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January 16, 2020

MFG IDENT CODE **4HVG5**	**PROJECT CODE**	SIERRA NEVADA CORPORATION INTEGRATED MISSION SYSTEMS **18635 Jarkey Drive** **Hagerstown, MD 21742**

REVISIONS					
Issues	**Descriptions**	**Date**	**Author**	**TW/Checker**	**Engineering**
A	Initial Release				

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1.0 INTRODUCTION

1.1 GENERAL

Sierra Nevada Corporation (SNC), located at 18635 Jarkey Drive Hagerstown, MD. wished to apply for an experimental station license for a large number of frequencies. SNC was recently granted a Special Temporary Authority (STA) with call sign WP9XNK from the FCC that is due to expire on 02/29/2020. SNC would like to add frequencies to support further aircraft testing that will be accomplished over the next two years. It is SNC's understanding that the STA authorization is a one-time six month approval and it is advised to get an Experimental License. Due to the unique nature of our testing, the number of frequencies requested and the anticipated need, it is rationalized that adding frequencies via a Form 442 request is the best approach. SNC is a Systems Integrator specializing in modifications to aircraft and producing Intelligence, Surveillance and Reconnaissance (ISR) systems for the United States Government as well as Foreign Military Sale. Final testing of the platform pre-delivery requires transmitting on known frequencies to exercise the installed equipment to validate performance requirements. The purpose of this exhibit is to document current needs, detail equipment that will be utilized, define the proposed test area and identify the frequency needs.

1.2 CURRENT NEEDS

SNC was recently awarded a contract with the U.S. Army to modify seven King Air Guardrail Common Sensor (GRCS) Aircraft with upgraded systems under contract NRO000-15-C-0346. Part of this contract will require re-verification (calibration) of an existing system on the aircraft. This system is a receive only system that operates in a range from 20 MHz to 1000 Mhz. To calibrate this system it will be necessary to transmit RF energy from a ground station to the aircraft while airborne across this wide span at known frequencies/amplitudes. The spectral energy received at the aircraft is then collected and analyzed to produce calibration tables used by this system during operational use. Due to the wideband nature of this system it will be necessary to transmit across the entire 20 MHz to 963 MHz band at a frequency spacing of 1.3%. These frequencies will be rounded to the nearest 5 kHz. See Table 1 below:

#	Frequency (20 MHz)
1	**20**
2	20 x 1.013 = **20.26**
3	20.26 x 1.013 = 20.52338 => **20.525**
4	20.525 x 1.013 = 20.791825 => **20.79**
	...
201	261.42 x 1.013 = 264.81846 => **264.82**
202	264.82 x 1.013 = 268.26266 => **268.265**
	...

Table 1: Frequency Example

It will be necessary to transmit 8 frequencies simultaneously during these calibration events. Each group of eight frequencies is defined as a Set. There are approximately 40 frequency Sets planned to cover the span of 20 MHz to 963 Mhz. The transmit system when commanded by the operator will automatically start at frequency set one, transmit that set for 10 milliseconds, end transmission and transition to frequency set two, transmit on that set for 10 milliseconds, end transmission and so on until all forty sets are complete. At the completion of all forty sets the system will start back at frequency set one and repeat. It is anticipated that it will require one flight per day for two days. Each flight is estimated at four hours.

2.0 TRANSMITTING EQUIPMENT

To automatically generate these frequency sets and to control the transmission length and timing SNC is required to utilize special equipment. For generation of individual frequencies SNC will utilize a National Instruments PXIe Chassis outfitted with a National Instruments 5840 Vector Signal Transceiver (VST). This device is used to consolidate frequency sets, allocate timing of each set and generate the RF signal set (that contains 8 individual frequencies). The output of the VST is then applied to the input of an AR amplifier which amplifies the signal set to 100 watts. When generating multiple frequencies within the set, the 100 watt output of the amp is divided up between the individual frequencies. The output of the amplifier is cabled to a log periodic transportable antenna that will be oriented in the vertical position.

