

REQUEST FOR ADDITIONAL TEST LOCATION

Pursuant to Section 5.3 (f), Section 5.51 and Section 5.53 of the Federal Communications Commission ("FCC") rules, 47 C.F.R. §§ 5.3 (f), 5.51, 5.53 (2014), Southwest Research Institute ("SwRI") respectfully requests a modification of its experimental license issued under call sign WF2XCH, 0294-EX-RR-2015, to add a second, nearby test location at its campus for purposes of validation and verification of radionavigation satellite service ("RNSS") equipment associated with the Cyclone Global Navigation Satellite System ("CYGNSS").

In support of SwRI's request, which is in compliance with NTIA Manual Paragraph 8.3.28, the following is shown:

1) Applicant's Address, Background and FRN:

Southwest Research Institute is headquartered at 6220 Culebra Road, San Antonio, TX 78238-5166. It is an independent, not-for-profit, applied engineering and development organization devoted to technology research, design and development. It conducts business with the industry and government entities (in the U.S. and other friendly nations) on a worldwide basis. Approximately 50% of the SwRI's business is for the U.S. Government. Its FCC Registration Number ("FRN") is 0004074217.

2) Background and Need for License Modification:

The CYGNSS is a NASA funded system which will collect information related to hurricanes using GPS signals as a mechanism to detect wind speed. The system will use eight micro-satellites to measure wind speeds over Earth's oceans, increasing the ability of scientists to understand and predict hurricanes. Each satellite will take information based on the signals received from four GPS satellites. See <https://www.nasa.gov/cygnss> Thus, GPS signals are a fundamental element of the CYGNSS.

The testing of CYGNSS satellites in production requires 'live sky' GPS signals for complete validation and verification of satellite hardware. Those signals need to be provided indoors due to cleanliness requirements during spacecraft construction. Accordingly, SwRI seeks a modification of its license so that it may to conduct tests at its indoor facilities identified below to obtain real-world data samples of the characteristics of CYGNSS transmissions. It acknowledges that such operation is limited to testing radionavigation satellite service equipment and systems.

3) Location of Additional Site:

The proposed tests will be conducted on the campus of Southwest Research Institute, 6220 Culebra Road, San Antonio (Bexar County), Texas. The campus is comprised of approximately 1200 acres, and the location of the transmitter would be near the center of the campus. Thus, the nearest off-campus property is over 800 meters away.

Specifically, the proposed tests will be conducted within Building 178, a site nearby where SwRI is already authorized to conduct related indoor GPS operations under its existing license, issued under call sign WF2XCH. The coordinates of the new site are NL 29-26-43; WL 98-37-31 (NAD 83).

4) FCC Station Codes:

The FCC radio service code and station class code for the proposed operation are "XT" and "FX," respectively.

5) Equipment To Be Used:

SwRI proposes to operate a single transmitter capable of operating on the channels listed in Section 6. Specifically, it proposes to deploy a transmitter (Model L1/L2GHNRKIT) manufactured by GPS Networking. The technical specifications of the equipment are provided under Attachment A.

6) Frequencies Desired:

As stated in Section 2 above, SwRI seeks to obtain real-world data samples of the characteristics of CYGNSS transmissions. Thus, it is critical for SwRI to conduct tests centered on GPS channels 1227.6 MHz and 1575.42 MHz. SwRI recognizes that the use of certain frequencies will require coordination through the Interdepartment Radio Advisory Committee ("IRAC"), and it is amendable to coordinating with Federal government personnel prior to commencing any transmissions.

7) Power Level:

SwRI will operate with the minimum necessary power to conduct its tests, and in no event will that level exceed the levels set out in the table provided under Attachment B. Specifically, the maximum equivalent isotropically radiated power ("EIRP") will 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 tests are being conducted. A link budget showing compliance with this requirement is provided in the table under Attachment B and is based on free space propagation with no allowance for additional attenuation (e.g., building attenuation).

8) Type of Emission, Modulation Technique, and Bandwidth Required:

The primary emission designator for the proposed operations is 2M46G3D, as indicated on the accompanying FCC Form. Other emission modes and modulation techniques may be utilized, but in no event will the emissions extend beyond the limits associated with the above-referenced emission.

SWRI does not propose to supply station identification as set forth in Section 5.115 of the Commission's Rules, 47 C.F.R. § 5.115 (2014),

9) Antenna Information and Compliance with Human Exposure Limits:

SwRI will comply with all Federal Aviation Administration ("FAA") and FCC rules and regulations regarding the installation and operation of antennas and their support structures. The antenna to be deployed under the authority requested will not extend more than six meters more than six meters above the building.

10) Restrictions on Operation:

GPS users in the area of potential interference to GPS reception will be notified that GPS information may be impacted during testing. In addition, it will post signs on doors to the test area notifying that, "GPS re-radiator is in use and the GPS information you receive may be in error."

