Infotainment Business Unit

STA8089-90 Binary Image 4.5.7 GNSS Performance Report

1 Introduction

This document reports test results about STA8090 Binary Image 4.5.7 based on GNSS library 8.4.9.14 release.

Tested release enables and uses GPS, GLONASS, GALILEO and BEIDOU constellations.

Tests have been done in order to evaluate the release performances in terms of time to first fix (TTFF), sensitivity and positioning accuracy of SW library release. Tests have been done accordingly to Product Test Specification.

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3.1 Revision History

Rev	Date	Author	Notes
1.0	15/12/2015	Antonio Cascella	Initial Release

Table 1: Revision History

3.2 Acronyms

Keyword	Definition
BEIDOU	Chinese global navigation satellite system
CEP	Circular Error Probable
DGPS	Differential GPS (it is the RTCM SC-104)
DUT	Device under test
FW	Firmware
GALILEO	European global navigation satellite system
GLONASS	GLObal NAvigation Satellite System (The Russian GNSS)
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System - United States Satellite Navigation System
HDOP	Horizontal Time Dilution of Precision
LNA	Low Noise Amplifier
NF	Noise Figure
PDOP	Positional Time Dilution of Precision
QZSS	Quasi-Zenith Satellite System
SBAS	Satellite-based augmentation system
SEP	Spherical Error Probable
STAGPS	Self-Trained Assisted GPS
TTFF	Time to first fix
VDOP	Vertical Time Dilution of Precision

Table 2: Acronyms

3.3 Reference Documents

None

4 Test Methods

All data reported in this document are the results of tests carried out capturing the GNSS signal in three different methods:

1. GNSS Simulator
2. Antenna above the building roof (Roof Antenna Environment)
3. Antenna above the car roof (Road Test Environment)

All the results will be grouped in two specific families:

- **Static Position Testing**
  Main parameters tested are TTFF, Sensitivity and Position Accuracy by using a GNSS simulator and an Antenna on the roof of the building for acquiring the GNSS signals
- **Dynamic Position Testing**
  In this case the DUT is tested in dynamic conditions; typically we perform several road tests as comparison between previous FW and current one and for showing Multiconstellation benefits. By using the GNSS simulator we will test also the dynamic tracking sensitivity, the dynamic position sensitivity and the dynamic position accuracy in whilst highly obscured.

4.1 GNSS Simulator Method

All kind of sensitivity test is done using the GNSS simulator in accordance with the following scheme.

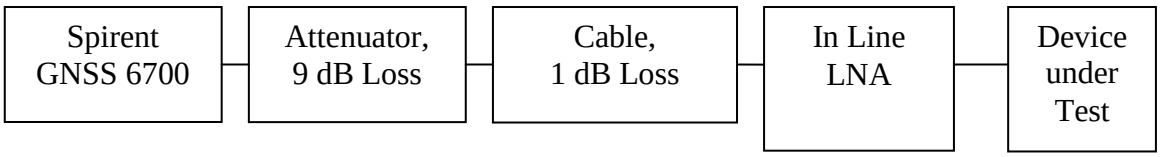

Figure 1 GNSS Simulator Method

The low noise amplifier has a noise figure (NF) of about 1dB and a gain of 20dB.

The overall system loss is 10 dB

4.2 Roof antenna Method

All start up and acquisition measurements are based on nominal supply voltage, room temperature and static position of the antenna, installed on the roof of building.

These tests are performed in two conditions:

		Full Sky	Attenuated Full Sky
Highest cn0		47dB	35dB
HDOP	**Average**	0.9	
	Minimum	0.7	
VDOP	**Average**	1.3	
	Minimum	0.8	
PDOP	**Average**	1.6	
	Minimum	1.1	

Table 3: Roof Antenna test conditions

The following images show the sky view for 24 hours of tracking and the signal strength (cn0 in dB)

