

# NEO-M9N chipset characterization for GNSS-GAGAN performance

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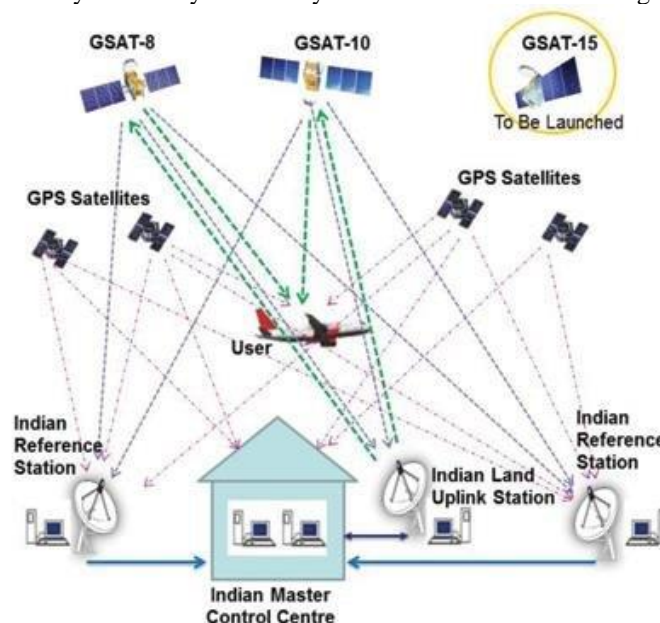
**Abstract:** GPS Aided GEO Augmented Navigation (GAGAN) is a Satellite Based Augmentation System (SBAS). In aviation industry, figure of merits of parameters associated with navigation is very stringent and dealing with such precision is not possible by GPS (Global Positioning System) alone and requires another sub-ordinate constellation of regional satellites (GAGAN) to correct the errors associated with latitude, longitude, height and UTC time value derived out of GPS. In this paper, we will discuss the errors associated with GPS only, and the improvements / minimizing the errors when SBAS-GAGAN is used alongside with GPS. Further to illustrate the case, we will thoroughly test and characterize the GNSS (Global Navigation Satellite System) chipset from U-blox with an inference at the end of each test,

## Introduction

GPS-Aided Geo Augmented Navigation (GAGAN) system will offer seamless navigation to the aviation industry, was recently launched by the Civil Aviation Minister. The GAGAN system is designed to help pilots to navigate successfully under all-weather conditions by the accuracy of up to three meters, this capability would enable aircraft landing even on tough terrain and extreme weather. It will allow an aircraft to reduce fuel burn by flying on a specific path on straight routes and between two three-dimensional defined points. The primary objective of GAGAN is to establish, deploy and certify satellite-based augmentation system for safety-of-life civil aviation applications for the Indian air space.

It plays an important role in safety of life applications in transport, sensitive commercial applications and liability-critical applications needing legal course. GAGAN offers free enhanced satellite navigation signals by correcting deviancies in GPS signals by deploying ground based navigational infrastructure. The system is inter-operable with other international SBAS systems like US-WAAS, European EGNOS, and Japanese MSAS etc. GAGAN will provide augmentation service for the GPS over the country, the Bay of Bengal, Southeast Asia and Middle East and up to Africa. The aircraft now being used by Indian operators are not compatible with GAGAN. Only those aircraft that are fitted with SBAS will be able to use the new technology. Cost of refurbishing aircraft with new equipment and downtime for electronic restructuring are expenses that the financially stressed Indian airline industry does not seem comfortable having to bear.

GAGAN consists of set of ground reference stations positioned across various locations in India called Indian Reference Station (INRES), which gathers GPS satellite data. A master station, Indian Master Control Centre (INMCC) collects data from reference stations and creates GPS correction messages. The corrected differential messages are uplinked via Indian Uplink Station (INLUS) and then broadcasted on a signal from three geostationary satellites (GSAT-8, GSAT-10 and GSAT-15). The information on this signal is compatible with basic GPS signal structure, which means any SBAS enabled GPS receiver can read this signal. GAGAN systems architecture has two segments, one is ground segment, and the other is space segment. At present the ground segment consists of 15 reference stations spread all over India and three master control centers (two are in operation and one in shadow mode). These 15 reference stations are stationed at various fixed positions which receive GPS signals. The locations of reference stations are precisely chosen by the survey so that any errors in the received GPS signals can be detected.



