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BGAN-X PTF 9E125C

HUGHES 9203

BGAN Patrol

FCC SAR Exemption for WLAN: Design Package

Revision 3.0

February 20, 2023

PROPRIETARY NOTICE

REVISION HISTORY

Revision	Date	Author	Scope
0.1	November 29, 2022	J. Widmer	1st Draft
1.0	December 1, 2022	J. Widmer	Updated with review comments
2.0	December 16, 2022	J. Widmer	Updated per feedback from Nemko
3.0	February 20, 2023	J. Widmer	Updated safety distance information and WLAN antenna gain measurements

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1.0 INTRODUCTION

1.1 SCOPE

This document describes the design of the Hughes 9203 BGAN Patrol terminal to support the request for exemption from FCC SAR for the integrated WLAN transmitter.

The document contains information about the BGAN Patrol terminal and its radio modules.

- Brief description of the L-Band satellite modem and antenna (for information of collocated radio module)
- Detailed description of the WLAN Module and antenna
- Description of how the terminal is installed in a typical use case scenario, including safety distances and user documentation

1.2 REFERENCES

Table 1-1 References

No.	Document Number	Title
[1]	Microchip DS70005425B	Microchip PIC32MZ W1 and WFI32E01 Family Datasheet. Most current version of the WLAN Module datasheet is available at http://www.microchip.com

1.3 DEFINITIONS AND ACRONYMS

Acronym	Definition
AC	Alternating Current
ATT	Attenuator
BGAN	Broadband Global Access Network
BNC	Bayonet Neill–Concelman
CONN	Connector
COTS	Commercial Off-The-Shelf
DC	Direct Current
EIRP	Effective Isotropic Radiated Power
FCC	Federal Communications Commission
FL	Filter
GPS	Global Positioning System
HW	Hardware
ICD	Interface Control Document
ID	Identifier
IP	Ingress Protection
IP	Internet Protocol
iUI	Internal User Interface (LCD/Button user interface)
LAN	Local Area Network
LCD	Liquid Crystal Display
Li-Ion	Lithium-Ion
LNA	Low Noise Amplifier

Acronym	Definition
PA	Power Amplifier
PA DR	Power Amplifier Driver
PASS ANT CONN	Passive Antenna Connector
PCB	Printed Circuit Board
PWR DET	Power Detector
RF	Radio Frequency
RX	Receive
SAR	Specific Absorption Rate
SCD	Source Control Drawing
SIM	Subscriber Identity Module
TBD	To Be Determined
TE	Terminal Equipment
TNC	Threaded Neill–Concelman
TX	Transmit
UI	User Interface
UICC	Universal Integrated Circuit Card
USIM	Universal Subscriber Identity Module
UT	User Terminal
WebUI	Web browser-based User Interface
WLAN	Wireless Local Area Network

2.0 TERMINAL DESCRIPTION

This section provides a general description of the Hughes 9203 BGAN Patrol portable satellite terminal.

2.1 TERMINAL APPLICATION AND USE CASE

The Hughes 9203 BGAN Patrol terminal is the newest addition to the family of robust and rugged Hughes BGAN products and operates on Inmarsat's BGAN L-Band geostationary satellite system. It addresses the need for comms-on-the-move in the order of 50 – 100 kbps IP connectivity. The terminal consists of a modem unit and an omnidirectional antenna mounted on a pole for backpack mounting. This new lightweight and easy to use solution enables users on foot or on small ATV/quads to provide live, two-way situational awareness updates without the need to stop for a long duration. The user can communicate with a terminal equipment (TE) either through the wired Ethernet/LAN connection or with a wireless device using the built-in WLAN access point. Figure 2-1 shows typical use case scenarios (Note: The terminal and antenna shown in these pictures are not showing the Hughes 9203).

Figure 2-1 Typical use case scenarios

2.2 INTENDED USERS

The terminal's intended application is in a rugged outdoor environment.
Targeted users are specialized and trained users in the fields of military, defense, and emergency response.

2.3 TERMINAL COMPONENTS

2.3.1 Hughes 9203 Block Diagram

The Hughes 9203 consists of a terminal unit and an external L-Band satellite antenna (see block diagram in Figure 2-2). The terminal unit contains the L-Band BGAN satellite modem and receiver/transmitter RF circuitry, a GPS receiver and a Commercial off-the-shelf (COTS) WLAN Module. The WLAN antenna is also integrated in the terminal unit.

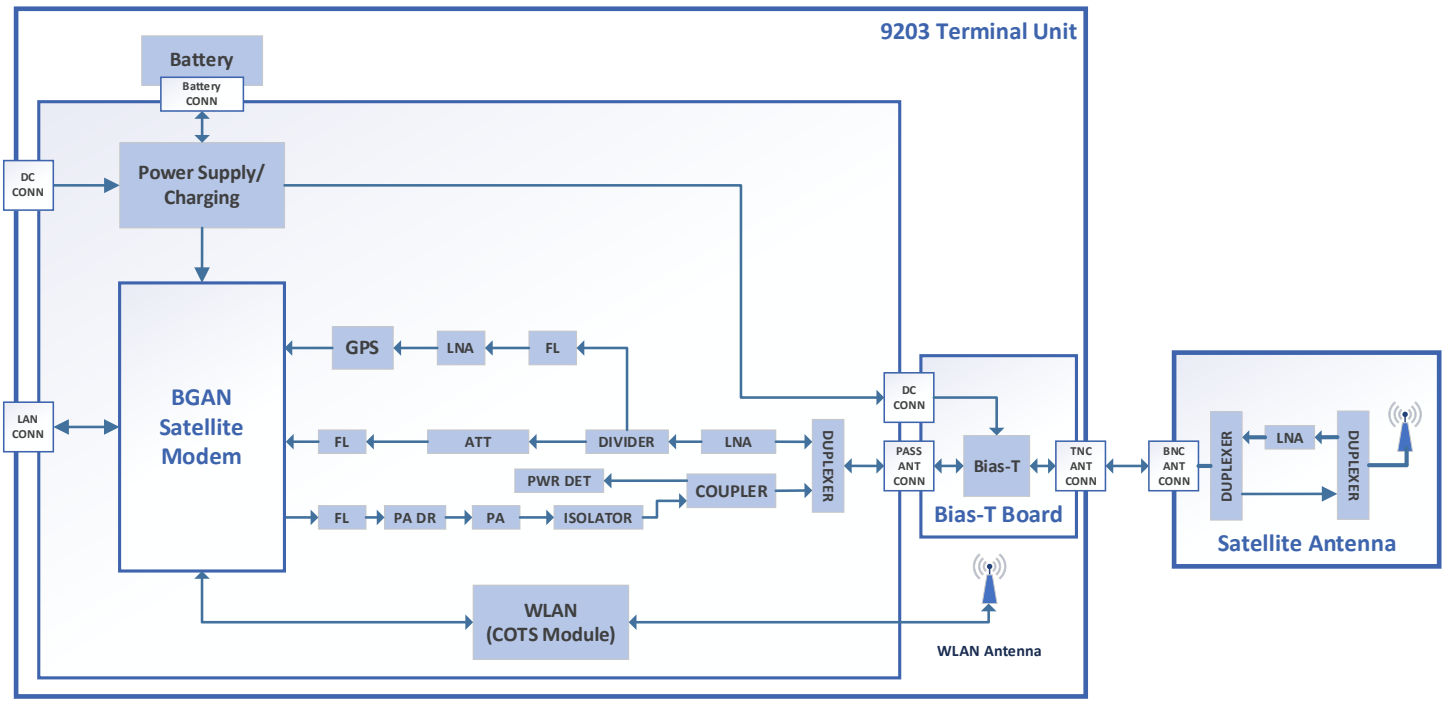


Figure 2-2 Hughes 9203 Block Diagram

2.3.2 Hughes 9203 Terminal Main Components

Figure 2-3 illustrates how the main components of the Hughes 9203 terminal are assembled:

