Systems & Technology Research

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1. Experiment Overview

Systems & Technology Research (STR) is leading an effort to design, test, and produce new ground-based, high power RF transmitters that operate in S, C and X-band at Effective Radiated Powers (ERPs) of up to 55 dBW.

STR will be performing over-the-air (OTA) testing at mWAVE Industries LLC, in Windham, ME. using their outdoor far-field RF test range. The goal of these tests is to measure the ERP and antenna beam patterns of the RF transmitters as well as to evaluate their RF characteristics. The transmitters utilize pulsed waveforms with duty cycles of up to 40% at carrier frequencies in the range of 2.475 GHz to 11.9 GHz. Some of the test waveforms will utilize LFM and phase modulation. The maximum instantaneous bandwidth (IBW) for all transmissions in any frequency band will not exceed 50 MHz. During each test event, the test waveforms will be transmitted for a brief interval on the order of 1 millisecond, over periods of several minutes. The test waveforms are listed in Table 1 (S/C-band) and Table 2 (X-band).

Test	F Tx low (MHz)	F Tx high (MHz)	Duty Cycle (%)	IBW (MHz)	Modulation	Emission Designator
1	2425	2475	10	50	LFM	50M0Q0N
2	2425	2475	30	50	Phase	50M0M3N
3	2425	2475	10	50	Unmod	50M0P0N
4	3075	3125	10	50	LFM	50M0Q0N
5	3075	3125	30	50	Phase	50M0M3N
6	3075	3125	10	50	Unmod	50M0P0N
7	3250	3300	10	50	LFM	50M0Q0N
8	3250	3300	30	50	Phase	50M0M3N
9	3250	3300	10	50	Unmod	50M0P0N
10	3875	3925	10	50	LFM	50M0Q0N
11	3875	3925	30	50	Phase	50M0M3N
12	3875	3925	10	50	Unmod	50M0P0N
13	4750	4800	10	50	LFM	50M0Q0N
14	4750	4800	30	50	Phase	50M0M3N
15	4750	4800	10	50	Unmod	50M0P0N
16	4875	4925	10	50	LFM	50M0Q0N
17	4875	4925	30	50	Phase	50M0M3N
18	4875	4925	10	50	Unmod	50M0P0N
19	5550	5600	10	50	LFM	50M0Q0N
20	5550	5600	30	50	Phase	50M0M3N
21	5550	5600	10	50	Unmod	50M0P0N
22	5875	5925	10	50	LFM	50M0Q0N
23	5875	5925	30	50	Phase	50M0M3N
24	5875	5925	10	50	Unmod	50M0P0N

Table 1: S/C-Band Test Waveform Parameters

Test	F Tx low (MHz)	F Tx high (MHz)	PW (us)	PRF (kHz)	Duty Cycle (%)	IBW (MHz)	Modulation	Emission Designator
1	8675	8725	1	100	10	50	LFM	50M0Q0N
2	8675	8725	60	5	30	50	Phase	50M0M3N
3	8675	8725	10	10	10	50	Unmod	50M0P0N
4	9475	9525	1	100	10	50	LFM	50M0Q0N
5	9475	9525	60	5	30	50	Phase	50M0M3N
6	9475	9525	10	10	10	50	Unmod	50M0P0N
7	10875	10925	1	100	10	50	LFM	50M0Q0N
8	10875	10925	60	5	30	50	Phase	50M0M3N
9	10875	10925	10	10	10	50	Unmod	50M0P0N
10	11875	11925	1	100	10	50	LFM	50M0Q0N
11	11875	11925	60	5	30	50	Phase	50M0M3N
12	11875	11925	10	10	10	50	Unmod	50M0P0N

Table 2: X-Band Test Waveform Parameters

2. Test Range

2.1. mWave Industries LCC

The OTA tests will be performed at a dedicated outdoor range at mWAVE Industries LCC in Windham, ME. An arial view of the test site is shown in Figure 1.

