Site Acceptance Test Report of the GSG-882 for DGA-MI

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Date	Rev From	Rev To	Summary of Change
16th February 2024	-	1	Preliminary Release

Contents

1. Introduction

This report provides the results for the GNSS Signal Simulator GSG-882 for DGA-MI on customer requirements. The test plans are described in another document referenced as the Acceptance Test Plan (ATP) that will be provided at the end of the FAT process. This document is related to the purchase order ME244673 for the end customer DGA-MI.

Regarding the SAT (On Site Acceptance Test), the description can be found on the original ATP document. The results of these tests will be filled in this document named Site Acceptance Test Report (SATR).

The SAT process will be conducted in DGA-MI facilities in Bruz, France. The SAT purpose is to verify that shipment and installation have not broken some parts or modified the performance of the simulator.

2. Related Documents

2.1. Applicable documents

SKYDEL User Manual's current version (11/2023): Skydel User Manual

2.2. Reference document

Reference	*Part Number*
Acceptance Test Plan (ATP)	***ATP-SCD-00207-rev3***
Acceptance Test Report (ATR)	***ATR-SCD-00207-rev1***

2.3 Glossary

AWGN: Additive White Gaussian Noise
BOC: Binary Offset Carrier
BPSK: Binary Phase-shift Keying
CPU: Central Processing Unit
CW: Continuous Wave
GNSS: Global Navigation Satellite System
GPU: Graphic Processing Unit
MSps: Megasamples Per Second
NA: Not Applicable (in the scope of this Document)
Ns: Nanosecond

OS: Operating System
PPB: Parts Per Billion
PPS: Pulse Per Second
RF: Radio Frequency
SDR: Software-Defined Radio

3. Test Procedure's

3.1. Acceptance test summary

Test number	Title	Description	Pass	Fail
Test 1	Visual inspection	Hardware integrity, safety of the GSG-8 system	☒	☐
Test 3	Static scenario 1	All GNSS Signals	☒	☐
Test 4	Static scenario 2	1 GNSS Signal + Interference (Spoofing)	☒	☐
Test 5	Static scenario 3	All GNSS Signals + Interference (Jamming)	☒	☐
Test 6	Moving scenario 1	Earth-orbiting vehicle + Inertial data	☒	☐
Test 7	Static scenario 4	IQ File generation	☒	☐

All tests are detailed in the following chapters with result contents.

Test operator:	**Brendan Lehuédé**

3.2 Test 1: Visual inspection

3.2.1 Objective

The purpose of this test is to visually inspect the GSG-8 system to verify:

- The quality of the assembly
- The height
- The physical integrity
- The external interface
- The power requirements

3.2.2 Test setup

The setup for this test is the basic setup shown in Figure 1.

The test performed in this section will require the following tools:

- SMA Torque Wrench
- Measuring tape

3.2.3 Test procedure

Get the GSG-882 system rack and verify that:

- Cables are correctly fastened and fixed
- All the RF and clock connectors are adequately tightened
- All other cables (power supplies, etc.) are correctly plugged

Check that there is no external damage to the structure.

3.2.4 Test result

Test 1: Visual Inspection	**Pass**	**Fail**
Cables are correctly fastened and fixed	☒	☐
All the RF and clock connectors are correctly tightened	☒	☐
All the other cables (power supplies, etc.) are correctly plugged.	☒	☐

No external damages on the structure or the painting	☒	☐
The covers can be closed without issues	☒	☐

3.3 ***Test 3: Static scenario 1*** *[All GNSS signals]*

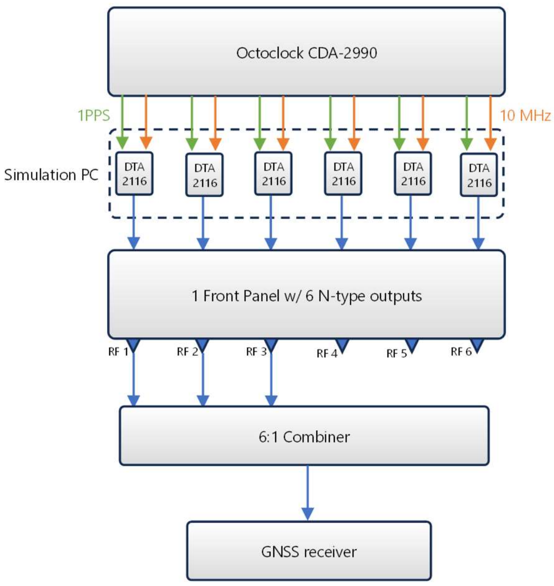
3.3.1 Objective

This test aims to validate the following:

- The simulation and tracking of all the specified GNSS signals (test vector). GNSS receiver connected. Accuracy of the position.