- Terminal unit
- L-band satellite antenna
- Pole
- RF cable

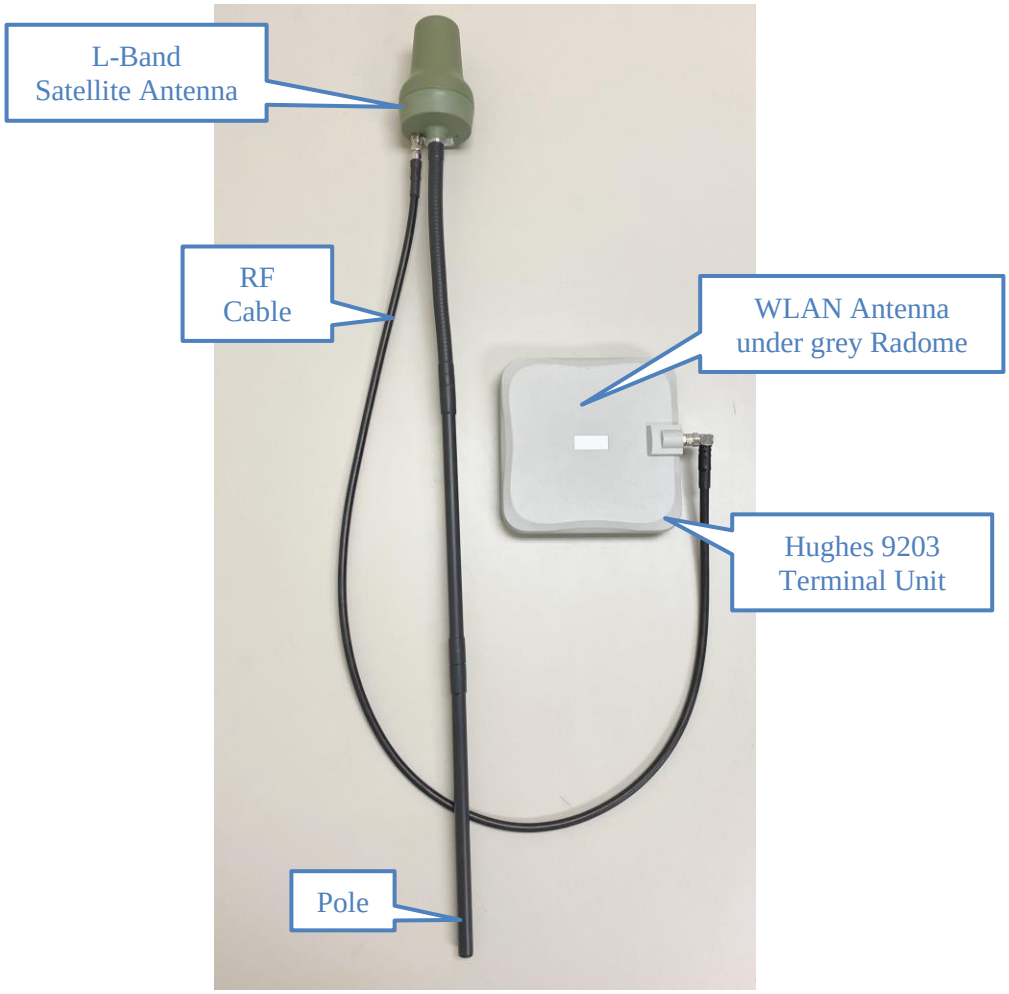


Figure 2-3 Assembled Hughes 9203 Terminal with Satellite Antenna, RF Cable and Pole

2.3.3 Hughes 9203 Backpack Installation

Figure 2-4 shows the Hughes 9203 terminal installed in a backpack. The antenna is mounted on the pole that is attached to the backpack while the terminal unit is stowed away inside the backpack. Note that the terminal unit is installed such that the WLAN antenna (under the terminal's grey radome) is facing away from the person carrying the backpack.

The Hughes 9203 terminal has a magnesium enclosure on the bottom side (facing the user). The WLAN antenna is mounted under the plastic radome.

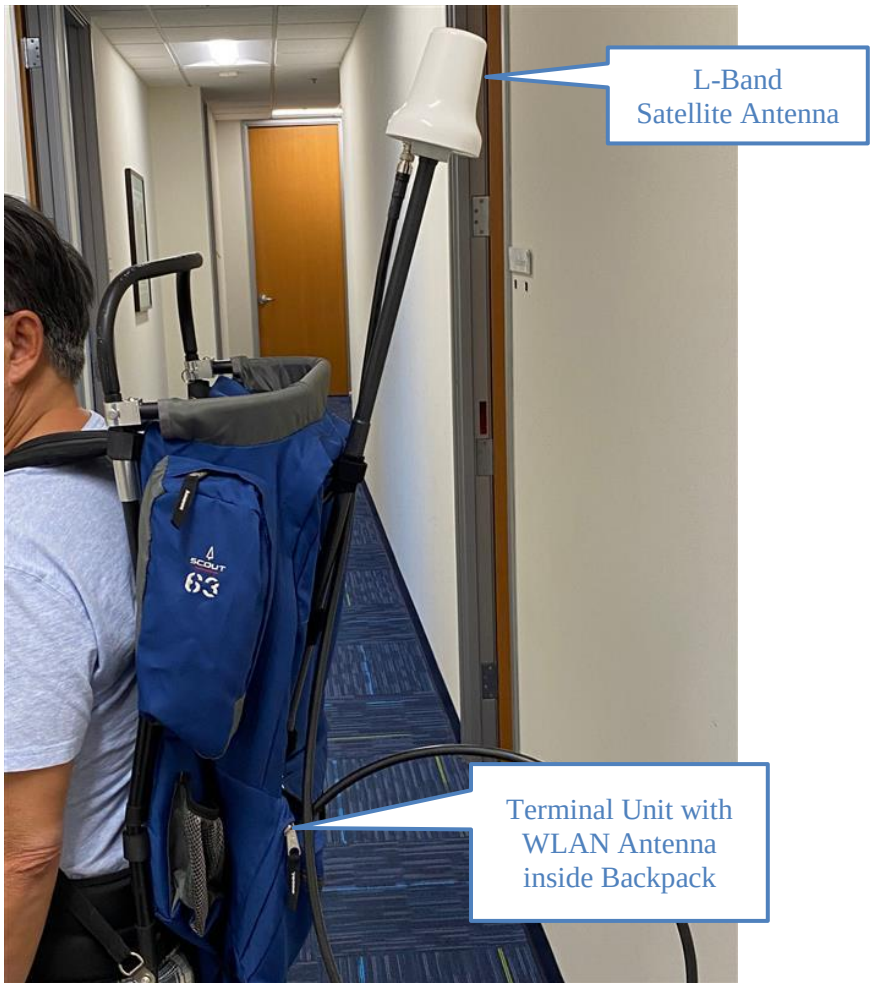


Figure 2-4 Hughes 9203 Terminal installed in a Backpack

2.3.4 Separation between Satellite and WLAN Antenna

When installed in the backpack the satellite antenna and the WLAN antenna will always be separated by more than 20 cm. Typically the separation distance is expected to be between 60 cm and 100 cm depending on the type of backpack and how the components are attached to and installed in the backpack.

2.3.5 WLAN Safety Distances

The modem unit shall be installed in the backpack such that there is a minimum distance of 25 mm between the body of the user and the chassis of the modem unit. The WLAN antenna is located inside the terminal 29 mm away from the backside of the chassis (see Figure 4-5).

This ensures a minimum distance of 54 mm between the WLAN antenna and the user's body.

Note:
The users are instructed and trained to install the terminal unit in an outside pocket of the backpack (see Figure 2-5).

