | -5.94721 |
| 74 | -58.7 | -97.8 | 4.65524 | 4.33111 | 274.4 | .334376 | -4.31818 |
| 75 | -58.7 | -97.8 | 9.31048 | 3.19998 | 275.1 | .283785 | -3.18737 |
| 76 | -58.7 | -97.8 | 13.9657 | 2.08888 | 275.9 | .21607 | -2.07767 |
| 77 | -58.7 | -97.8 | 18.621 | .976716 | 277.8 | .132892 | -.967633 |
| 78 | -58.7 | -97.8 | 23.2762 | .146082 | 75.3 | .0369975 | .141319 |
| 79 | -58.7 | -97.8 | 27.9314 | 1.23813 | 93.2 | -.0681567 | 1.23625 |
| 80 | -58.7 | -97.8 | 32.5867 | 2.30659 | 94.4 | -.178706 | 2.29965 |
| 81 | -58.7 | -97.8 | 37.2419 | 3.325 | 95. | -.290603 | 3.31227 |
| 82 | -58.7 | -97.8 | 41.8971 | 4.27348 | 95.4 | -.399807 | 4.25474 |
| 83 | -58.7 | -97.8 | 46.5524 | 5.13339 | 95.6 | -.502469 | 5.10874 |
| 84 | -58.7 | -97.8 | 51.2076 | 5.88818 | 95.8 | -.595112 | 5.85803 |
| 85 | -58.7 | -97.8 | 55.8629 | 6.52441 | 95.9 | -.674809 | 6.48941 |
| 86 | -58.7 | -97.8 | 60.5181 | 7.03301 | 96. | -.739407 | 6.99403 |
| 87 | -58.7 | -97.8 | 65.1733 | 7.41103 | 96.1 | -.787759 | 7.36904 |
| 88 | -58.7 | -97.8 | 69.8286 | 7.66364 | 96.1 | -.820067 | 7.61964 |
| 89 | -58.7 | -97.8 | 74.4838 | 7.80482 | 96.2 | -.837886 | 7.75972 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 90 | -58.7 | -97.8 | 79.1391 | 7.84906 | 96.2 | -.843317 | 7.80363 |
| 91 | -58.7 | -97.8 | 83.7943 | 7.79952 | 96.2 | -.837568 | 7.75441 |
| 92 | -58.7 | -97.8 | 88.4495 | 7.65132 | 96.2 | -.821184 | 7.60712 |
| 93 | -58.7 | -97.8 | 93.1048 | 7.4006 | 96.2 | -.794781 | 7.3578 |
| J9 | -58.7 | -97.8 | 97.76 | 7.08783 | 96.2 | -.763735 | 7.04656 |
| END | -58.7 | -85.3 | 74.57 | 0 | 0 | 0 | 0 |
| 94 | -58.7 | -87.8 | 79.208 | .683253 | 278.8 | .103948 | -.6753 |
| 95 | -58.7 | -90.3 | 83.846 | 1.255 | 278.7 | .190251 | -1.24049 |
| 96 | -58.7 | -92.8 | 88.484 | 1.74705 | 278.6 | .261788 | -1.72732 |
| 97 | -58.7 | -95.3 | 93.122 | 2.14998 | 278.5 | .316237 | -2.1266 |
| 2J2 | -58.7 | -97.8 | 97.76 | 2.4309 | 278.3 | .349677 | -2.40562 |
| END | -47.9 | -104.05 | 74.57 | 0 | 0 | 0 | 0 |
| 99 | -50.06 | -102.8 | 79.208 | .647736 | 274.4 | .0493737 | -.645851 |
| 100 | -52.22 | -101.55 | 83.846 | 1.1929 | 274.4 | .0922421 | -1.18933 |
| 101 | -54.38 | -100.3 | 88.484 | 1.6656 | 274.5 | .130757 | -1.66046 |
| 102 | -56.54 | -99.05 | 93.122 | 2.05649 | 274.6 | .163983 | -2.04994 |
| 2J2 | -58.7 | -97.8 | 97.76 | 2.33238 | 274.6 | .188724 | -2.32473 |
| END | -69.5 | -104.05 | 74.57 | 0 | 0 | 0 | 0 |
| 104 | -67.34 | -102.8 | 79.208 | .643191 | 275.4 | .0604116 | -.640348 |
| 105 | -65.18 | -101.55 | 83.846 | 1.18674 | 275.5 | .112934 | -1.18135 |
| 106 | -63.02 | -100.3 | 88.484 | 1.65936 | 275.5 | .159446 | -1.65168 |
| 107 | -60.86 | -99.05 | 93.122 | 2.05081 | 275.5 | .198196 | -2.04121 |
| 2J2 | -58.7 | -97.8 | 97.76 | 2.32714 | 275.6 | .225334 | -2.31621 |