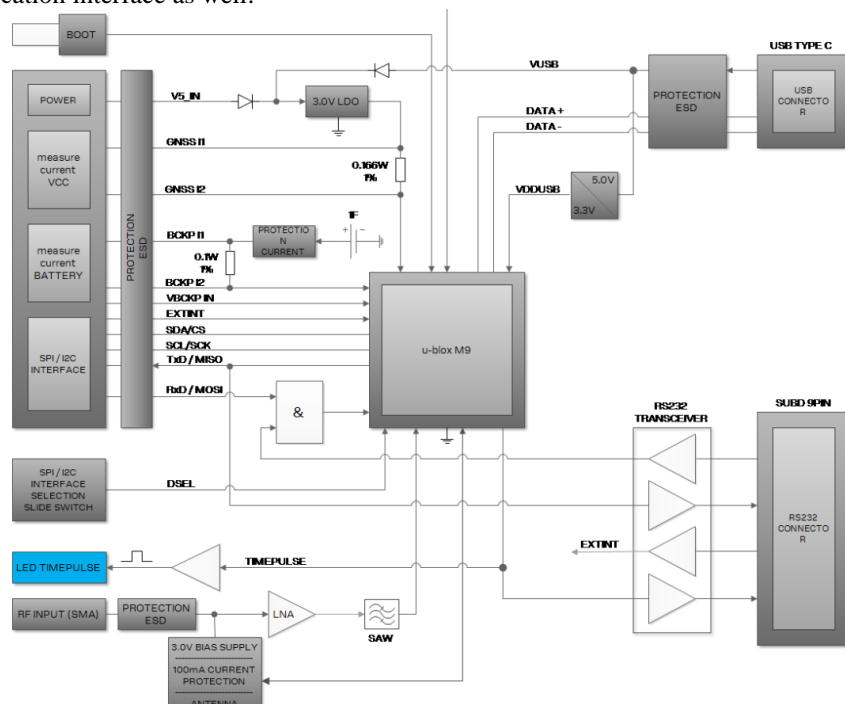
## Description of Tests

## Biasing, Test Setup

The tests will be conducted in normal lab environment, which is 22-27°C. Evaluation board of NEOM9N chipset is used to characterize the GNSS receiver; here the evaluation board is interfaced with PC through USB interface. The PC is installed with u-center software utility, this utility is accessory supplied by U-Blox used to characterize the receiver chipset.