Users shall maintain a safety distance in front of the grey radome of at least 20 cm.
The safety distances are documented in the user guide as follows:

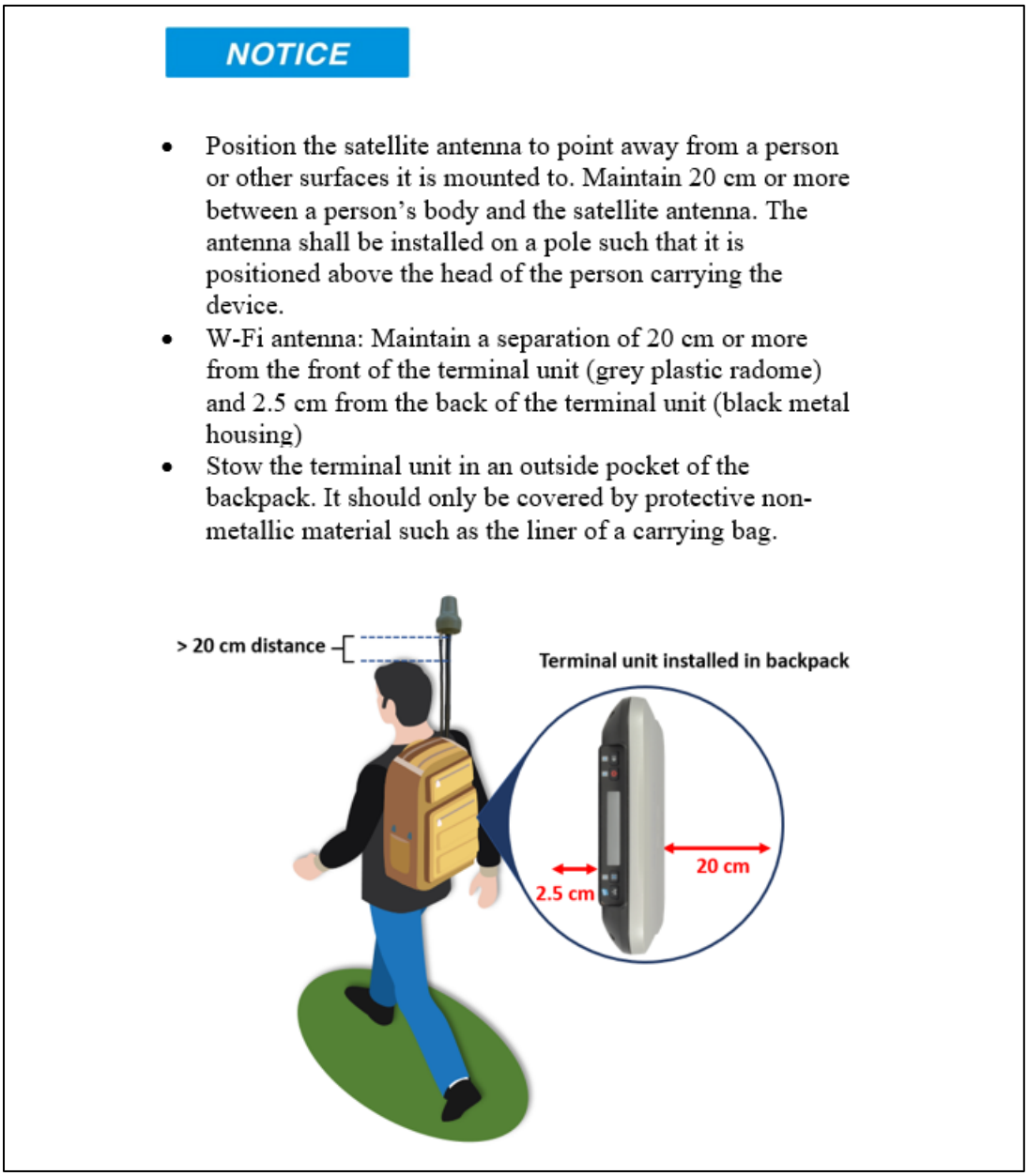


Figure 2-5 Excerpt from User Manual: Safety Distances

2.4 TERMINAL TECHNICAL SPECIFICATIONS

Table 2-1 Hughes 9203 Technical Specifications

Satellite TX Frequency	1626.5 – 1660.5 MHz and 1668 – 1675 MHz [4]
Satellite RX Frequency	1518 – 1559 MHz
GPS Frequency	1574.42 – 1576.42 MHz
Satellite EIRP (L-band Max Tx)	9 dBW
Continuous transmit	Up to 2 hours [1]
Continuous receive	Up to 4 hours [1]
Standby Time	Up to 36 hours [1]
Weight	Terminal: 1.4 kg Antenna with cable and pole: 1.1 kg
Dimensions	Terminal: 211 mm x 211 mm x 41 mm Antenna: 153 mm (height) x 94 mm (diameter)
Operating Temperature (with DC supply)	-25 °C to +55 °C [3]
Battery Charging Temperature	0 °C to +40 °C
Storage Temperature (including battery)	-25 °C to +55 °C (0 °C to +20 °C is recommended for longer battery life)
Storage Temperature (excluding battery)	-25 °C to +70 °C
Humidity	95% RH at +40 °C
Water and Dust	IP 65 compliant
Non-operational Mechanical Vibration	MIL-STD 810G, Method 514.7, Loose Cargo, in transportation case
Removal Battery	7.5 V 6400 mAh 48 Wh Li-ION rechargeable battery
Input Voltage (External Power/Charging)	19 V ⎓ 3.4 A [2]
Data Connectivity	RJ45 port (Ethernet 100BaseT) 802.11b/g/n WLAN
Other Features	Integrated User Interface (iUI) via LCD panel Web User Interface (Web UI) SIM/USIM Slot (behind battery) AC/DC adapter Rechargeable Li-Ion battery Compass

Note:

1. Performance may be affected by a wide range of factors.
2. The Hughes 9203 satellite terminal operates on DC power which can be supplied by an AC or DC power source. To comply with safety requirements, the terminal must be powered only with an AC/DC adapter or DC power adapter supplied or approved by Hughes.
3. Recommend using external battery or power source for continuous Tx above +40° C.
4. XL band 1668 – 1675 MHz operation available only within Alphasat I-4A F4 satellite coverage.

3.0 DETAILS OF SATELLITE MODEM AND ANTENNA

The satellite modem complies with the BGAN L-band satellite system air interface. The terminal's transmitter output power is factory calibrated to achieve an effective isotropic radiated power (EIRP) of 9 dBW at elevations higher than 30 degrees from horizon. The L-band satellite antenna has an omnidirectional characteristic.
The antenna is mounted on a pole such that it is installed higher than the user to achieve unobstructed line-of-sight to the satellite in all directions.

The satellite mode meets the FCC MPE limit of 1.00 mW/cm^2 at a distance of less than 20 cm.
The satellite antenna bears a radiation warning label of 20 cm.