2.1 NATIONAL INSTRUMENTS 5840 VST

The signal generation of the system resides within the National Instruments PXIe-1082 Chassis. The chassis contains the following Modules: PXIe-8861 Embedded Controller, and a PXI-5480 Vector Signal Transceiver (VST). The Embedded Controller is a Windows 10 computer that executes the LabVIEW operating environment code for timing, control and generation of signal sets. The GPS timing module provides an external time source to all components within the chassis and allows stable synchronization between the aircraft and the ground station. SNC developed LabVIEW code provides the user interface. Using this code the operator can import pre-programmed signal sets and generate the frequencies necessary. The VST operates as the signal generator in this system, generating low level RF outputs that are then applied to the AR amplifier.

2.2 AR AMPLIFIER

The Model 100U1000 is a solid-state, self-contained, air-cooled, broadband amplifier designed for applications where instantaneous bandwidth, high gain and linearity are required. The amplifier is rated for a frequency range of 10kHz to 1000 MHz and will provide 100W(typical) minimum output power. The maximum input rating for the amplifier is 1.0 mW. The amplifier receives an RF input from the VST, amplifies it accordingly and provides an amplified signal to the antenna to be transmitted over free space. Reference Table 2 for amplifier specifications.

Table 2: Amplifier Specifications

100U1000 Electrical Specifications	
Specification	**Performance**
Frequency Range	10 kHz-1000 MHz
Input Impedance	1.5:1 (50 Ohm) maximum
Output Impedance	50 ohms nominal
Gain @ max setting	50 dB minimum
Flatness	+/- 1.5 dB typical, 2.0 dB max
Noise Figure	8.5 db typical

Harmonic Distortion max @100W	-20 dBc
Harmonic Distortion typ. @100W	-30 dBc
Third Order Intercept	60 dBm typical

2.3 TLP-20 ANTENNA

The TLP-20 is a tactical log periodic antenna that cover the 20 Mhz-1000 MHz frequency range and is designed for transmit and receive purposes. The antenna uses a three piece boom for quick assembly in the field and can be used in the vertical or horizontal mode. In this application it will be used in the vertical polarization mode. The antenna will provide 4-8 dbi of gain to the system. The antenna will be fastened to a mast assembly mounted on a rotator. The rotator will position the antenna to automatically track the flight path of the aircraft. Software will limit transmission to a 60 degree cone between a magnetic direction of 240 degrees to 300 degrees. This is to keep the main beam of the antenna focused during the test event. The height of the antenna above ground level is 5.2 meters (17 feet). Reference Table 3 below for electrical specification of the antenna.

Table 3: Antenna Specifications

TLP-20 Electrical Specifications	
Specification	**Performance**
Frequency Range	20 MHz-1000 MHz
VSWR	2.0:1 (50 Ohm) typical
Gain	4-8 dbi
Polarization	Linear
Vertical -3 dB Beamwidth	40-90 degrees
Horizontal -3 dB Beamwidth	70-140 degrees
Power Input	200 Watts

2.4 SCAN PLAN

The ground calibration source transmits multiple narrowband tones at once based upon the frequency set, while the airborne sensor collects the same multiple frequencies within a wideband tune. This is then repeated for the next set of frequencies working up through the 20 MHz to 963 MHz range. The system will then repeat this loop as the aircraft flies a predetermined flight path and RF data is collected at different arrival angles with respect to the ground station. The airborne system will collect frequency data over a 25 millisecond period, however the ground station will only be transmitting for 10 milliseconds within that period. The External Collect bars depicted below in green are the only times that ground station will be radiating RF energy. With 40 frequency sets (each containing 8 frequencies), it is anticipated that one full cycle of this plan will take 1 second. This will, however have to be repeated for a period of 4 hours to collect the necessary data.