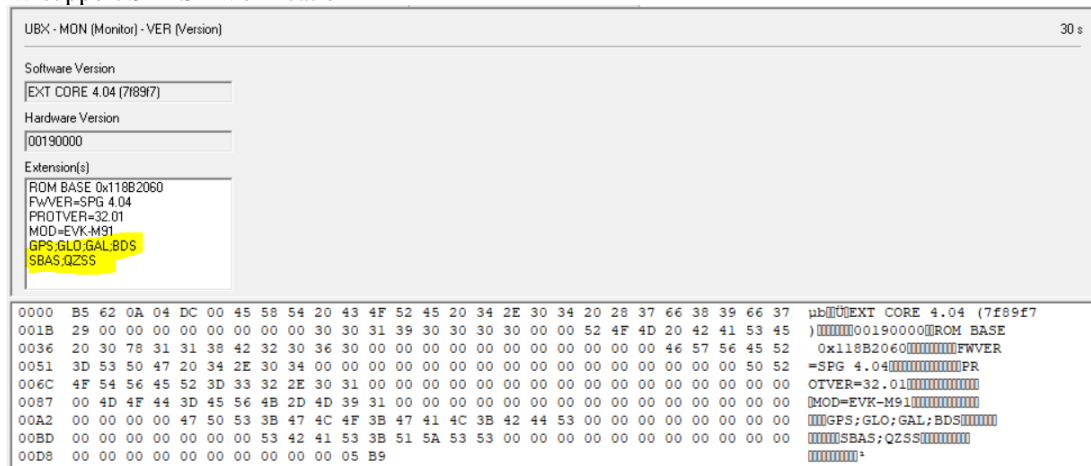
- Download and install the u-center GNSS evaluation software from [www.u-blox.com/u-center](http://www.u-blox.com/u-center)
- Connect the unit to a PC. Options:
  - Connect via USB port. The USB driver installs automatically when the device is connected to the PC; internet connection is required.
  - Connect via RS232 port (UART interface). Set the interface switch (2) to I2C.
  - SPI / I2C: Set switch to either SPI or I2C and connect the appropriate pins (1).
- The device must always have power, either via USB on the back or the V5 IN pin (3) on the front.
- Connect the provided GNSS antenna to the evaluation unit and place the antenna so that it has an unobstructed view to the sky. Alternatively, connect a GNSS simulator signal directly to the EVK-M91 RF input.
- Start the u-center GNSS evaluation software and select the corresponding COM port and baud rate.

The below block diagram represents the evaluation board of NEO-M9N; EVK-M91 evaluation unit contains the GNSS receiver, external TCXO, SAW and an LNA. The EVK-M91 supports all three communication interfaces: UART, I2C and SPI. For connecting the EVK to a PC, use a standard SUBD-9 cable or the included USB Type-C cable depending on the interface in use. The USB Type-C connector on the evaluation board can be used for both power supply and communication. The easiest way to evaluate the EVK-M91 operation is to connect the EVK to a PC by the USB-C 2.0 cable and then to use the u-center to configure and monitor the GNSS functions. The USB connector has a direct connection to the u-blox M9 receiver, which enables the USB interface to be used as a communication interface as well.



## Test Summary

## EVAL-M91 FW support SBAS – Verification



### Figure 3 Observation- SBAS support

Test Result: Test Passed

Purpose of this test is to check if the firmware loaded in flash has SBAS. Is it observed from the u-center utility that the NEO-M9N receiver is SBAS enabled GNSS receiver, the SBAS that NEO-M9N supports include GAGAN.

#### Type of Datum – Verification

NMEA - GxDTM (Datum Reference)				0
Parameter	Value	Unit	Description	
Local Datum Code	W84		W84 = WGS84, P90 = PZ90, 999 = User Defined	
Local Datum Sub Code			Subdivision Code, according to UBX Datum Table	
Latitude Offset	0.0	minutes		
Latitude Offset	N	N/S	N = North, S=South	
Longitude Offset	0.0	minutes		
Longitude Offset	E	E/W	E = East, W=West	
Altitude Offset	0.0	m		
Reference Code	W84		W84 = WGS84	

0000	24	47	4E	44	54	4D	2C	57	38	34	2C	2C	30	2E	30	2C	4E	2C	30	2E	30	2C	45	2C	30	2E	30		\$GNDTM,W84,,0.0,N,0.0,E,0.0	
001B	2C	57	38	34	2A	37	31	0D	0A																				,W84*71	

Figure 4 NMEA Datum Code

Test Result: Test Passed

The Datum of GNSS when used together with SBAS gives model of earth that is used in mapping. It is observed that NEO-M9N received data is based on W84 – Worldwide reference ellipsoid WGS-84. The WGS-84 coordinate system is a three dimensional, right-handed, Cartesian coordinate system with its original coordinate point at the center of mass of an ellipsoid, which approximates the total mass of the Earth.