Figure 3-1 Warning Label on the external L-Band Satellite Antenna

4.0 DETAILS OF WLAN MODEM AND ANTENNA

4.1 COTS WLAN MODULE MICROCHIP WFI32E01UE

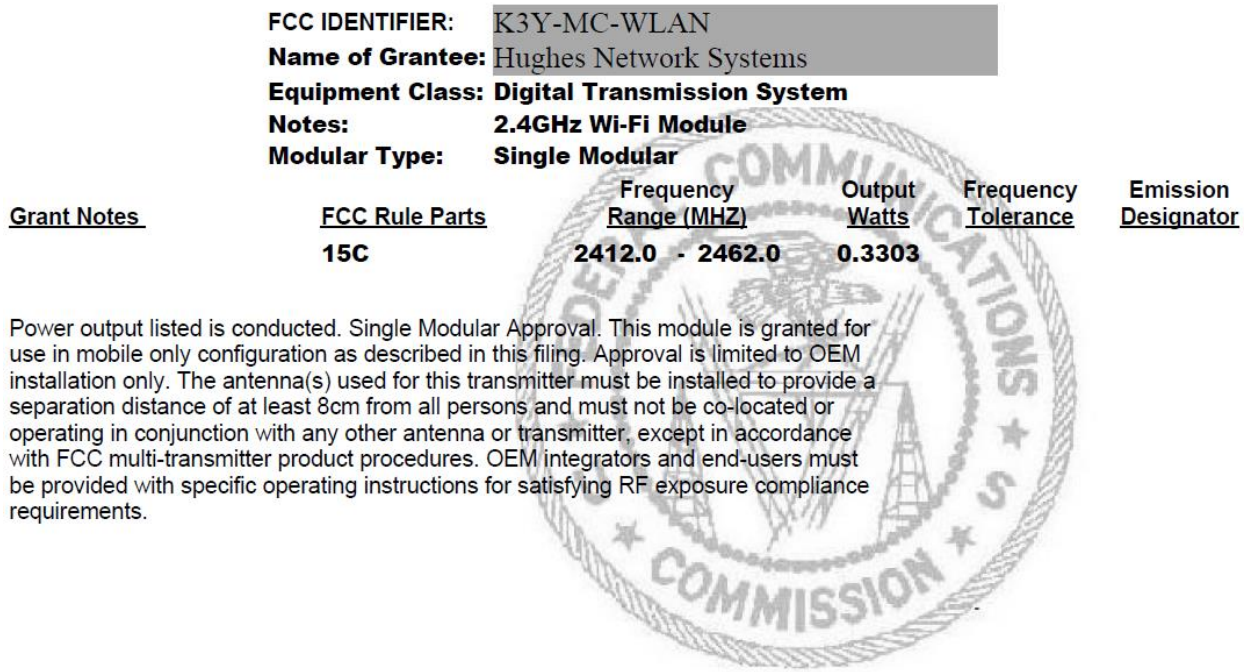
4.1.1 Overview

The Hughes 9203 terminal uses a built-in commercial off-the-shelf (COTS) WLAN Module from Microchip: The WFI32E01UE [1].
The WFI32E01 is a fully RF certified wireless module that contains the PIC32MZ1025W104 SoC and an integrated Frontend Module (FEM).
The WFI32E01UE version of the module has a U.FL connector for an external WLAN antenna.

4.1.2 WLAN Module Certification

The Microchip WLAN module is FCC certified for use with approved antennas. The FCC ID is 2ADHKWFI32E01

Hughes recertified the module with antennas used in the Hughes mobile satellite terminal products.
The Hughes-specific FCC ID is: K3Y-MC-WLAN



FCC IDENTIFIER: K3Y-MC-WLAN
Name of Grantee: Hughes Network Systems
Equipment Class: **Digital Transmission System**
Notes: **2.4GHz Wi-Fi Module**
Modular Type: **Single Modular**

Grant Notes	FCC Rule Parts	Frequency Range (MHZ)	Output Watts	Frequency Tolerance	Emission Designator
	15C	2412.0 - 2462.0	0.3303		

Power output listed is conducted. Single Modular Approval. This module is granted for use in mobile only configuration as described in this filing. Approval is limited to OEM installation only. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 8cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures. OEM integrators and end-users must be provided with specific operating instructions for satisfying RF exposure compliance requirements.

Figure 4-1 WLAN Module FCC Grant for Hughes Approved Antennas

4.1.3 WLAN Module Technical Specifications

Excerpts from the Microchip datasheet [1] relevant to the WLAN module transmitter characteristics are shown below.

TABLE 41-40: RADIO SPECIFICATIONS

Feature	Description
WLAN standards	IEEE 802.11b, IEEE 802.11g, and IEEE 802.11n
Frequency range	2.412 GHz ~ 2,472 GHz (2400 ~ 2483.5 MHz ISM band)
Number of channels	11 for North America and 13 for Europe and Japan

TABLE 41-42: TRANSMITTER PERFORMANCE CHARACTERISTICS

RF CHARACTERISTICS		Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C			
Parameter	**Description**	**Min.**	**Typ.(3)**	**Max.**	**Unit**
Frequency	—	2412	—	2472	MHz
Output power(1)(2) 802.11b	1 Mbps DSSS	—	20.5	—	dBm
	2 Mbps DSSS	—	20.5	—	
	5.5 Mbps DSSS	—	20.5	—	
	11 Mbps DSSS	—	20.5	—	
Output power(1)(2) 802.11g	6 Mbps OFDM	—	19.5	—	dBm
	9 Mbps OFDM	—	19.5	—	
	12 Mbps OFDM	—	19.5	—	
	18 Mbps OFDM	—	19.5	—	
	24 Mbps OFDM	—	19.5	—	
	36 Mbps OFDM	—	19.5	—	
	48 Mbps OFDM	—	19.5	—	
	54 Mbps OFDM	—	18.5	—	

TABLE 41-42: TRANSMITTER PERFORMANCE CHARACTERISTICS (CONTINUED)

RF CHARACTERISTICS		Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C			
Parameter	**Description**	**Min.**	**Typ.(3)**	**Max.**	**Unit**
Output power(1)(2) 802.11n (Bandwidth at 20 MHz)	MCS 0	—	18.5	—	dBm
	MCS 1	—	18.5	—	
	MCS 2	—	18.5	—	
	MCS 3	—	18.5	—	
	MCS 4	—	18.5	—	
	MCS 5	—	18.5	—	
	MCS 6	—	18	—	
	MCS 7	—	17	—	
Transmit Power Control (TPC) Accuracy	—	—	±1.5(2)	—	dB
Harmonic Output Power (Radiated, Regulatory mode)	2nd	—	—	-41.25(7)	dBm/MHz
	3rd	—	—	-41.25(7)	

Note 1: Measured at IEEE 802.11 specification compliant EVM/Spectral mask.

2: Measured after RF matching network and FEM output (assume 50Ω impedance).

3: RF performance is ensured at 3.3V, 25°C, with a 2-3 dB change at boundary conditions.

4: With respect to TX power, different (higher/lower) RF output power settings may be used for specific antennas and/or enclosures, in which case re-certification may be required.

5: The availability of some specific channels and/or operational frequency bands are country-dependent and should be programmed in the host product at the factory to match the intended destination. Regulatory bodies prohibit exposing the settings to the end user. This requirement needs to be taken care of via host implementation.

6: The host product manufacturer must ensure that the RF behavior adheres to the certification (for example, FCC, ISED) requirements when the module is installed in the final host product.

7: FCC Radiated Emission limits (Restricted Band).

4.1.4 WLAN Output Power

The following table shows the worst case (highest) output power levels of the WLAN module according to the module certification tests:

TÜVRheinland®

Prüfbericht - Produkte
Test Report - Products

Prüfbericht - Nr.: **60359686 002**
Test Report No.

Seite 11 von 19
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4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The test modes were adapted accordingly in reference to the instructions for use.
During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output expected by the customer and is going to be fixed on the firmware of the final end product.

Table for Parameters of Test Software Setting

802.11b		802.11g		802.11n HT20	
Channel	Power Setting	Channel	Power Setting	Channel	Power Setting
1	20.25	1	16.50	1	16.00
6	22.25	6	20.25	6	20.25
11	20.00	11	16.25	11	15.50

Figure 4-2 Excerpt from Microchip Test Report: WLAN Module Output Power

4.1.5 WLAN Module Installation in the Hughes 9203

The Microchip WLAN module is installed on a Hughes daughter card that is mounted on the Hughes satellite modem board.