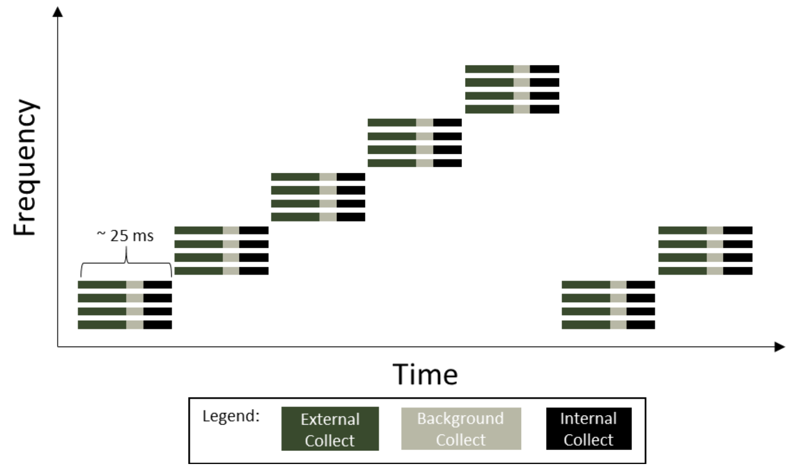

Figure 1: Scan Plan Illustration

2.5 RADIATION FREQUENCY

SNC is under contract to modify seven (7) aircraft over the next two years. It is anticipated that this testing will occur on each aircraft over a period of two days approximately 120 days apart. It is anticipated that the total number of days necessary to complete this testing will be fourteen (14).

2.6 SIGNAL CHARACTERISTICS

SNC will generate signals across the band of 20 MHz to 963 MHz. Up to eight individual carriers will be generated for each frequency set. Approximately forty frequency sets will be generated for 10 milliseconds each. The power level of each carrier signal will be 10 W maximum with an maximum individual signal bandwidth of .5 kHz measured at the -3db point. See Figure 2 spectral plot.

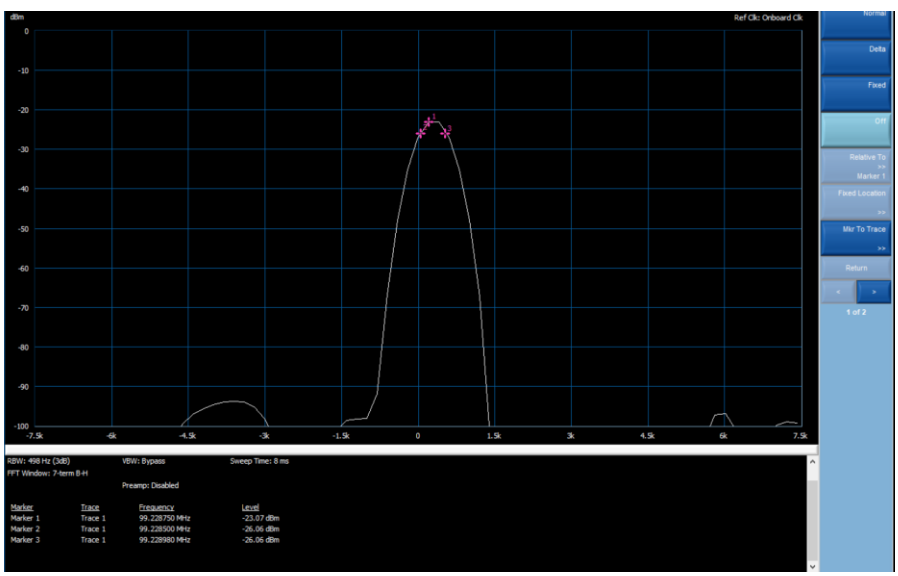

Figure 2: Single Carrier Plot

3.0 TEST SITE

The proposed test site will include a fixed location for the ground transmit equipment as well as airspace to the West of Hagerstown Regional Airport. The ground transmit equipment will be housed in an enclosed trailer which will be moved to the ramp area. Figure 3 represents the location of the ground transmit location and transmit azimuth directions. For testing the directional azimuth will be limited from 240 degrees to 300 degrees creating a 60 degree transmit cone to the west. No transmit operations will be conducted between 300 degrees and 240 degrees.

