B855 GPS Re-Radiation (Re-Rad) System Technical Description

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Purpose for the Application

The purpose of this application is to obtain an experimental license to operate a GPS re-radiation system supporting aircraft development and testing.

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Why we are Applying for a License

The Boeing Company would like the ability to perform functional testing of receive GPS systems inside a building to support testing of aircraft subsystems with integrated GPS receivers.

Technical Description

This technical description shows compliance with all NTIA items in Chapter 8.3.28.

1. Individual authorization is for indoor use only and is required for each device at a specific site. ***Operation will be conducted indoors. The device information is provided in application and specific site information provided below.***

2. Applications for frequency assignment should be applied for as an XT station class with a note indicating the device is to be used as an "Experimental RNSS Test Equipment for the purpose of testing GPS receivers" and describing how the device will be used.

3. Approved applications for frequency assignment will be entered in the GMF. ***Boeing concurs.***

4. The maximum length of the assignment will be two years, with possible renewal. ***Boeing concurs.***

5. The area of potential interference to GPS reception (e.g., military or contractor facility) must be under the control of the user. ***The site is under Boeing's control.***

6. The maximum equivalent isotropically radiated power (EIRP) must be such that the calculated emissions are no greater than -140 dBm/24 MHz as received by an isotropic antenna at a distance of 100 feet (30 meters) from the building where the test is being conducted. The calculations showing compliance with this requirement must be provided with the application for frequency assignment and should be based on free space propagation with no allowance for additional attenuation (e.g., building attenuation.) ***Link budgets provided below and meet specified levels. Calculations do not allow for building attenuation.***

7. GPS users in the area of potential interference to GPS reception must be notified that GPS information may be impacted for periods of time. ***GPS users in area will be notified.***

8. The use is limited to activity for the purpose of testing RNSS equipment/systems. ***Use will be limited to testing RNSS equipment.***

9. A "Stop Buzzer" point of contact for the authorized device must be identified and available at all times during GPS re-radiation operation of the device under any condition. ***Stop Buzzer information provided below.***

N38 32 11, -89 48 04

Location

The GPS Re-Radiation systems will be installed on one building. The specific location of the system is:

38-32-11N
89-48-04W

Stop Buzzer

Primary Stop Buzzer:
Andrew (Odie) Odegaard
Work Desk: 210-705-0452
Home Phone:

Backup Stop Buzzers:
Mitchell Friedman
Work Desk: 314-406-8529
Home Phone:

Michael J. Gibson
Work Desk: 314-281-1297
Home Phone:

Technical Description

System:

Receiving and transmitting antennas with LNAs and attenuators to control radiating power.

Frequency: L1 1575.42 MHz
Emission: 24M0G1D

Frequency: L2 1227.60 MHz
Emission: 24M0G1D

Requirements:

1. Provide range limited GPS repeater capability to the Boeing MQ25 – Building 855 Production Hanger, located in building 855 of the Boeing Mid America St. Louis Airport in Illinois at the following geodetic coordinates: 38º32’11” N x 89º 48’ 04.3” W.
2. Within the Building 855 Production Hanger, there will be two fixed re-radiating antennas providing two 40 Ft diameter circular areas of RF signals over aircraft staging locations.
3. Use the following equipment to control the Re-radiated GPS RF power (or equivalent):
    a. Roof-top antenna with built in 40 dB LNA (GPS Source GNSS-3A GPS Antenna with built in 30 dB LNA) and a 40 dB Amplifier (GSP Source A114M).
    b. Low Loss RF Cable – 131 Ft (Times Microwave LMR-600-DB) and Surge Protector.
    c. Two Passive Splitters (Pasternack PE20DV2102) and a DC Block.
    d. Flexible interconnecting SMA RF cables.
    e. Variable Attenuator to further attenuate the GPS RF as needed based on GPS receiving equipment in the lab (Fairview Microwave SA3710SMA)
    f. Flexible RF Cable – 87.5 Ft. (Times Microwave LMR-600-DB)
    g. GPS Re-radiating antenna (GPS Source GNSS-3P)
    h. See Figure 1 below for the proposed MQ25 Building 855 Re-Radiator System
4. Range limitation (Based on an NTIA maximum of -140 dBm/24 MHz at 100 feet):
    a. L1: Total re-radiated power across a 24 MHz band centered at 1572.42 MHz shall not exceed -140 dBm at 100 Ft.
    b. L2: Total re-radiated power across a 24 MHz band centered at 1227.60 MHz shall not exceed -140 dBm at a distance of 100 Ft.