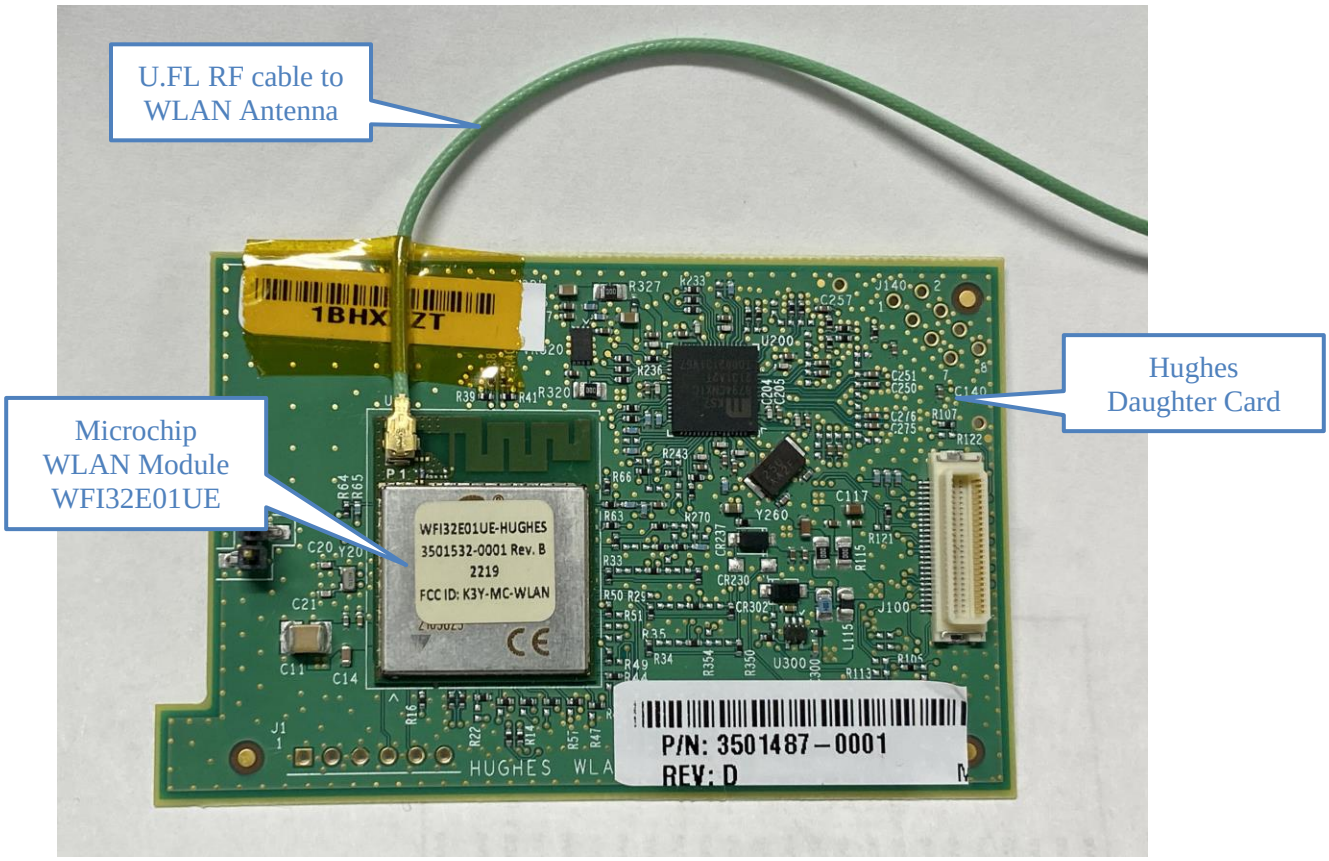


Figure 4-3 WLAN Module installed on Hughes Daughter Card

4.2 WLAN ANTENNA

4.2.1 WLAN Antenna Description

The Hughes 9203 terminal uses a WLAN antenna in compliance with the Hughes-specific FCC ID K3Y-MC-WLAN, namely the 3.5 dBi patch antenna.

The Hughes patch antenna is etched in a double layer PCB that also serves as an EMC shield plate:

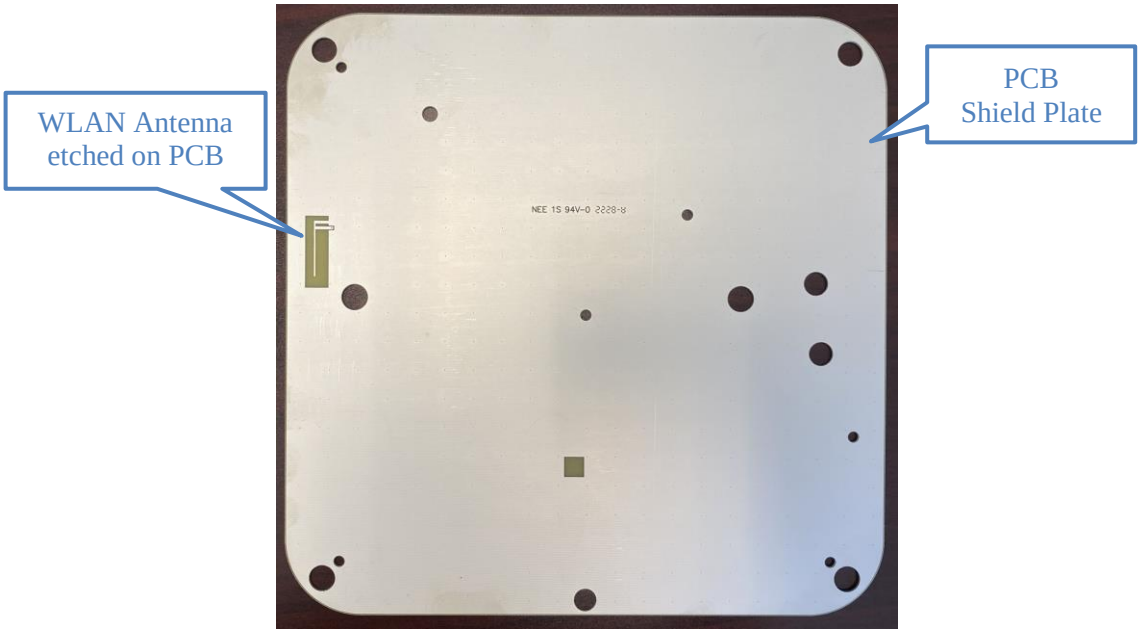


Figure 4-4 WLAN Patch Antenna integrated in EMC Shield

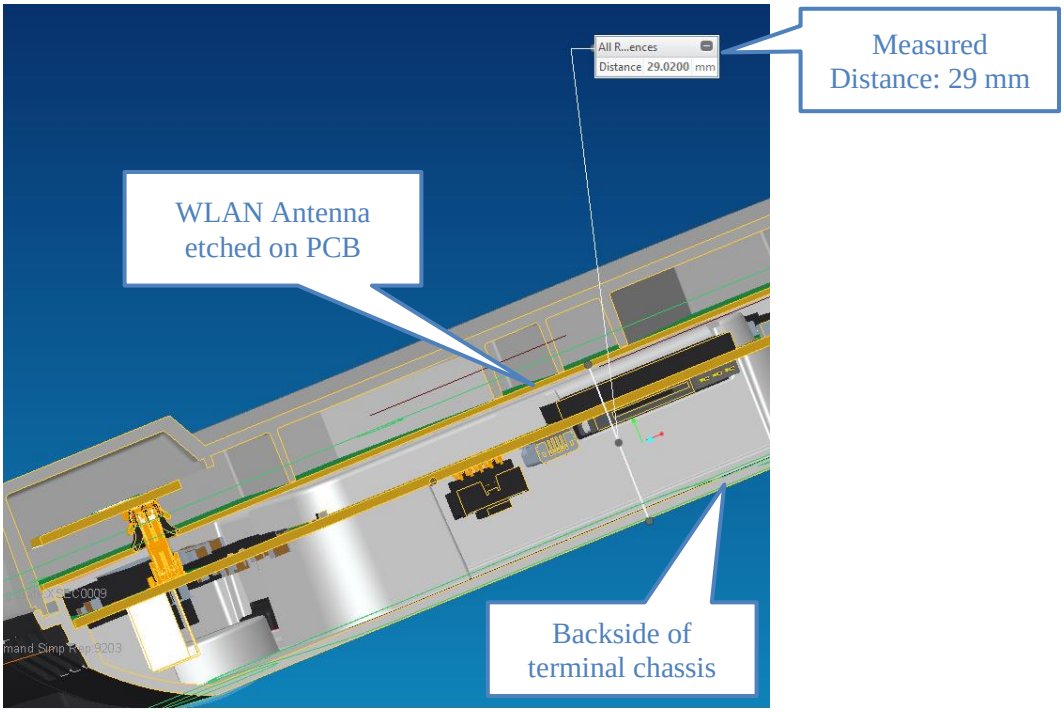


Figure 4-5 WLAN antenna location referenced to the back of the terminal chassis

The WLAN antenna is located inside the terminal 29 mm away from the backside of the chassis (see Figure 4-5).