#### NMEA GPGBS GNSS satellite fault detection – Verification

NMEA - GxGBS (Satellite fault Detection) - GNGBS (Satellite fault Detection)

11

Parameter	Value	Unit	Description
UTC	030007.00	hhmmss.sss	Universal time coordinated
Error Latitude	1.0	m	Expected Error in Latitude (North) Direction
Error Longitude	1.5	m	Expected Error in Longitude (East) Direction
Error Altitude	3.3	m	Expected Error in Altitude
Failed SV			ID number of most probably failed SV
Missed Det		%	Probability of missed detection
Bias Estimation		m	Estimate Bias on most likely failed Satellite
Bias StdDev			Standard Deviation of Bias Estimation
GNSS System ID			
GNSS Signal ID			Note: BeiDou Signal ID 3 mapping depends on NMEA version. NMEA 4.10: B2I, NMEA 4.11: B1C

000024474E4742532C3033303030372E30302C312E30352C332E\$GNGBS,030007.00,1.0,1.5,3.

001B332C2C2C2C2C2A35450D0A3.....\*5E

Figure 5 Observation-GNSS RAIM

This test read the output of Receiver Autonomous Integrity Monitoring Algorithm (RAIM).

#### NMEA GPGGA GNSS Global positioning system fix data – Verification

NMEA - GxGGA (Global Positioning System Fix Data) - GNGGA (Global Positioning System Fix Data)				0
Parameter	Value	Unit	Description	
UTC	030247.50	hhmmss.sss	Universal time coordinated	
Lat	1255.19937	ddmm.mmmm	Latitude	
Northing Indicator	N		N=North, S=South	
Lon	07735.20723	dddmm.mmmm	Longitude	
Easting Indicator	E		E=East, W=West	
Status	2		0=Invalid, 1=2D/3D, 2=DGNSS, 4=Fixed RTK, 5=Float RTK, 6=Dead Reckoning	
SVs Used	12		Number of SVs used for Navigation	
HDOP	1.24		Horizontal Dilution of Precision	
Alt (MSL)	915.6	m	Altitude (above means sea level)	
Unit	M		M=Meters	
Geoid Sep.	-86.5	m	Geoid Separation = Alt(HAE) - Alt(MSL)	
Unit	M		M=Meters	
Age of DGNSS Corr		s	Age of Differential Corrections	
DGNSS Ref Station	0000		ID of DGNSS Reference Station	

0000	24	47	4E	47	47	41	2C	30	33	30	32	34	37	2E	35	30	2C	31	32	35	35	2E	31	39	39	33	37		\$GNGGA,030247.50,1255.19937	
001B	2C	4E	2C	30	37	37	33	35	2E	32	30	37	32	33	2C	45	2C	32	2C	31	32	2C	31	2E	32	34	2C		,N,07735.20723,E,2,12,1.24,	
0036	39	31	35	2E	36	2C	4D	2C	2D	38	36	2E	35	2C	4D	2C	2C	30	30	30	30	2A	36	42	0D	0A			915.6,M,-86.5,M,0000*6B	

Figure 6 Observation- NMEA GPGGA (GPS data)

Test Result: Test Pass

This test read the number of GPS satellites in use and time, position data. In observation it is seen that NEO-M9N receiver is receiving time signals from 12 satellites simultaneously and Horizontal Dilution of Precision is 1.24.

Data format: \$--GGA,hhmmss.ss,llll.lll,a,yyyyy.yyy,a,x,uu,v.v,w.w,M,x.x,M,,zzzz\*hh

### NMEA GPGLL\_Geographical Position – Latitude and Longitude – Verification

This test read the Latitude and longitude, with time of position fix and status. From the observation of u-center utility, while testing this case, co-ordinates are shown in terms of latitude and longitude as Lat'1255.19884-N and Long'07735.20653-E, when we put these lat and long info in Google map is showed my home location.