Physical Design:

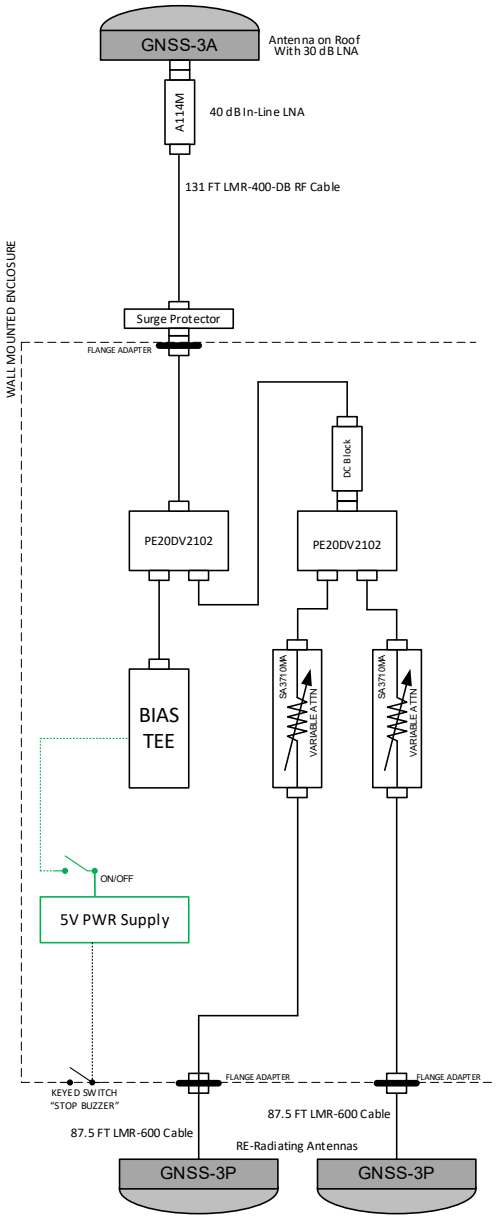

Figure 1, F-22 AIL FTB Ground Lab Re-Radiator System

Functional Description:

GPS Satellite signals received and amplified by the roof-top antenna are conducted through a 131 foot transmission line (coaxial cable) into the MQ25 Production Hanger (building 855) wall mounted junction box. The roof-top antenna will be mounted on the roof near the center of the building. The wall mounted junction box contains a Bias-T to provide DC power to the roof top LNA and the roof-top antenna's LNA. It also contains a 1 dB attenuator to ensure re-radiated power levels at 100 Feet are below the NTIA maximum of -140 dBm/24 MHz. There is also a variable attenuator necessary to reduce the re-radiated signal level below the target GPS receiver's maximum input. This variable attenuator will allow the ability to lower the re-radiated signal level to reduce potential multipath portions of the signal.

The wall mounted junction box is connected to two re-radiating antennas by 87.5 feet RF cables. These cables allow the re-radiating antennas to send GPS signals to the aircraft in the hanger. Power levels at 100 foot distance from the building are less than -140 dBm, meeting the power limit requirement.

Below are the calculations demonstrating NTIA compliance at 100 Feet.

Part No	Description	Multiplier length (ft) attn (dB)	L1 RF Power delta (dB)	L1 RF Power (dBm)	L2 RF Power delta (dB)	L2 RF Power (dBm)
	Frequency (MHz)		1575.42		1227.60	
	GPS Satellite Signal at Earth's Surface			-128.50		-131.50
GNSS-3A	GPS Active Antenna & LNA (Gain = 33.2 dBi, LNA = +40.6 dB)		73.8	-54.7	72.7	-58.8
LMR-600-DB	Low Loss, External, RF Cable	131	-4.751	-59.45	-4.21	-63.01
PE73SP1016	Flange & Surge Protector		-0.15	-59.6	-0.15	-63.16
PE34414-XX	RF Cable - SMA/TNC	0.5	-0.271	-59.9	-0.264	-63.42
PE2074	Power Divider		-3.3	-63.17	-3.3	-66.72
PE34414-XX	RF Cable - SMA/TNC	0.5	-0.342	-63.5	-0.33	-67.05
PE34414-XX	DC Block		-0.05	-63.56	-0.05	-67.1
PE2074	Power Divider		-3.3	-66.86	-3.3	-70.4
PE34414-XX	RF Cable - SMA/TNC	0.5	-0.271	-67.14	-0.264	-70.67
50DR-055-SMA	Variable Attenuator	0.5	-0.5	-67.64	-0.5	-71.17
PE34414-XX	RF Cable - SMA/TNC	0.5	-0.271	-67.9	-0.264	-71.43
PE9276	RF Flange Adapter		-0.05	-68.0	-0.05	-71.48
LMR-400-UF	Low Loss, RF Cable	87.5	-2.982	-70.94	-2.595	-74.08
S67-1575-714	GPS passive antenna @ 74.4		-5.4	-76.34	-5.4	-79.48
	Total Calculated RF box Loss		-8.4		-8.37	
	Measured RF Box Loss		-7.18		-6.83	

	Maximum GPS Radiated Power @ 100ft = -140 dBm / 24MHz					
	Calculated					
	Free Space Loss @ 100ft from hanger	145.5 ft	-69.31		-67.14	
	Radiated Power @ 100ft from hanger			**-145.75**		**-146.6**
	Measured					
Calculated-------→	Free Space Loss @ 100ft from hanger	145.5 ft	-69.31		-67.14	
	Radiated Power @ 100ft from hanger			**-144.42**		**145.08**