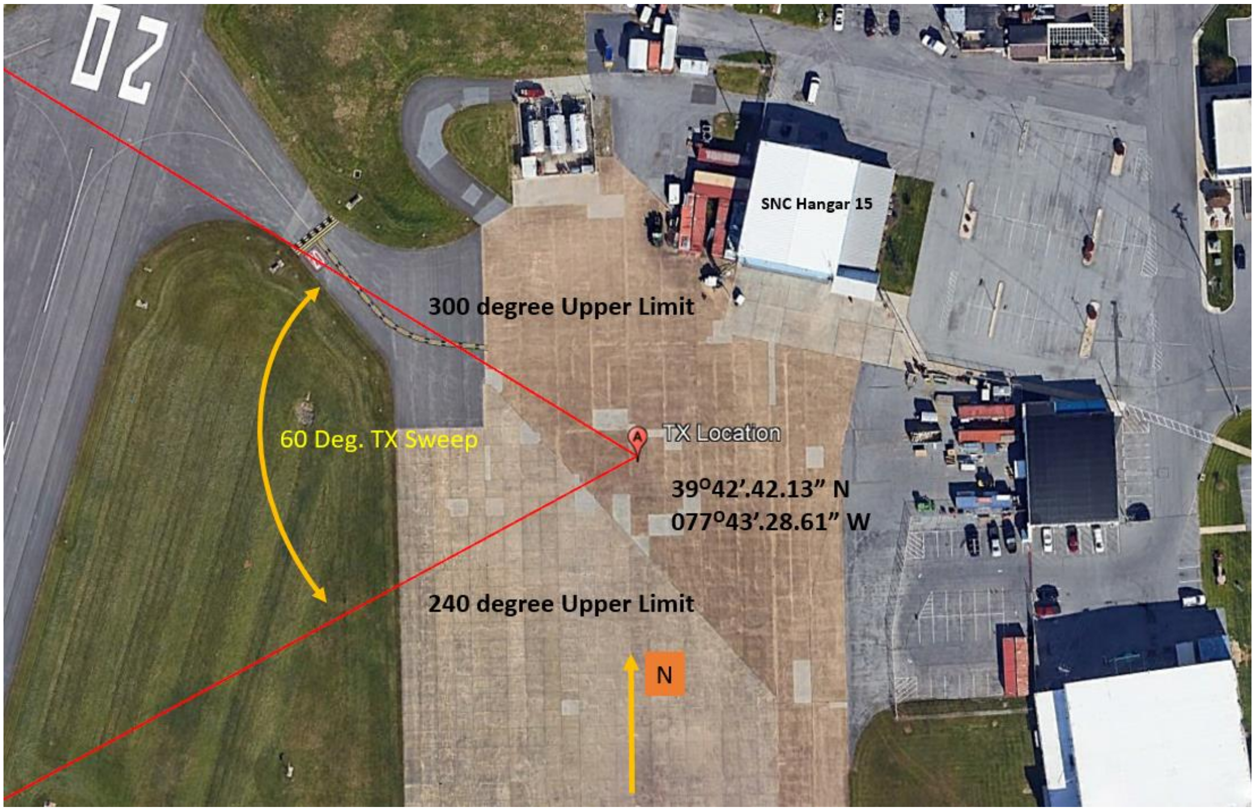

Figure 3: Ground Test Site

The flight test area is to the west of the ground test sight. The aircraft will fly established arcs starting at a distance of 24 miles from the ground test site in both a north/south and south/north direction. During these test arcs the ground station will emit RF energy at the aircraft in pre-programmed frequency sets. At the termination of the test arcs transmit operations will cease, the aircraft will turn around and fly the test arc in the opposite direction. When the aircraft is established on the flight path transmit operations will begin again throughout the test arc. The flight routes will be repeated at various altitudes during the collection effort. The aircraft will collect this spectral data for use in development of calibration tables that will be eventually used for the system under test in an operational environment. Figure 4 provides a larger overview and represent the anticipated flight area, depicts the transmit site location, azimuth limits of transmit operations and flight tracks. It is intended to complete these calibration flights during periods of darkness from 2200 hours to 0600. This reduces the amount of ambient RF noise.