| GND | 21.3 | -41.8 | 0 | 4.94429 | 277.5 | .644534 | -4.90209 |
| 110 | 21.3 | -41.8 | 4.40905 | 3.19418 | 278.5 | .473777 | -3.15884 |
| 111 | 21.3 | -41.8 | 8.8181 | 2.04694 | 279.6 | .342413 | -2.0181 |
| 112 | 21.3 | -41.8 | 13.2271 | .963487 | 282.1 | .201519 | -.942177 |
| 113 | 21.3 | -41.8 | 17.6362 | .109005 | 62.5 | .0502882 | .0967124 |
| 114 | 21.3 | -41.8 | 22.0452 | 1.10895 | 95.7 | -.109404 | 1.10354 |
| 115 | 21.3 | -41.8 | 26.4543 | 2.08945 | 97.5 | -.274146 | 2.07139 |
| 116 | 21.3 | -41.8 | 30.8633 | 3.02108 | 98.4 | -.439815 | 2.9889 |
| 117 | 21.3 | -41.8 | 35.2724 | 3.88988 | 98.9 | -.601984 | 3.84302 |
| 118 | 21.3 | -41.8 | 39.6814 | 4.68209 | 99.3 | -.756194 | 4.62062 |
| 119 | 21.3 | -41.8 | 44.0905 | 5.38492 | 99.6 | -.898195 | 5.30948 |
| 120 | 21.3 | -41.8 | 48.4995 | 5.98731 | 99.8 | -1.02414 | 5.89907 |
| 121 | 21.3 | -41.8 | 52.9086 | 6.48082 | 100. | -1.13081 | 6.3814 |
| 122 | 21.3 | -41.8 | 57.3176 | 6.8606 | 100.2 | -1.21588 | 6.752 |
| 123 | 21.3 | -41.8 | 61.7267 | 7.12675 | 100.3 | -1.27817 | 7.0112 |
| 124 | 21.3 | -41.8 | 66.1357 | 7.28596 | 100.4 | -1.31806 | 7.16575 |
| 125 | 21.3 | -41.8 | 70.5448 | 7.35138 | 100.5 | -1.33753 | 7.22868 |
| 126 | 21.3 | -41.8 | 74.9538 | 7.33642 | 100.5 | -1.33898 | 7.21319 |
| 127 | 21.3 | -41.8 | 79.3629 | 7.24527 | 100.5 | -1.32373 | 7.12332 |
| 128 | 21.3 | -41.8 | 83.7719 | 7.07573 | 100.5 | -1.29215 | 6.95675 |
| 129 | 21.3 | -41.8 | 88.181 | 6.82465 | 100.5 | -1.24466 | 6.71019 |
| J13 | 21.3 | -41.8 | 92.59 | 6.52859 | 100.5 | -1.18886 | 6.41943 |
| END | 21.3 | -29.3 | 70.62 | 0 | 0 | 0 | 0 |
| 130 | 21.3 | -31.8 | 75.014 | .614332 | 282.4 | .131868 | -.600013 |
| 131 | 21.3 | -34.3 | 79.408 | 1.13026 | 282.4 | .243565 | -1.10371 |
| 132 | 21.3 | -36.8 | 83.802 | 1.5768 | 282.4 | .339479 | -1.53982 |
| 133 | 21.3 | -39.3 | 88.196 | 1.94499 | 282.4 | .416663 | -1.89984 |
| 2J2 | 21.3 | -41.8 | 92.59 | 2.20302 | 282.3 | .468313 | -2.15267 |
| END | 32.1 | -48.05 | 70.62 | 0 | 0 | 0 | 0 |
| 135 | 29.94 | -46.8 | 75.014 | .588547 | 278.5 | .0865704 | -.582145 |
| 136 | 27.78 | -45.55 | 79.408 | 1.08485 | 278.6 | .161515 | -1.07276 |
| 137 | 25.62 | -44.3 | 83.802 | 1.51681 | 278.7 | .228976 | -1.49943 |
| 138 | 23.46 | -43.05 | 88.196 | 1.8757 | 278.8 | .287538 | -1.85352 |
| 2J2 | 21.3 | -41.8 | 92.59 | 2.12959 | 279. | .331403 | -2.10365 |
| END | 10.5 | -48.05 | 70.62 | 0 | 0 | 0 | 0 |
| 140 | 12.66 | -46.8 | 75.014 | .615865 | 279.7 | .103648 | -.607081 |
| 141 | 14.82 | -45.55 | 79.408 | 1.13041 | 279.9 | .193586 | -1.11371 |
| 142 | 16.98 | -44.3 | 83.802 | 1.5747 | 280. | .27368 | -1.55073 |
| 143 | 19.14 | -43.05 | 88.196 | 1.94093 | 280.1 | .341236 | -1.91069 |
| 2J2 | 21.3 | -41.8 | 92.59 | 2.19784 | 280.2 | .389145 | -2.16312 |