Data format: \$--GLL,llll.lll,a,yyyyy.yyy,b,hhmmss.sss,A,a\*hh

NMEA - GxGLL (Geographic Position - Latitude/Longitude) - GNGLL (Geographic Position - Latitude/Longitude)															108
Parameter	Value		Unit	Description											
Lat	1255.19884		ddmm.mmmm	Latitude											
Northing Indicator	N			N=North, S=South											
Lon	07735.20653		dddmm.mmmm	Longitude											
Easting Indicator	E			E=East, W=West											
UTC	033059.00		hhmmss.sss	Universal time coordinated											
Status	A			A=Valid, V=Invalid											
Mode Indicator	D			A=Autonomous, D=Differential, E=Dead Reckoning, N=None											

**Figure 7 Observation- NMEA GPGLL (Position data)**

Test Result: Test Passed.

### NMEA GPGNS\_GNSS fix data – Verification

NMEA - GxGNS (GNSS Fix Data) - GNGNS (GNSS Fix Data)			
Parameter	Value	Unit	Description
UTC	033529.40	hhmmss.sss	Universal time coordinated
Lat	1255.19894	ddmm.mmmm	Latitude
North Indicator	N		N=North, S=South
Lon	07735.20580	dddmm.mmmm	Longitude
Easting Indicator	E		E=East, W=West
Mode Indicator	DDDD		A=Autonomous, D=Differential, R=Fixed RTK, F=Float RTK, E=Dead Reckoning, N=None
SVs Used	15		Number of SVs used for Navigation
HDOP	0.96		Horizontal Dilution of Precision
Alt (MSL)	907.8	m	Altitude (above means sea level)
Geoid Sep.	-86.5	m	Geoid Separation = Alt(HAE) - Alt(MSL)
Age of DGNSS Corr		s	Age of Differential Corrections
DGNSS Ref Station	0000		ID of DGNSS Reference Station
Navigational Status	V		S=Safe C=Caution U=Unsafe V=Not valid

0000	24	47	4E	47	4E	53	2C	30	33	33	35	32	39	2E	34	30	2C	31	32	35	35	2E	31	39	38	39	34	2C	4E	2C	\$GNGNS,033529.40,1255.19894,N,
001E	30	37	37	33	35	2E	32	30	35	38	30	2C	45	2C	44	44	44	44	2C	31	35	2C	30	2E	39	36	2C	39	30	37	07735.20580,E,DDDD,15,0.96,907
003C	2E	38	2C	2D	38	36	2E	35	2C	2C	30	30	30	30	2C	56	2A	33	34	0D	0A	.8,-86.5,,0000,V*34									

**Figure 8 Observations- NMEA GPGNSS**

This test read the Time and position, together with GNSS fixing-related data.

### NMEA GPGSA\_GNSS DOP and active satellite – Verification

NMEA - GxGSA (GNSS DOP and Active Satellites) - GNGSA (GNSS DOP and Active Satellites)			
Parameter	Value	Unit	Description
Op. Mode	A		M=Manual, A=Automatic 2D/3D
Nav. Mode	3		1=No, 2=2D, 3=3D
SVID	16(=G16)		Satellite ID
SVID	8(=G8)		Satellite ID
SVID	40(=S127)		Satellite ID
SVID	41(=S128)		Satellite ID
SVID	27(=G27)		Satellite ID
SVID			Satellite ID
SVID			Satellite ID
SVID			Satellite ID
SVID			Satellite ID
SVID			Satellite ID
SVID			Satellite ID
SVs Used	5		Number of SVs used for Navigation
PDOP	1.70		Positional Dilution of Precision
HDOP	1.05		Horizontal Dilution of Precision
VDOP	1.33		Vertical Dilution of Precision
GNSS System ID	1		

0000 24 47 4E 47 53 41 2C 41 2C 33 36 2C 30 38 2C 34 30 2C 34 31 2C 32 37 2C 2C 2C 2C 2C

001E 2C 2C 2C 31 2E 37 30 2C 31 2E 30 35 2C 31 2E 33 33 2C 31 2A 30 39 0D 0A \$GNGSA,A,3,16,08,40,41,27,,,,,1.70,1.05,1.33,1\*09

**Figure 9 Observation- NMEA GPGSA (SBAS Information)**

This test read the GNSS receiver operating mode, satellites used for navigation, and DOP values.