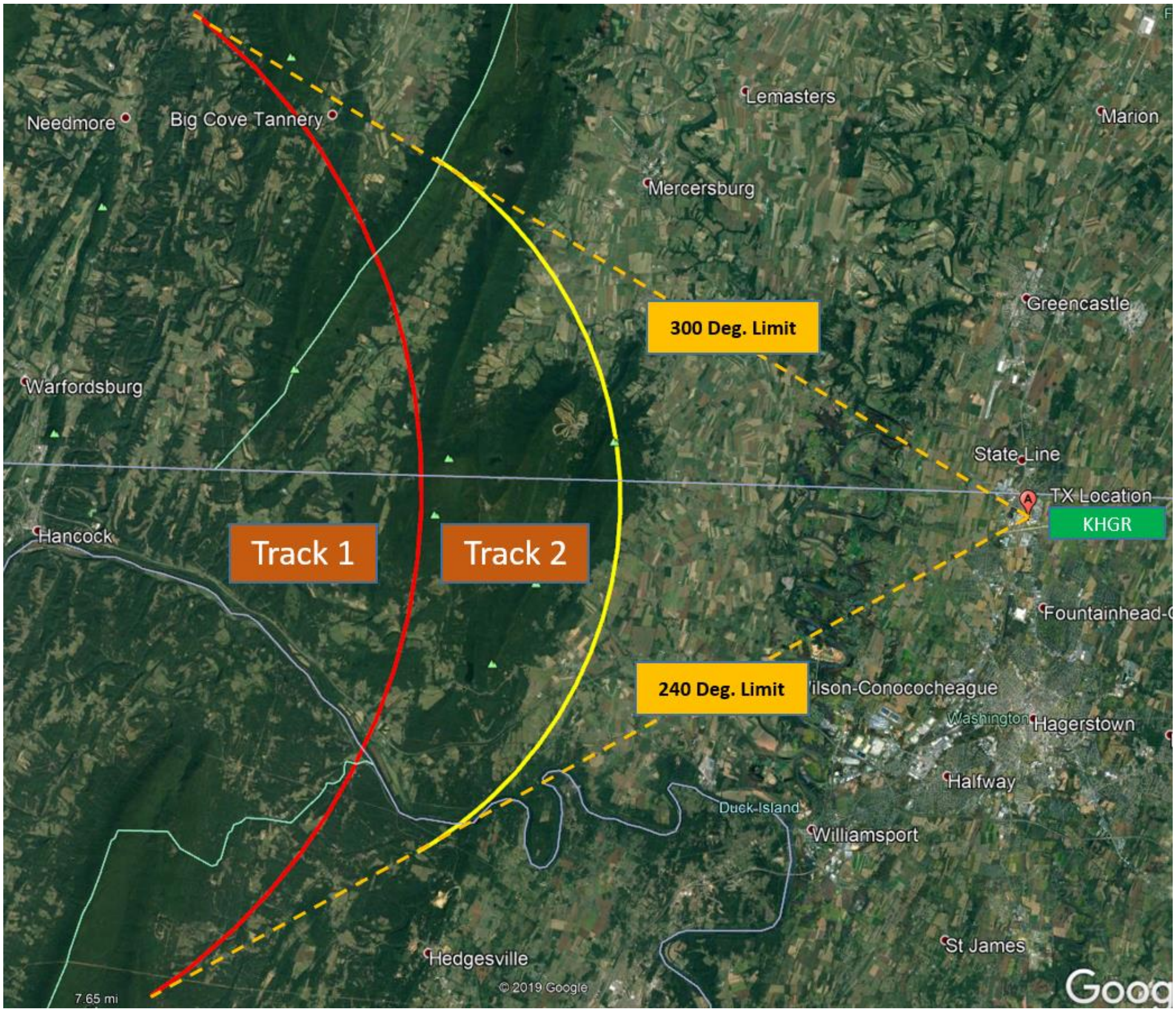

Figure 4: Flight Test Overview

4.0 REQUESTED FREQUENCIES

Appendix A of this document lists the frequencies that SNC is requesting to add to our current Fixed Authorization. The frequencies requested are a filter of the frequencies granted under STA WP9XNK and are frequencies in which no limitations or special conditions were placed as part of that STA.

5.0 ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Description
FCC	Federal Communication Commission
GPS	Global Positioning System
GRCS	Guardrail Common Sensor
ISR	Intelligence, Surveillance and Reconnaissance
RF	Radio Frequency
SNC	Sierra Nevada Corporation
STA	Special Temporary Authority
VST	Vector Signal Transceiver

APPENDIX A REQUESTED FREQUENCIES

The frequencies listed within this Appendix a filter of frequencies that were authorized to SNC under STA WP9XNK. These frequencies had no special conditions applied per that authorization.

#	Frequency (MHz)	Power	BW	#	Frequency (MHz)	Power	BW	#	Frequency (MHz)	Power	BW	#	Frequency (MHz)	Power	BW
1	20	10 W	.5 kHz	**26**	27.62	10 W	.5 kHz	**51**	39.165	10 W	.5 kHz	**76**	56.22	10 W	.5 kHz