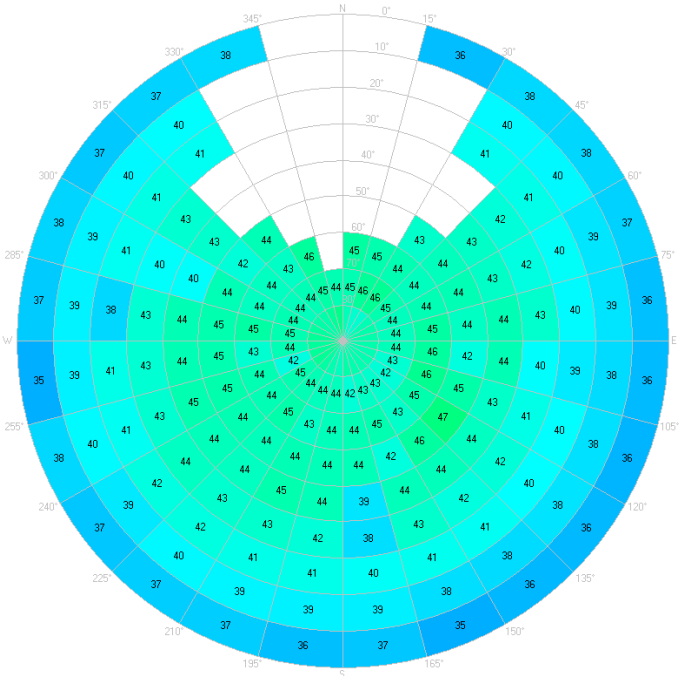

Figure 2. 24h sky view in full sky condition

5 GNSS performance

Parameter	Specifications			
Receiver type	GPS L1C/A			
	SBAS L1C/A			
	QZSS L1C/A			
	GLONASS L1OF			
	BeiDou B1			
	Galileo E1B/C			
	GNSS	**GPS & GLONASS**	**GPS & BeiDou**	**GPS & Galileo**
Time To First Fix[1] [s]	Cold start	<32	<36	<30
	Warm start	<25	<29	<26
	Hot start	<1.5	<2.5	<2
Sensitivity[2,12,14] [dBm]	Tracking	-163	-163	-163
	Navigation[7]	-158	-158	-158
	Reacquisition[8,9]	-156	-156	-156
	Cold start	-147	-147	-147
	Warm start	-148	-148	-148
	Hot start	-154	-151	-154
	GNSS	**GPS & GLONASS**	**GPS & BeiDou**	**GPS & Galileo**
Max fix rate [Hz]		10	10	10
Velocity accuracy[3] [m/s]		0.01		0.01
Velocity accuracy[4] [m/s]		0.1		0.1
Heading accuracy[3] [°]		0.01		0.01
Heading accuracy[4] [°]		2.3		2.4
Horizontal position accuracy[11] [m]	Autonomous	<1.8[11]	<1.5[11]	
	SBAS	<1.5[11]		
Accuracy of time pulse	RMS			
	99%			
Frequency of time pulse				
Operational limits[13]	Dynamic[6]	<4.5g	<4g	<4.5g
	Altitude[10] [m]	18000	18000	18000
	Velocity[10] [m/s]	515	515	515

[1] All satellites at -130dBm - TTFF@50%
[2] Demostrated with a good external LNA
[3] 50% @ 30m/s - linear path
[4] 50% @0.5g - figure8 shape path
[5] CEP 50%, 24h static, Simulator,-130dBm, >6SVs
[6] Special configuration for high dynamic scenario
[7] Configurable Value
[8] All satellites at same signal level
[9] Minimum level to get valid fix after reacquisition
[10] ITAR limits
[11] CEP 50%, 24h static, Roof Antenna
[12] For hot start , all sats have the same signal level except one (pilot sat @-145dBm)
[13] Verified the limit checking the fix avaibility
[14] For BEIDOU traccking sensitivity refer to MEO sats. For GEO the tracking sensitivity is -146dBm

Table 4: GNSS performance

Parameter	Specifications				
Receiver type	GPS L1C/A				
	SBAS L1C/A				
	QZSS L1C/A				
	GLONASS L1OF				
	BeiDou B1				
	Galileo E1B/C				
	GNSS	**GPS**	**GLONASS**	**Galielo**	**BeiDou**
Time To First Fix[1] [s]	Cold start	<32	<33	<32	<34
	Warm start	<31	<28	<30	<32
	Hot start	<1.3	<2.0	<3	<3.5
Sensitivity[2,12,14] [dBm]	Tracking	-163	-163	-160	-162
	Navigation[7]	-158	-158	-158	-158
	Reacquisition[8,9]	-156	-155	-152	-156
	Cold start	-147	-147	-140	-143
	Warm start	-148	-148	-142	-146
	Hot start	-154	-153	-145	-147
	GNSS	**GPS**	**GLONASS**	**Galileo**	**BeiDou**
Max fix rate [Hz]		10		10	10
Velocity accuracy[3] [m/s]		0.01	0.01	0.01	
Velocity accuracy[4] [m/s]		0.1	0.1	0.1	
Heading accuracy[3] [°]		0.01	0.01	0.01	
Heading accuracy[4] [°]		2.4	2.4	2.5	
Horizontal position accuracy[11] [m]	Autonomous	<1.7[11]	<4.2[11]		<1.5[11]
	SBAS	<1.2[11]	<3.0[11]		
Accuracy of time pulse	RMS				
	99%				
Frequency of time pulse					
Operational limits[13]	Dynamic[6]	<4.5g	<4.0g		<4g
	Altitude[10] [m]	18000	18000		18000
	Velocity[10] [m/s]	515	515		515

[1] All satellites at -130dBm - TTFF@50%
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Table 5: Single constellation performance

6 STA8090 Binary Image Components

All software libraries included in the binary image are listed in the following tables together with their version numbers.

Library	Version
GNSS	8.4.9.14
SBAS	2.19.0
DGPS	1.2.0
STAGPS	5.1.0
OS20+	4.3.0
OS20 Services	2.3.0
Application	4.5.7
Boot Code	2.2.1

NOTE: the binary image software is compiled with tool chain ARM RVCT 5.04 build 27 (from ARM DS-5 5.17 build 5170015).

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