UBX - NAV (Navigation) - SBAS (SBAS Status)									
SBAS ID used		127	System		GAGAN				
SBAS Mode			Operational			Integrity Used		N/A	
<input checked="" type="checkbox"/> Ranging			<input checked="" type="checkbox"/> Corrections			<input checked="" type="checkbox"/> Integrity			
SV	UDRE	Fast	iono	Longterm	Integrity	System	Service		
G26	06	0.01m	0.00m			GPS	Rng		
R12	14	0.00m	0.00m						
G27	11	0.00m	0.00m			GPS	Rng		
B10	14	0.00m	0.00m						
B36	14	0.00m	0.00m						
B19	14	0.00m	0.00m			GPS	Rng		
G32	05	0.00m	0.00m						
R2	14	0.00m	0.00m						
R13	14	0.00m	0.00m						
R17	14	0.00m	0.00m						
R18	14	0.00m	0.00m						
R24	14	0.00m	0.00m						
S127	14	0.00m	0.00m			GAGAN	Rng Corr Int		
G8	14	0.00m	0.00m			GPS	Rng		
R23	14	0.00m	0.00m						
G10	05	0.00m	0.00m			GPS	Rng		
S123	14	0.00m	0.00m				Test		
S128	14	0.00m	0.00m			GAGAN	Test		

**Figure 10 Observation- UBX NAV SBAS Status**

Test Result: Test PASS

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values. From the observation using u-center utility, NEO-M9N GNSS receiver relates to GPS satellite with satellite ID- G16, G8, G27, and also connected with GAGAN-SBAS constellation of satellite with ID- S127, S128. This NMEA message gives dilution of precision value along with satellite IDs. Data Format: \$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,u,u,v,v,z,z\*hh

**NMEA GPGST\_GNSS pseudo range error statistics – Verification**

NMEA - GxGST (GNSS Pseudorange Error Statistics) - GNGST (GNSS Pseudorange Error Statistics)

Parameter	Value	Unit	Description
UTC	034513.40	hhmmss.sss	Universal time coordinated
RMS	1496		RMS value of the standard deviation of the range inputs to the navigation process.
Std Dev Maj	1.9	m	Standard deviation of semi-major axis of error ellipse
Std Dev Min	1.5	m	Standard deviation of semi-minor axis of error ellipse
Orientation	112	°	Orientation of semi-major axis of error ellipse
Std Dev Lat	0.63	m	Standard deviation of latitude error
Std Dev Lon	0.74	m	Standard deviation of longitude error
Std Dev Alt	1.7	m	Standard deviation of altitude error

0000

24 47 4E 47 53 54 2C 30 33 34 35 31 33 2E 34 30 2C 31 34 39 36 2C 31 2E 39 2C 31 2E 35 2C

\$GNGST,034513.40,1496,1.9,1.5,

001E

31 31 32 2C 30 2E 36 33 2C 30 2E 37 34 2C 31 2E 37 2A 37 39 0D 0A

112,0.63,0.74,1.7\*79

**Figure 11 Observation- NMEA GNGST**

This test read message reports statistical information on the quality of the position solution.

**NMEA GPGSV\_GNSS satellites in view – Verification**

NMEA - GxGSV (GNSS Satellites in View) · GPGSV (GNSS Satellites in View)

This message is sent in different pages.  
Each page contains position and signal to noise ratio for some of the visible satellites.