2	20.26	10 W	.5 kHz	**27**	27.98	10 W	.5 kHz	**52**	39.675	10 W	.5 kHz	**77**	56.95	10 W	.5 kHz
3	20.525	10 W	.5 kHz	**28**	28.345	10 W	.5 kHz	**53**	40.19	10 W	.5 kHz	**78**	57.69	10 W	.5 kHz
4	20.79	10 W	.5 kHz	**29**	28.715	10 W	.5 kHz	**54**	40.71	10 W	.5 kHz	**79**	58.44	10 W	.5 kHz
5	21.06	10 W	.5 kHz	**30**	29.09	10 W	.5 kHz	**55**	41.24	10 W	.5 kHz	**80**	59.2	10 W	.5 kHz
6	21.335	10 W	.5 kHz	**31**	29.47	10 W	.5 kHz	**56**	41.775	10 W	.5 kHz	**81**	60	10 W	.5 kHz
7	21.61	10 W	.5 kHz	**32**	29.855	10 W	.5 kHz	**57**	42.32	10 W	.5 kHz	**82**	60.75	10 W	.5 kHz
8	21.89	10 W	.5 kHz	**33**	30.245	10 W	.5 kHz	**58**	42.87	10 W	.5 kHz	**83**	61.54	10 W	.5 kHz
9	22.175	10 W	.5 kHz	**34**	30.64	10 W	.5 kHz	**59**	44.56	10 W	.5 kHz	**84**	62.34	10 W	.5 kHz
10	22.465	10 W	.5 kHz	**35**	31.04	10 W	.5 kHz	**60**	45.14	10 W	.5 kHz	**85**	63.15	10 W	.5 kHz
11	22.755	10 W	.5 kHz	**36**	31.445	10 W	.5 kHz	**61**	46.32	10 W	.5 kHz	**86**	63.97	10 W	.5 kHz
12	23.05	10 W	.5 kHz	**37**	31.855	10 W	.5 kHz	**62**	46.92	10 W	.5 kHz	**87**	64.8	10 W	.5 kHz
13	23.35	10 W	.5 kHz	**38**	32.27	10 W	.5 kHz	**63**	47.53	10 W	.5 kHz	**88**	65.64	10 W	.5 kHz