SwRI also understands that: (a) permission to operate has been granted under experimental authority issued by the Federal Communications Commission, is strictly temporary, and may be cancelled at any time and that (b) operation is subject to the condition that it not cause harmful interference.

Moreover, SwRI does not propose to market, sell, or lease unapproved equipment to end users or conduct a market study in conjunction with these tests. After the completion of the tests, SwRI will recover all devices that do not comply with FCC regulations.

11) Interference Protection/Stop Buzzer Contact Information:

As noted above, GPS users in the area of potential interference to GPS reception will be notified that GPS information may be impacted during testing. It also understands that it may be required to discontinue its operations immediately, if any interference occurs. SwRI does not expect interference to occur, however, as its tests will be conducted only on a limited basis and only periodically during the term of its experimental license. Moreover, SwRI personnel will be monitoring the RF spectrum and will take steps to minimize any potential for interference.

In that regard, SwRI advises the Commission that Scott Thompson is the technical contact overseeing these tests. He will be personally responsible for the operations and will serve as the "stop buzzer" in the event that operations must be terminated because of any interference concerns. Mr. Thompson can be reached at (210) 522-6408, email sthompson@swri.org

12) Application Contact Information:

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ATTACHMENT A

Equipment Specifications



L1/L2GHNRRKIT

Technical Product Data

Features

- **Amplified High Gain Roof Antenna (L1/L2/L5 Galileo/GLONASS and Omnistar)**
Gain $\geq 40\text{dB}$
- **Re-Radiating Amplifier with Power Supply**
Gain $\geq 20\text{dB}$
- **Optional Mounting Kit Hardware**
L1/L2GRAMB Roof Antenna Mount & WRUMT Re-Radiating Amp Mount
- **Variable Gain Option Available**
Re-Radiating Amp Gain Varies from 0 to +20 dB

Description

The GPS L1/L2/L5 Galileo/GLONASS/Omnistar Hanger Networked Re-Radiating Kit (L1/L2GHNRRKIT) is a complete re-radiating system that allows re-radiation of the GPS L1, L2, L5, Galileo, GLONASS and Omnistar signals indoors. The L1/L2GHNRRKIT consists of an active roof antenna, a re-radiating amplifier with a wall mount plug-in transformer that powers the entire system, and a passive re-radiating antenna. The signal from the roof antenna is amplified and radiated indoors. Thus, if a receiver has line of sight with the re-radiating antenna, it can receive all of the GNSS signals indoors up to 100 feet away.

Re-Radiating Amplifier

Electrical Specifications, $T_A = 25^\circ\text{C}$

Parameter	Conditions	Min	Typ	Max	Units
Freq. Range	Ant – J1	1.0		2.0	GHz
In/Out Imped.	Ant, J1		50		Ω
Gain ⁽¹⁾	Ant – J1, Normal Configuration	20	24.5	33	dB
	Variable Gain Option	0		+20	dB
Input SWR	J1 - 50 Ω			1.8:1	-
Output SWR	Ant - 50 Ω			1.8:1	-
Noise Figure	Ant – J1		2.4	2.7	dB
Gain Flatness	L1 – L2 ; Ant – J1		0.5	1	dB
Reverse Isolation	J1 – Ant	35			dB
Group delay Flatness	$\tau_{d,max} - \tau_{d,min}$: Ant – J1			1	ns

(1) For performance plots, see LA20RPDC Data Sheet

L1/L2/L5 Galileo/GLONASS Active Roof Antenna Specifications

Parameter	Conditions	Min	Typ	Max	Units
Frequency	L1		1.575		GHz
	L2		1.227		GHz
	L5		1.176		GHz
	Galileo L1		1.575		GHz
	Galileo L2		1.278		GHz
	GLONASS L1		1.602		GHz
	GLONASS L2		1.246		GHz
	Omnistar		1.535		GHz
Bandwidth					MHz
Out Imped.			50		Ω
Pre-Amp Gain			40		dB
Noise Figure			2.75		dB
Output SWR				2.0:1	-
Req. DC Input V.		3.3		24	Vdc
Current		20	35	40	mA

Re-Radiating Antenna

Electrical Specifications, $T_A = 25^{\circ}\text{C}$

Parameter	Conditions	Min	Typ	Max	Units
Frequency	L1/L2/L5		1.575/1.227/1.176		GHz
	Galileo		1.575/1.278		GHz
	GLONASS		1.602/1.246		GHz
	Omnistar		1.535		GHz
					GHz
Bandwidth				20	MHz
Impedance			50		Ω
Peak Gain			+3	+3.5	dBic
VSWR				1.5:1	
Polarization			RHCP		
DC Grounding	Lightning Protection		YES		

Mechanical Specifications (Passive L1/L2G Antenna)