Page Count / Total

4

Visible Satellites

12

Satellite	Elevation [°]	Azimuth [°]	C/NO [dBHz]	Signal ID
1(=G1)	20	226		1
3(=G3)	62	303		1
4(=G4)	28	335		1
7(=G7)	09	259		1
8(=G8)	16	174	29	1
9(=G9)	03	313		1
16(=G16)	71	075	35	1
21(=G21)	16	201	18	1
22(=G22)	21	089		1
26(=G26)	37	040		1
27(=G27)	23	141	22	1
31(=G31)	06	047		1

0000

24 47 50 47 53 56 2C 34 2C 31 2C 31 35 2C 30 31 2C 32 30 2C 32 32 36 2C 2C 30 33 2C 36 32

\$GPGSV,4,1,15,01,20,226,,03,62

001E

2C 33 30 33 2C 2C 30 34 2C 32 38 2C 33 33 35 2C 2C 30 37 2C 30 39 2C 32 35 39 2C 2C 31 2A

,303,,04,28,335,,07,09,259,,1\*

003C

36 43 0D 0A 24 47 50 47 53 56 2C 34 2C 32 2C 31 35 2C 30 38 2C 31 36 2C 31 37 34 2C 32 39

6C\$GPGSV,4,2,15,08,16,174,29

005A

2C 30 39 2C 30 33 2C 33 31 33 2C 2C 31 36 2C 37 31 2C 30 37 35 2C 33 35 2C 32 31 2C 31 36

,09,03,313,,16,71,075,35,21,16

0078

2C 32 30 31 2C 31 38 2C 31 2A 36 30 0D 0A 24 47 50 47 53 56 2C 34 2C 33 2C 31 35 2C 32 32

,201,18,1\*60\$GPGSV,4,3,15,22

0096

2C 32 31 2C 30 38 39 2C 2C 32 36 2C 33 37 2C 30 34 30 2C 31 36 2C 32 37 2C 32 33 2C 31 34

,21,089,,26,37,040,16,27,23,14

00B4

31 2C 32 32 2C 33 31 2C 30 36 2C 30 34 37 2C 2C 31 2A 36 31 0D 0A 24 47 50 47 53 56 2C 34

1,22,31,06,047,,1\*61\$GPGSV,4

00D2

2C 34 2C 31 35 2C 32 32 2C 32 31 2C 30 38 39 2C 2C 32 36 2C 33 37 2C 30 34 30 2C 2C 32 37

,4,15,22,21,089,,26,37,040,,27

00F0

2C 32 33 2C 31 34 31 2C 32 32 2C 33 31 2C 30 36 2C 30 34 37 2C 2C 31 2A 36 31 0D 0A

,23,141,22,31,06,047,,1\*61

**Figure 12 Observation- NMEA GPGSV Satellites in View**

Test Result: Test Pass

This test checks number of satellites in view, together with each SV ID, elevation azimuth, and signal strength. From the u-center utility, it is observed that around 15 satellites are in view of NEO-M9N GNSS receiver with corresponding elevation and azimuth information.

Data Format: \$--GSV,x,u,xx,uu,vv,zzz,ss,uu,vv,zzz,ss,...,uu,vv,zzz,ss\*hh



**NMEA GPRMC - Recommended Minimum Specific GNSS Data**

NMEA - GPRMC (Recommended Minimum Specific GNSS Data)									
Parameter	Value	Unit	Description						
UTC	051522.70	hhmmss.sss	Universal time coordinated						
Status	A		A=Valid, V=Invalid						
Lat	1255.19937	ddmm.mmmm	Latitude						
Northing Indicator	N		N=North, S=South						
Lon	07735.20750	dddmm.mmmm	Longitude						
Easting Indicator	E		E=East, W=West						
SOG	0.071	knots	Speed Over Ground						
COG (true)		°	Course Over Ground (true)						
Date	110222	ddmmyy	Universal time coordinated						
Magnetic Variation		°	Magnetic Variation						
Magnetic Variation		°	E=East, W=West						
Mode Indicator	D		A=Autonomous, D=Differential, R=Fixed RTK, F=Float RTK, E=Dead Reckoning, N=None						
Navigation Status	V		S=Safe C=Caution U=Unsafe V=Not valid						

```

0000 24 47 4E 52 4D 43 2C 30 35 31 35 32 32 2E 37 30 2C 41 2C 31 32 35 35 2E 31 39 39 33 37 2C $GNRMC,051522.70,A,1255.19937,
001E 4E 2C 30 37 37 33 35 2E 32 30 37 35 30 2C 45 2C 30 2E 30 37 31 2C 2C 31 31 30 32 32 32 2C
003C 2C 2C 44 2C 56 2A 31 33 0D 0A ,,,D,V*13

```

**Figure 13 Observation- NMEA GPRMC**

Test Result- Test Pass

This test read the output recommended minimum sentence defined by NMEA for GNSS system data. The observation is recorded as UTC time to be 051522.70, Lat to be 1255.19937, lon to be 07735.20750.