14	23.655	10 W	.5 kHz	**39**	32.69	10 W	.5 kHz	**64**	48.15	10 W	.5 kHz	**89**	66	10 W	.5 kHz
15	23.965	10 W	.5 kHz	**40**	33.115	10 W	.5 kHz	**65**	48.775	10 W	.5 kHz	**90**	67.36	10 W	.5 kHz
16	24.275	10 W	.5 kHz	**41**	33.545	10 W	.5 kHz	**66**	49.41	10 W	.5 kHz	**91**	68.235	10 W	.5 kHz
17	24.59	10 W	.5 kHz	**42**	33.98	10 W	.5 kHz	**67**	50.05	10 W	.5 kHz	**92**	69.12	10 W	.5 kHz
18	24.91	10 W	.5 kHz	**43**	34.42	10 W	.5 kHz	**68**	50.7	10 W	.5 kHz	**93**	70.02	10 W	.5 kHz
19	25.235	10 W	.5 kHz	**44**	34.865	10 W	.5 kHz	**69**	51.36	10 W	.5 kHz	**94**	70.93	10 W	.5 kHz
20	25.565	10 W	.5 kHz	**45**	36.245	10 W	.5 kHz	**70**	52.03	10 W	.5 kHz	**95**	72	10 W	.5 kHz
21	25.895	10 W	.5 kHz	**46**	36.715	10 W	.5 kHz	**71**	52.705	10 W	.5 kHz	**96**	72.785	10 W	.5 kHz
22	26.23	10 W	.5 kHz	**47**	37.19	10 W	.5 kHz	**72**	53.39	10 W	.5 kHz	**97**	75.66	10 W	.5 kHz
23	26.57	10 W	.5 kHz	**48**	37.675	10 W	.5 kHz	**73**	54	10 W	.5 kHz	**98**	76	10 W	.5 kHz
24	26.915	10 W	.5 kHz	**49**	38.165	10 W	.5 kHz	**74**	54.79	10 W	.5 kHz	**99**	77.64	10 W	.5 kHz
25	27.265	10 W	.5 kHz	**50**	38.66	10 W	.5 kHz	**75**	55.5	10 W	.5 kHz	**100**	78.65	10 W	.5 kHz