3.3.2 Test setup

This test is done with all the GNSS signals of interest using 3 x DTA-2116 as depicted below.



Note: Accuracy, precision and all the features, in general, are defined in the software (i.e., algorithms and modulation that are running in CPU and GPU).

The test performed in this section will require the following element:

- GNSS receiver

Configure the SKYDEL scenario in the settings as described below:

- 3 Radios/SDRs (DTA-2116)

	Radio 1 (DTA-2116)	**Radio 2 (DTA-2116)**	**Radio 2 (DTA-2116)**
Upper L Band	GPS L1 CA + GPS L1C + GALILEO E1 + GLONASS G1 + BEIDOU B1		
Lower L-Band		GPS L2C + GPS L5	GALILEO E6 HAS
GPU	#0	#0	#0

3.3.3 Test procedure

- Check the installed Skydel signal licenses: SKY-GPSCA, SKY-GPSL1C, SKY-GPSL2C, SKY-GPSL5, SLY-GALE1, SKY-OSNMA SKY-GALHAS, SKY-GLOG1, SKY-BEIB1.

- Create a new scenario with all the signals listed below:

Parameter		Frequency	**Unit**
4. Output Frequencies	GPS L1 (C/A and C)	1575.42	MHz
		1575.42	
	GPS L2C	1227.6	MHz
	GPS L5	1176.45	MHz
	GLONASS G1	1598.0625-1609.3125	MHz
	GALILEO E1	1575.42	MHz
	BEIDOU B1 (I)	1561.098	MHz

- Cold start the receiver, and let it acquire the signals for 10 minutes.
- Check that the receiver tracks all the simulated signals for all the constellations.
- Verify that the receiver's accuracy stays within 2 meters for 30 minutes.

3.3.4 Test result

Test 3: Static scenario 1	**Pass**	**Fail**
All the GNSS signals are tracked	☒	☐
Accuracy stays within 2 meters	☒	☐

3.4 ***Test 4: Static scenario 2*** *[Spoofing]*

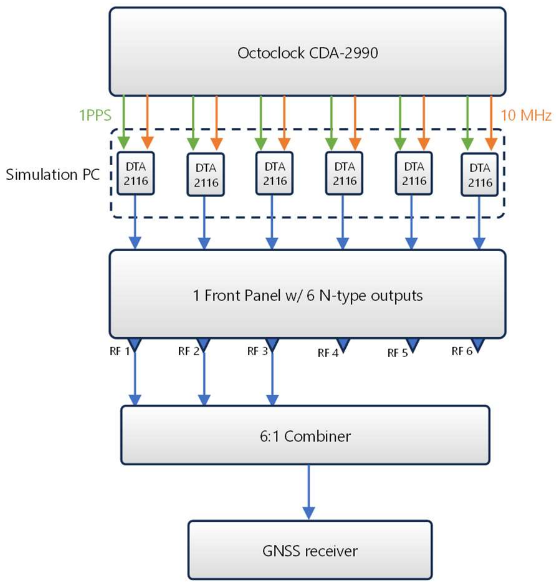
3.4.1 Objective

This test aims to validate the following:

- The generation of the spoofing signal

3.4.2 Test setup

This test is done with all the GNSS signals of interest using 2 SDRs.



Note: Accuracy, precision and all the features, in general, are defined in the software (i.e., algorithms and modulation that are running in CPU and GPU).