**Cold Start – Time to First Fix (TTFF)**

UBX - NAV (Navigation) - STATUS (Navigation Status)	
Param	Value
Position Fix Type	3D Fix
Position within Limits (FixOK)	Yes
DGNSS Fix	No
Weeknumber Valid	Yes
Time of Week Valid	Yes
Diff Corrections Available	No
Map Matching	None
<b>TTFF</b>	<b>85.980 s</b>
Time since Powerup	389.084 s
PSM state	ACQUISITION
Spoofing detection state	OK
Carrier Range Status	N/A

Test Result - Test passed

This test will measure the time; it takes for the receiver to determine its first good location fix when the receiver is placed in Cold Start state. In this test, the receiver is placed into a cold start state by powering it OFF for more than a day. Using the option to read TTFF, provided in u-center under UBX protocol. TTFF information is available under STATUS drop down within NAV (Navigation) section of UBX protocol. The time it takes for the receiver to determine its first good location fix is recorded.

**Warm Start – Time to First Fix (TTFF)**

UBX - NAV (Navigation) - STATUS (Navigation Status)	
Param	Value
Position Fix Type	3D Fix
Position within Limits (FixOK)	Yes
DGNSS Fix	No
Weeknumber Valid	Yes
Time of Week Valid	Yes
Diff Corrections Available	No
Map Matching	None
TTFF	8.984 s
Time since Powerup	13.484 s
PSM state	ACQUISITION
Spoofing detection state	OK
Carrier Range Status	N/A

Test Result - Test passed

This test will measure the time; it takes for the receiver to determine its first good location fix when the receiver is placed in Warm Start state. In this test, the receiver is placed into a warm start state. Using the option to read TTFF, provided in u-center under UBX protocol. TTFF information is available under STATUS drop down within NAV (Navigation) section of UBX protocol the time it takes for the receiver to determine its first good location fix is recorded.

**Hot Start – Time to First Fix (TTFF)**

UBX - NAV (Navigation) - STATUS (Navigation Status)	
Param	Value
Position Fix Type	3D Fix
Position within Limits (FixOK)	Yes
DGNSS Fix	No
Weeknumber Valid	Yes
Time of Week Valid	Yes
Diff Corrections Available	No
Map Matching	None
TTFF	0.582 s
Time since Powerup	45.382 s
PSM state	ACQUISITION
Spoofing detection state	OK
Carrier Range Status	N/A

Test Result - Test passed

This test will measure the time; it takes for the receiver to determine its first good location fix when the receiver is placed in Hot Start state. In this test, the receiver is placed into a hot start state. Using the option to read TTFF, provided in u-center under UBX protocol. TTFF information is available under STATUS drop down within NAV (Navigation) section of UBX protocol the time it takes for the receiver to determine its first good location fix is recorded.

**Conclusion**

The performance parameters of NEO-M9N series GNSS receiver chipset from U-blox is characterized using EVALUATION BOARD and U-center software utility, the main parameters we touch based in this white paper include, cold start, worm start, hot start TIME TO FIRST FIX (TTFF) along with NMEA (Navy Marine Electronics Association) message that include following

\$GPGGA – Time, position, and fix related data of the receiver

\$GPGLL – Position, time and fix status

\$GPGSA – Used to represent the IDs of satellites which are used for position fix

\$GPGSV – Satellite information about elevation, azimuth and CNR

\$GPRMC – Time, data, position, course and speed data

\$GPVTG – Course and speed relative to the ground

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