Size: Diameter 2.60 in. (66.04 mm) Height: .64 in (16.18mm)

Weight: 4.06 oz. (115 Kg)

Finish: Skydrol Resistant Polyurethane Enamel, Base Iridite per MIL-C-5441

Color: Gloss White #17925 per FED STD-595B

Material: 6061-T6 ALUMINUM ALLOY BASE, THERMOSET PLASTIC
RADOME, UV, ABRASION & SKYDROL RESISTANCE

Connector: N-TYPE FEMALE

Environmental Specifications (L1/L2/L5 Galileo/GLONASS Active/Passive Antennas)

Temperature: -67F to +185F (-55C to +85C)

Altitude: 70,000 Feet

Vibration: > 30G's

Leakage: Hermetically Sealed

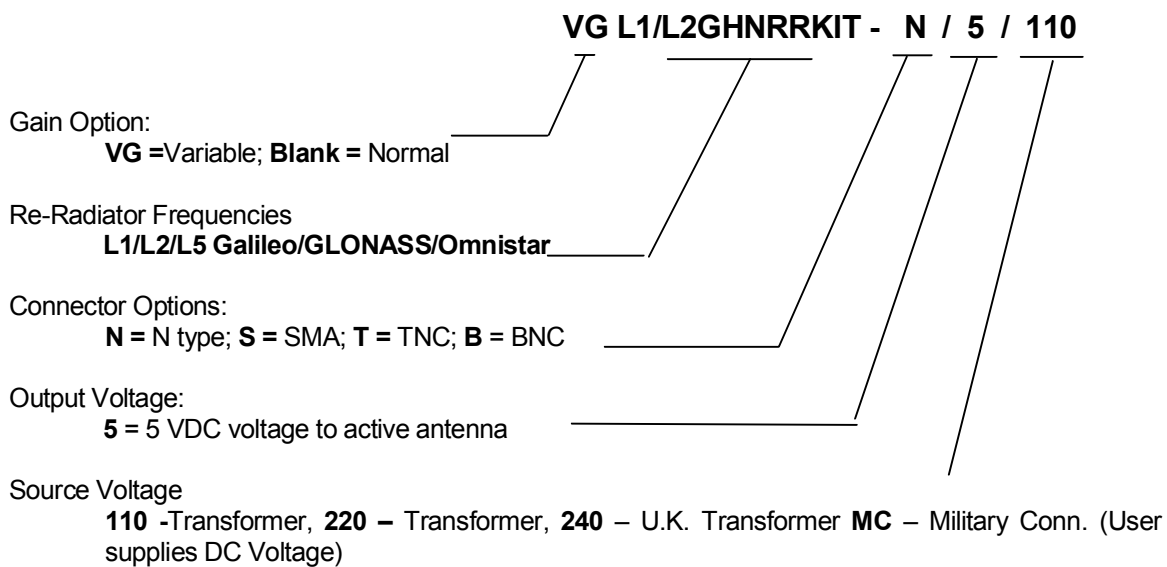
Federal and Military Specifications

Design to: FAA TSO-C144, DO-160D, MIL-C-5541, MIL-E-5400, MIL-I-45208A & MIL-STD-810 and SAE J1455

Available Options

Re-Radiating Amp System Power Supply Options		
Source Voltage Options	VOLTAGE INPUT	STYLE
	110VAC	Transformer (Wall Mount)
	220 VAC	Transformer (Wall Mount)
	240 VAC (United Kingdom)	Transformer (Wall Mount)
	Customer Supplied DC 9-32 VDC	Military Style Connector
Re-Radiating Amp Gain Control Options		
Normal Gain	Gain ≥ 20 dB	
Variable Gain	0dB to +20dB	
Re-Radiating Amp RF Connector Options		
Connector Options	CONNECTOR STYLE	CHARGE
	Type N	NC
	Type SMA	NC
	Type TNC	NC
	Type BNC	NC

Part Number



ATTACHMENT B

Budget Link Calculations

The following calculations represent the architecture of SwRI's proposed GPS re-radiation configuration and the signal power calculations which demonstrates compliance with NTIA Manual 8.3.28.

	Individual element	Cumulative total
GPS signal received power from GPS spacecraft	-130	-130 dBm
Receive Antenna pattern gain (estimated)	3	-127
Receive Antenna amplifier gain (data sheet)	40	-87
Transmission line loss to re-radiator antenna (estimated)	-27	-114
Powered coaxial signal distribution splitter gain (data sheet)	14	-100
Re-radiator amplifier (data sheet)	20	-80
Re-radiator antenna gain (estimated)	3	-77
<u>Free space path loss (FSPL) at 100 feet inside Building 178</u>	<u>-66</u>	<u>-143 dBm</u>

These calculations indicate that SwRI will not re-radiate GPS signals above -140dBm/24 MHz at 100 feet from the re-radiation source.