

Raytheon Request for FCC Experimental License

STA File Number: 0354-EX-CR-2021

Date: 06/03/2021

Raytheon Program Office request a 24 month extension 09/04/2021 – 09/04/2023

Purpose of Operation:

Frequency authorization is being requested for X-band at frequencies between 9000 – 9200 MHz, in order to test prototype radar arrays in a relevant environment. Outdoor testing, across multiple frequencies as noted above is required to assess hardware compliance with requirements and to continue research and development. Up to two units may be tested over this range simultaneously.

Technical Synopsis:

- Spectrum needed: 9000 - 9200 MHz
- A minimum of 2 frequencies separated by at least 12 MHz. Four frequencies preferred.
- Power levels requested: 160 W output power, 953.4 kW ERP (peak)
- Location of use: Raytheon Test Facility in Marlborough, MA

Direction of radiation:

- Antenna 1: North West (boresite $18^{\circ} \pm 20^{\circ}$)
- Antenna 2: North East (boresite $288^{\circ} \pm 20^{\circ}$)
- Each antenna has a ± 45 degree scan angle

New Stop buzzer contact:

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Test Summary:

The system will transmit pulsed Frequency Modulated (Chirp) waveforms. For all waveform types, the maximum pulse duration is $55\mu\text{s}$ and the maximum duty factor is 22%. See the detailed waveform explanation in a later section. Each operational frequency requires approximately 12 MHz of spectrum. At least 2 separate frequencies are necessary to conduct our research and development effort, however 4 frequencies are preferred. It is expected that the radars will be operated periodically, < 8 hours a day, up to 7 days a week.

New Raytheon Technical Point of Contact:

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Equipment Information:

Indicate all equipment that will be involved in this operation.

Transmitter info:

Manufacturer: Raytheon
Model: LPR3
Number of units: 6
Experimental (Y/N): Y

For each frequency band:

RF output at the transmitter terminals:
160 Watts peak

Effective radiated power from the antenna (if pulsed emission, specify peak power):

The effective radiated power from the antenna, including antenna transmit gain and front-end losses, is 953.4 kW (peak power).

$EIRP = Power * gain$, Power = 160 W, gain = 39.9 dBi, $EIRP = 160 * 9772.37 = 1563579.2 \text{ W}$

$ERP = EIRP/1.64 = 953402 \text{ W}$ or 953.4 kW

Frequency Tolerance:

Less than 0.001 %

List each type of emission separately for each frequency (basically list the emission designators)

The LPR3 can tune at 1 MHz intervals within the band(s) authorized.

For each tunable frequency authorized, the LPR3 has the following emission designators:

12M0Q3N - 55µsec FM-Pulsed (LP) with a 2 MHz LFM chirp, centered at Ftune – 3 MHz

12M0Q3N - 6µsec FM-Pulsed (SP) with a 2.5 MHz NLFM chirp, centered at Ftune + 3 MHz

The transmit waveform chain-pulse sequence transmits a Long Pulse (LP) then a Short Pulse (SP) for each pulse repetition interval (PRI). The PRI for a pulse sequence is 256 usec (PRF = 3906.25 Hz). The Long Pulse (LP) is 55 usec pulse length using a 2 MHz linear FM chirp at a 22% duty factor. The Short Pulse (SP) is a 6 usec pulse length using a 2.5 MHz non-linear FM chirp at a 2.3% duty factor.

IMPORTANT: The pulse sequence requires 11.9 MHz (LP necessary bandwidth/2 + SP necessary bandwidth/2 + 6.0 MHz = $4.7/2$ MHz + $7.1/2$ MHz + 6.0 MHz = 11.9 MHz). Therefore the emission designator is defined as 12M0Q3N.

List as appropriate for the type of modulation:

LP: Linear Frequency-Modulated Pulsed (Chirp)

SP: Non-Linear Frequency-Modulated Pulsed (Chirp)

Necessary bandwidth. Explain how determined.

The necessary bandwidth was calculated using the equations in Annex J of the NTIA Manual.

Locations:

The street address for the Raytheon location is 1001 Boston Post Road, MA 01752. The ground elevation of the facility is 71 meters above sea level. The radars will be located on Raytheon property, mounted on a rooftop, with following coordinates: 42° 20' 54.37" North, 071° 29' 29.24" West.

Is a directional antenna (other than radar used)?

No.

If yes, give the following info: (Although not necessary for this application, additional antenna detail is provided below)

Width of beam in degrees at the half-power point:

1.98° Azimuth, 2.1° Elevation at boresight

Orientation in horizontal plane:

+/- 45° Electronically Scanned

Orientation in vertical plane:

0° to 30°, relative to ground horizontal, electronically scanned

Will the antenna extend more than 6 meters above ground, or if mounted on an existing building, will it extend more than 6 meters above the building, or will the proposed antenna be mounted on an existing structure other than a building?

No.

Overall height above ground to tip of antenna in meters:

About 11 meters when mounted on the rooftop.

Necessary Bandwidth Calculation Table

FM-Pulsed Radar		
Modulation	LFM	NLFM
Pulse Width (μ s e c)	55	6
Rise Time (μ s e c)	0.128	0.128
Fall Time (μ s e c)	0.128	0.128
Chirp BW (MHz)	2	2.5
Necessary BW (MHz)	12	12
Designator	12M0Q3N	12M0Q3N

Necessary BW Formula

Symbols:

t = Emitted pulse duration at 50% amplitude (voltage) points. The 100% amplitude point is the nominal peak level of the pulse.

tr = Emitted pulse rise time in μ sec from the 10% to the 90% amplitude points on the leading edge.

tf = Emitted pulse fall time in μ sec from the 90% to the 10% amplitude points on the trailing edge.

FM-Pulsed Radar: *If tf is less than tr, then tf is to be used in place of tr when performing the necessary bandwidth calculations.