The test site has an available range of ~150 m, where **the transmitter will be positioned with a boresight azimuth of 328°, antenna AMSL of 46.5 m, and antenna AGL of 3 m**. The receiver has a diameter of 0.6 m and AGL of 6 m. **The transmit antenna has a frequency dependent half-power beam width (HPBW) ranging from 1–8 degrees**. A previously measured beam pattern is shown in Figure 2. Safe standoff distances will be abided by in accordance with FCC OET bulletin 65 (Edition 97-01) to ensure safe controlled exposure levels for personnel.

Figure 1: mWAVE Test Facility in Windham, ME

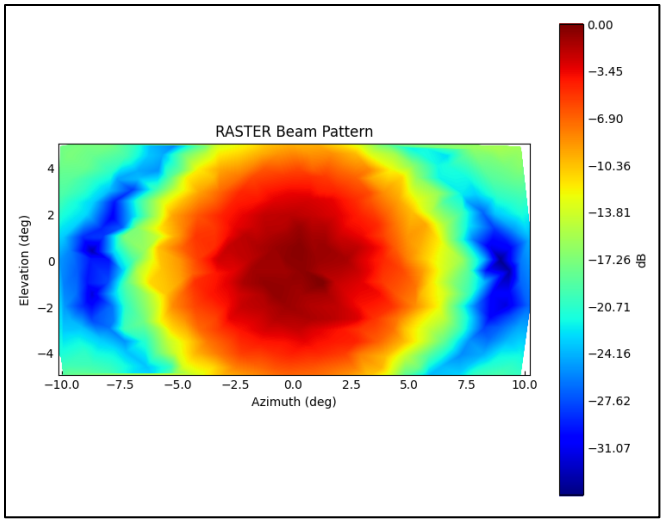

Figure 2: A SIREN antenna beam pattern measured at 3.275 GHz.

3. Interference Avoidance

During test events, the typical transmit duration for each test waveform will be on the order of 1 millisecond. Tests such as antenna beam mapping that require extended transmitting over durations of several minutes will utilize duty cycles of 10% or less. If the STR team is notified of potential interference during a test (by, for example, a Broadcast Auxiliary Service or Fixed Microwave Service licensee), the team will halt the transmission immediately via the system's control software.

4. STR System Overview

4.1. Overview

Each RF transmitter under test utilizes a single 0.9-m dish antenna that can transmit using one of two linear polarizations. The antenna boresight will be centered on an azimuth of 328 degrees and will be able to rotate up to +/- 15 degrees from this position. The antenna elevation will not exceed +5 degrees while transmitting. Figure 3 shows a generalized block diagram of a single system in its test configuration at mWAVE. The distance between the transmitter and receiver will range from 35−80-m.

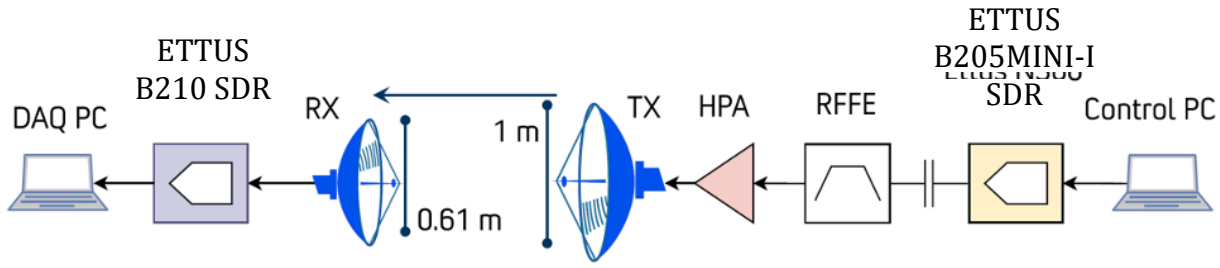

Figure 3: STR system test configuration

4.2. System ERP

Estimates of peak ERPs for the STR S, C, and X-band systems are listed in Table 3.

Carrier Freq (GHz)	2.450	3.100	3.275	4.775	5.575	5.900	8.700	9.500	10.900	11.900
ERP (dBW)	49	50	52	52	53	49	52	53	54	55
ERP (kW)	79	100	158	158	199	79	164	231	303	367

Table 3: Estimates of peak ERP for the S, C and X-band systems.