Together with the 25 mm safety distance this ensures a minimum distance of 54 mm between the WLAN antenna and the user's body.

4.2.2 WLAN Antenna Patterns/Gain

The characteristics of the Hughes 9203 WLAN antenna was measured in an antenna test chamber. The antenna gain is – 6dBi or less. In fact, it is significantly less in the direction of the metallic backside of the terminal.

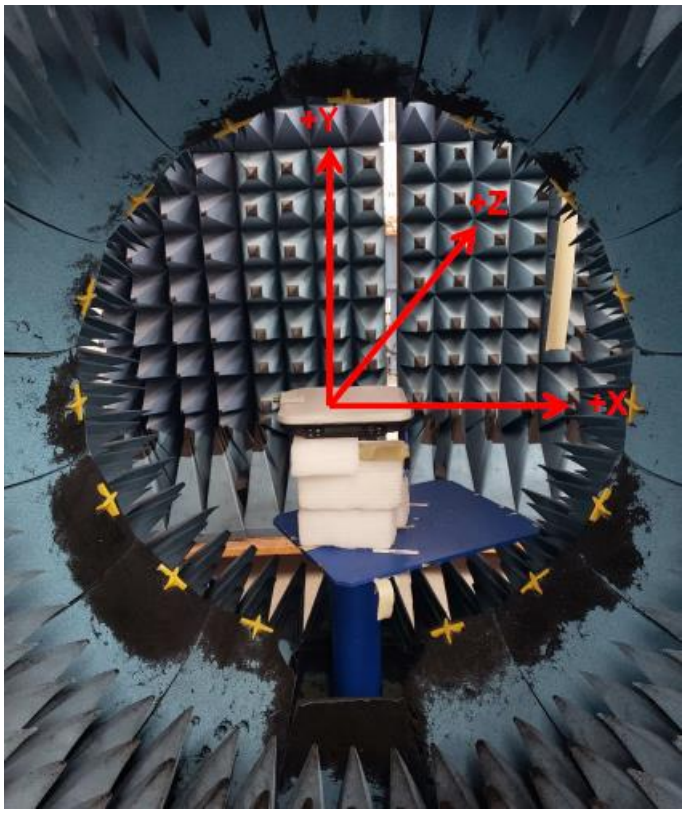


Figure 4-6 WLAN Antenna Measurement: Coordinate System

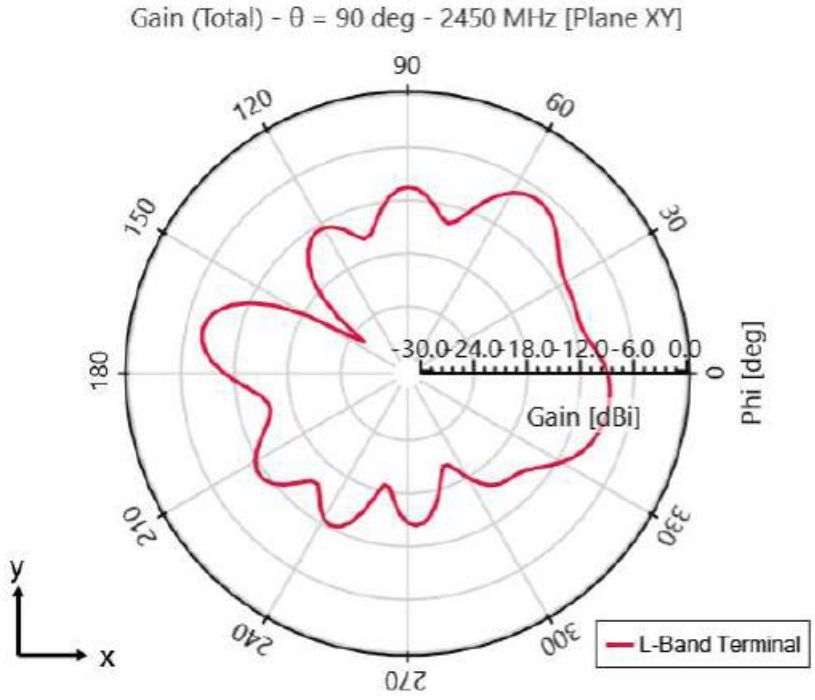


Figure 4-7 WLAN Antenna Measurement: Theta = 90 Degrees

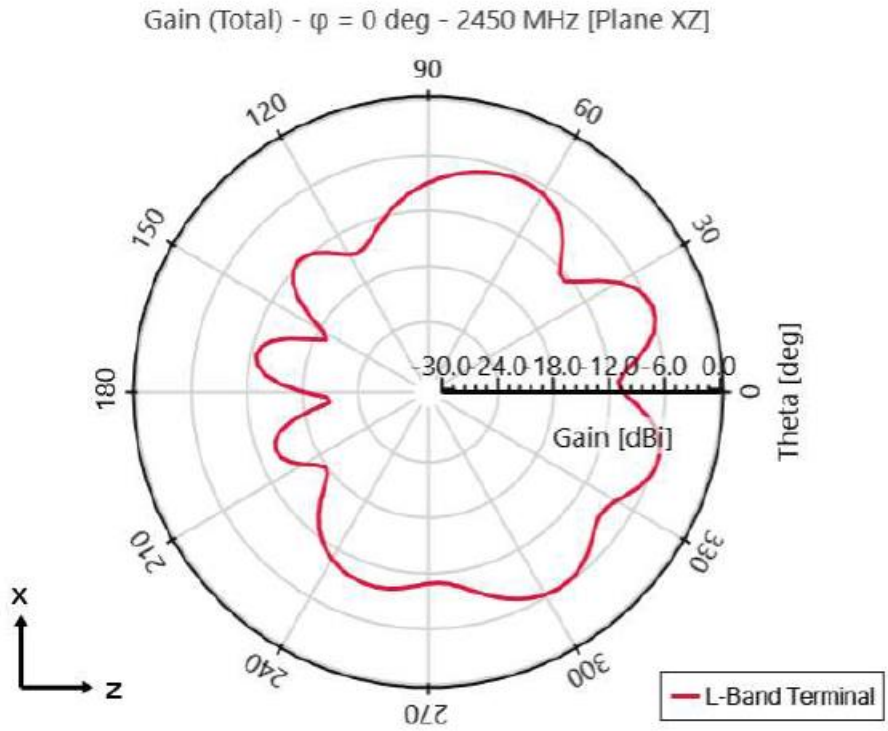


Figure 4-8 WLAN Antenna Measurement: Phi = 0 Degrees

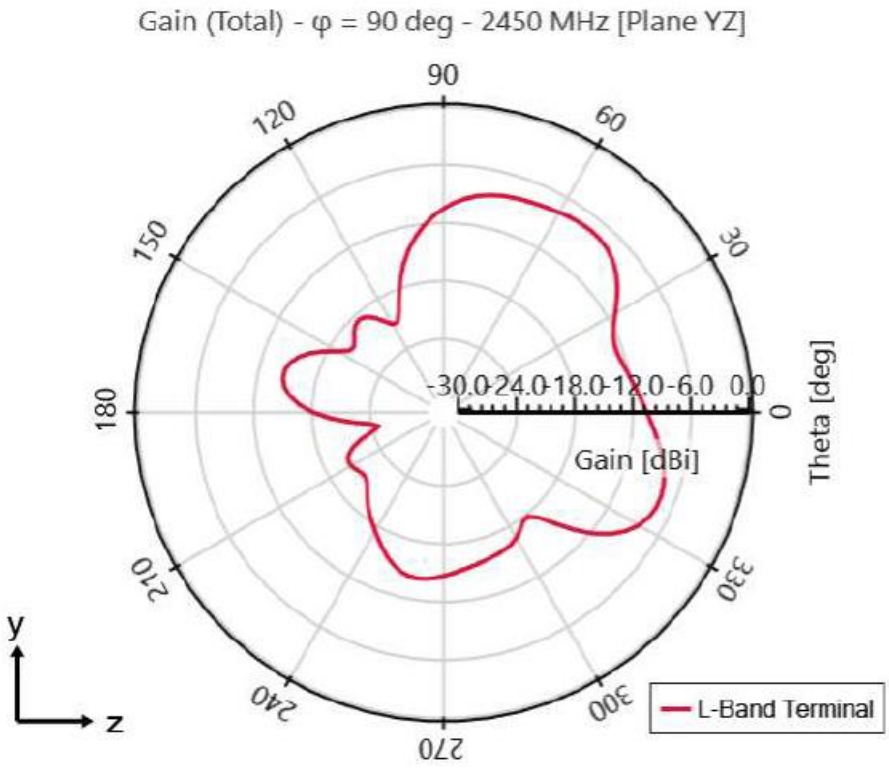


Figure 4-9 WLAN Antenna Measurement: Phi = 90 Degrees

4.2.3 WLAN Antenna Intended Radiation Direction

Figure 4-11 shows a side view of the Hughes 9203 terminal unit. The black part of the housing is the magnesium bottom housing which houses the electronics boards and blocks WLAN radiation towards the carrier of the backpack. The light grey plastic part is the radome housing the WLAN antenna.