Configuration of the SKYDEL scenario in the settings as below:

- 2 Radios/SDRs: DTA-2116

	Radio 1	Radio 2
Skydel set up	Truth Instance	Spoofer instance
GNSS Signal	GPS L1 CA	GPS L1 CA

3.4.3 Test procedure

Create a static scenario with a GNSS signal. Activate the spoofing signal.

On the Skydel Spectrum tab, check that the spoofing signal is correctly simulated (correct shape and power-same with GPS L1 CA).

Deactivate GNSS 'truth' signal and cold to reset the receiver. Check the receiver can track the spoofing signals.

3.4.4 Test result

Test 4: Static scenario 2	**Pass**	**Fail**
Spoofing is correctly generated. *Note 19/02/2024: Septentrio MosaicX5/ Ublox F9T receivers were able to track and get the fix with the spoofer signal. We observed altitude divergence when switching from truth sky and spoofer signals. All spoofing scenarios run during the training were working properly.*	☒	☐

3.5 ***Test 5: Static scenario 3*** *[Jamming]*

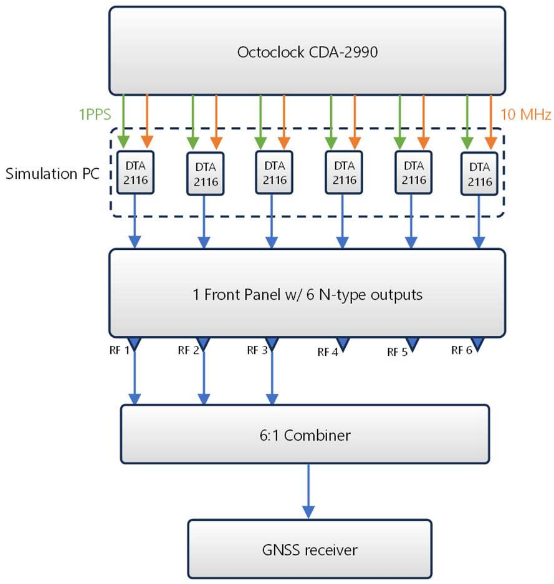
3.5.1 Objective

This test aims to validate the following:

- The generation of the jamming signals

3.5.2 *Test Setup*

This test is done with all the GNSS signals of interest using 4 SDRs.



Configuration of the SKYDEL scenario in the settings as below:

- Group 1: GPS L1 CA + GPS L1C+ GALILEO E1 + GLONASS G1 + BEIDOU B1
- Group 2: GPS L2C + GPS L5
- Group 3: GALILEO E6 HAS

Radio 1 (DTA-2116)	**Radio 2 (DTA-2116)**	**Radio 3 (DTA-2116)**	**Radio 4 (DTA-2116)**	**Radio 5 (DTA-2116)**	**Radio 6 (DTA-2116)**
Group 1			Interference Group 1 (1582.0 MHz)		
	Group 2			Interference Group 2 (1202.0 MHz)	
		Group 3			Interference Group 3 (1278.75 MHz)
GPU #0	GPU #0	GPU #0	GPU #0	GPU #0	GPU #0

3.5.3 Test Procedure

Create a static scenario with all the GNSS signals of interest and add a dynamic transmitter. Adjust the distance/power of the transmitter to have -40 dBm power at the receiver level. Add the following waveforms to it and keep them disabled:

- AWGN, CW, Chirp, BOC, BPSK at L1, L2/L5 and L6 central frequency

Activate the jammers one by one on the three frequencies.

On the Skydel spectrum tab, check that each jammer is correctly simulated (correct shape and power).

3.5.4 Test result

Test 5: Static scenario 3	**Pass**	**Fail**
All the jammers are correctly generated	☒	☐

3.6 ***Test 6: Moving scenario 1*** *[Inertial data]*

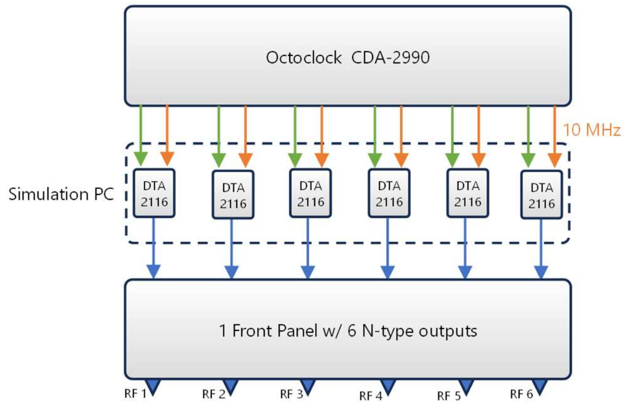
3.6.1 Objective

This test aims to validate the following:

- The ability to simulate earth-orbiting spacecraft trajectory.
- The simulator can generate inertial data logging files consistent with the RF signal. The maximum data frequency available must be 100Hz.