#	Frequency (MHz)	Power	BW	#	Frequency (MHz)	Power	BW	#	Frequency (MHz)	Power	BW	#	Frequency (MHz)	Power	BW
101	79.67	10 W	.5 kHz	**126**	128.485	10 W	.5 kHz	**151**	194.23	10 W	.5 kHz	**176**	500	10 W	.5 kHz
102	80.705	10 W	.5 kHz	**127**	130.155	10 W	.5 kHz	**152**	196.755	10 W	.5 kHz	**177**	506	10 W	.5 kHz
103	81.755	10 W	.5 kHz	**128**	131.845	10 W	.5 kHz	**153**	198	10 W	.5 kHz	**178**	512	10 W	.5 kHz
104	82	10 W	.5 kHz	**129**	137.055	10 W	.5 kHz	**154**	201.905	10 W	.5 kHz	**179**	518	10 W	.5 kHz
105	83.895	10 W	.5 kHz	**130**	138.835	10 W	.5 kHz	**155**	204	10 W	.5 kHz	**180**	524	10 W	.5 kHz
106	84.985	10 W	.5 kHz	**131**	140.64	10 W	.5 kHz	**156**	207.19	10 W	.5 kHz	**181**	530	10 W	.5 kHz
107	86.09	10 W	.5 kHz	**132**	142.47	10 W	.5 kHz	**157**	210	10 W	.5 kHz	**182**	536	10 W	.5 kHz
108	87.21	10 W	.5 kHz	**133**	144.32	10 W	.5 kHz	**158**	212.615	10 W	.5 kHz	**183**	542	10 W	.5 kHz
109	88	10 W	.5 kHz	**134**	146.195	10 W	.5 kHz	**159**	216	10 W	.5 kHz	**184**	548	10 W	.5 kHz
110	89.4	10 W	.5 kHz	**135**	148.095	10 W	.5 kHz	**160**	223.89	10 W	.5 kHz	**185**	554	10 W	.5 kHz
111	90.6	10 W	.5 kHz	**136**	150.02	10 W	.5 kHz	**161**	400.365	10 W	.5 kHz	**186**	560	10 W	.5 kHz
112	91.8	10 W	.5 kHz	**137**	151.97	10 W	.5 kHz	**162**	405.57	10 W	.5 kHz	**187**	566	10 W	.5 kHz
113	93	10 W	.5 kHz	**138**	153.945	10 W	.5 kHz	**163**	421.59	10 W	.5 kHz	**188**	572	10 W	.5 kHz
114	94.2	10 W	.5 kHz	**139**	155.945	10 W	.5 kHz	**164**	427.07	10 W	.5 kHz	**189**	578	10 W	.5 kHz
115	95.4	10 W	.5 kHz	**140**	157.97	10 W	.5 kHz	**165**	432.62	10 W	.5 kHz	**190**	584	10 W	.5 kHz
116	96.8	10 W	.5 kHz	**141**	160.025	10 W	.5 kHz	**166**	438.245	10 W	.5 kHz	**191**	590	10 W	.5 kHz
117	98	10 W	.5 kHz	**142**	162.105	10 W	.5 kHz	**167**	443.94	10 W	.5 kHz	**192**	596	10 W	.5 kHz
118	99.2	10 W	.5 kHz	**143**	164.21	10 W	.5 kHz	**168**	449.71	10 W	.5 kHz	**193**	602	10 W	.5 kHz
119	100.6	10 W	.5 kHz	**144**	177.44	10 W	.5 kHz	**169**	461.475	10 W	.5 kHz	**194**	620	10 W	.5 kHz
120	101.8	10 W	.5 kHz	**145**	180	10 W	.5 kHz	**170**	467.475	10 W	.5 kHz	**195**	626	10 W	.5 kHz
121	103.2	10 W	.5 kHz	**146**	182.08	10 W	.5 kHz	**171**	470	10 W	.5 kHz	**196**	632	10 W	.5 kHz
122	104.6	10 W	.5 kHz	**147**	184.445	10 W	.5 kHz	**172**	476	10 W	.5 kHz	**197**	638	10 W	.5 kHz
123	105.8	10 W	.5 kHz	**148**	186	10 W	.5 kHz	**173**	482	10 W	.5 kHz	**198**	644	10 W	.5 kHz
124	107.2	10 W	.5 kHz	**149**	189.275	10 W	.5 kHz	**174**	488	10 W	.5 kHz	**199**	650	10 W	.5 kHz
125	122.015	10 W	.5 kHz	**150**	192	10 W	.5 kHz	**175**	494	10 W	.5 kHz	**200**	656	10 W	.5 kHz

#	Frequency (MHz)	Power	BW
201	662	10 W	.5 kHz
202	668	10 W	.5 kHz
203	674	10 W	.5 kHz
204	680	10 W	.5 kHz
205	686	10 W	.5 kHz
206	692	10 W	.5 kHz
207	770	10 W	.5 kHz
208	782	10 W	.5 kHz
209	800	10 W	.5 kHz
210	806	10 W	.5 kHz
211	830	10 W	.5 kHz
212	836	10 W	.5 kHz
213	842	10 W	.5 kHz
214	848	10 W	.5 kHz
215	903.31	10 W	.5 kHz
216	915.055	10 W	.5 kHz
217	926.95	10 W	.5 kHz
218	939	10 W	.5 kHz
219	951.205	10 W	.5 kHz
220	963.57	10 W	.5 kHz