Figure 4-12 shows the position of the terminal when installed in the backpack with the antenna radiation direction pointing away from the carrier of the backpack. Also refer to Figure 2-5 for the user instructions on how to install the terminal in the backpack.

The WLAN radiation warning label states a safety distance of 20 cm from the front of the plastic radome.

Figure 4-10 WLAN Radiation Warning Label

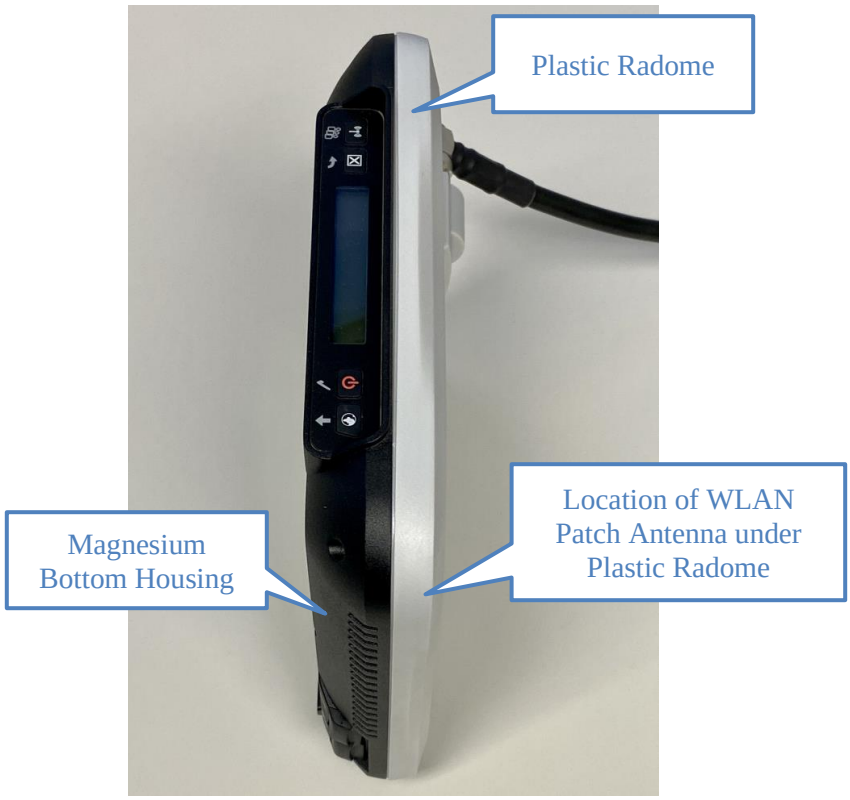


Figure 4-11 Hughes 9203 Terminal – WLAN Antenna Location

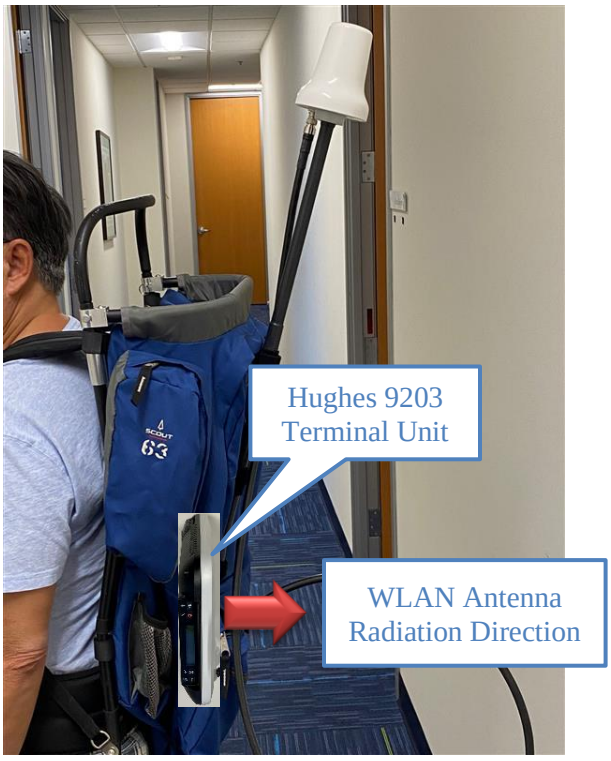
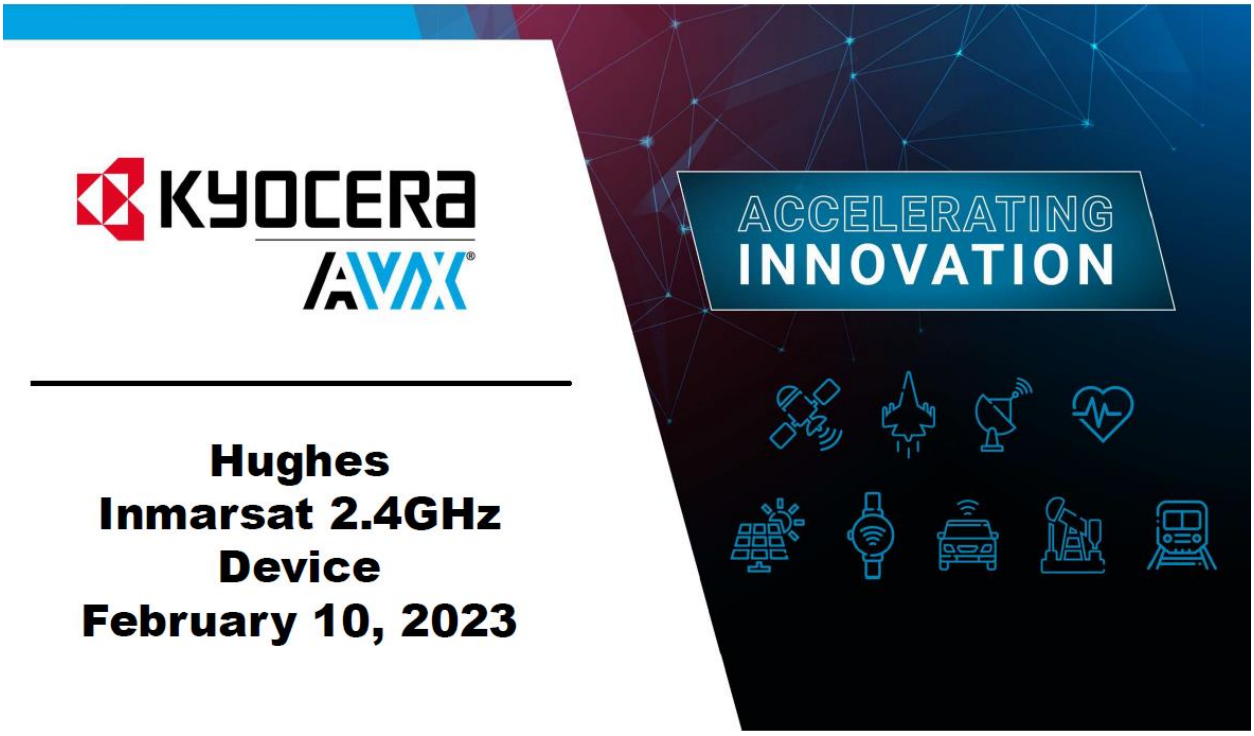