3.6.2 *Test Setup*

The setup for this test is the basic setup. The NoneRT output mode is used so there is no RF signal generated.



Configure the SKYDEL scenario in the settings as described below:

- 3 NoneRT outputs

	NoneRT 1	**NoneRT 2**	**NoneRT 3**
Upper L Band	GPS L1 CA + GPS L1C + GALILEO E1 + GLONASS G1 + BEIDOU B1		
Lower L-Band		GPS L2C + GPS L5	GALILEO E6 HAS
GPU	#0	#0	#0

3.6.3 Test Procedure

- Create an earth-orbiting scenario with all the signals listed below (NoneRT mode):

Parameter		Frequency	**Unit**
5. Output Frequencies	GPS L1 (C/A and C)	1575.42	MHz
		1575.42	
	GPS L2C	1227.6	MHz
	GPS L5	1176.45	MHz
	GLONASS G1	1598.0625-1609.3125	MHz
	GALILEO E1	1575.42	MHz
	GALILEO E6	1278.75	MHz
	BEIDOU B1 (I)	1561.098	MHz

- Enable logging files.

- Run the inertial data Python script. The Python script will generate a inertial data logging file.

- Verify the shape of the trajectory on the map.
- Check the content and frequency of the inertial data logging file.
- Verify the consistency between the Skydel raw data and the inertial data logging file.

3.6.4 Test result

Test 6: Moving scenario 1	**Pass**	**Fail**
Earth-orbiting trajectory simulated	☒	☐
Inertial data generation	☒	☐
Inertial data frequency of 100Hz	☒	☐

*3.7 **Test 7: Static scenario 4** [IQ Files]*

3.7.1 Objective

This test aims to validate the following:

➢ The ability to generate IQ files in binary format.

3.7.2 Test Setup

The setup for this test is the basic setup shown in ***Figure 1***. The File output mode is used to generate the IQ files.

Configure the SKYDEL scenario in the settings as described below:

- 3 File outputs

	File 1	**File 2**	**File 3**
Upper L Band	GPS L1 CA + GPS L1C + GALILEO E1 + GLONASS G1 + BEIDOU B1		
Lower L-Band		GPS L2C + GPS L5	GALILEO E6 HAS
GPU	#0	#0	#0
Sampling rate	60 MSps	75 MSps	50 MSps

4.8.3 Test Procedure

- Create a static scenario with all the signals listed below (File mode):

Parameter		Frequency	**Unit**
6. Output Frequencies	GPS L1 (C/A and C)	1575.42	MHz
		1575.42	
	GPS L2C	1227.6	MHz
	GPS L5	1176.45	MHz
	GLONASS G1	1598.0625-1609.3125	MHz
	GALILEO E1	1575.42	MHz
	GALILEO E6	1278.75	MHz
	BEIDOU B1 (I)	1561.098	MHz

- Select a simulation duration of 30 seconds.

- Verify the size of the generated IQ files.

4.8.4 Test result

Each file size corresponds can be determined using the following equation:

Size(byte) = Sampling rate * Duration * bit depth * 2/8

Where:

Sampling rate is equal to 60MSps for L1, 75MSps for L2/L5, 50 MSps for L6.

Duration=30 seconds

Bit depth = 16 bits

Test 7: Static scenario 4	**Pass**	**Fail**
IQ files generated with right sizes	☒	☐

4. Final acceptance

Date: 19/02/2024

Final acceptance	Pass	Fail
	☒	☐

Signature for final acceptance:

Customer representative:

....

Supplier representative:

Pierre-Marie LE VEEL - Program Manager
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