Figure 4-12 Hughes 9203 Terminal – WLAN Antenna Radiation Direction

5.0 APPENDIX A: WLAN ANTENNA TEST REPORT

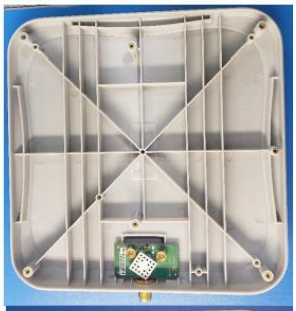


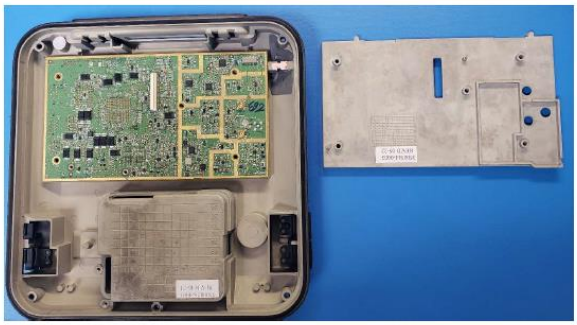
Summary

- The purpose of this report is to characterize Hughes L-Band Terminal Wifi antenna.
- This report will provide measured return loss, efficiency and radiation patterns.

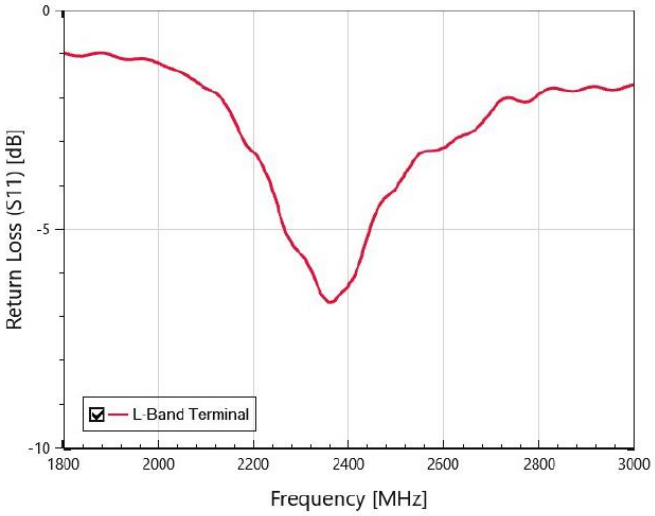
Inmarsat Device

Inmarsat Device Disassembled

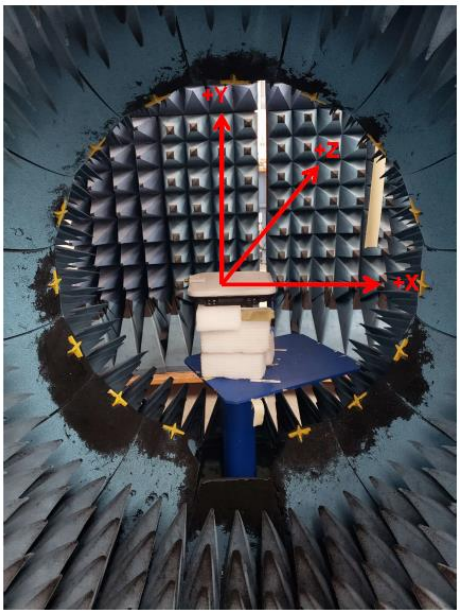




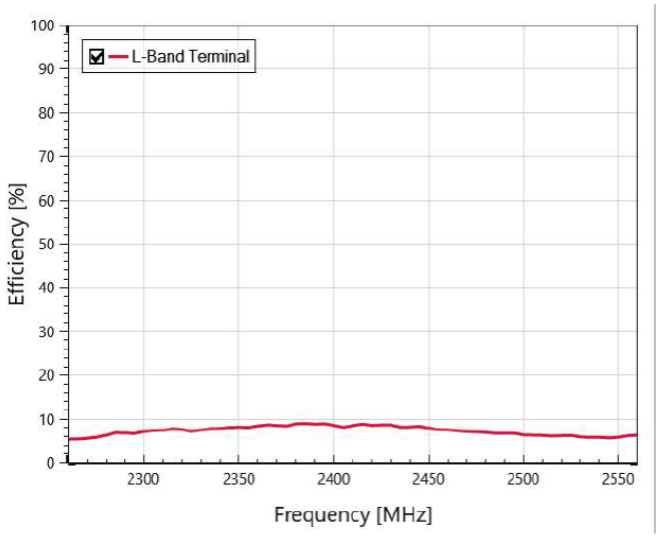
Return Loss



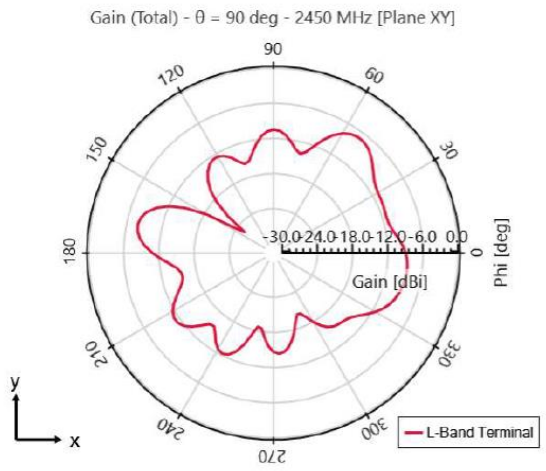
Coordinate System

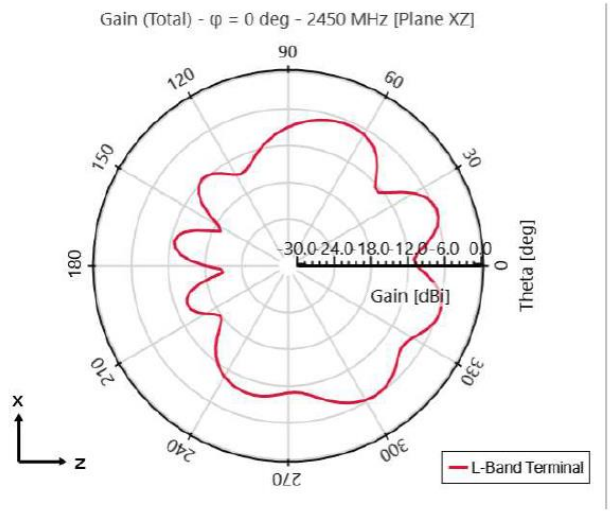


Efficiency

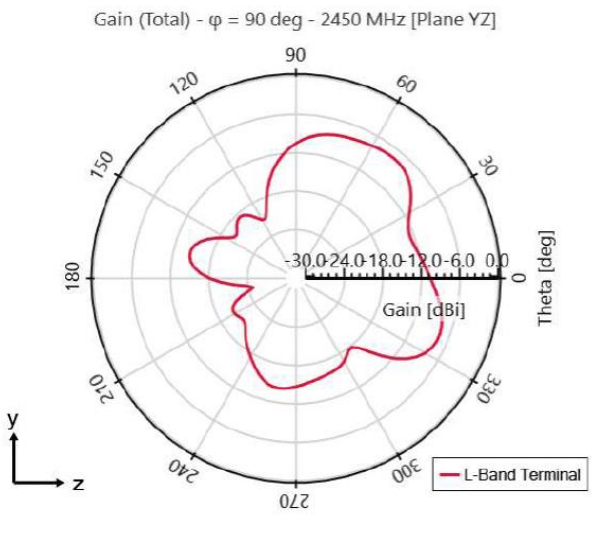


Radiations Patterns





Radiations Patterns



THANK YOU.

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KYOCERA-AVX.com