ETSI TS 138 171 V16.4.0 (2022-08)



5G; NR; Requirements for support of Assisted Global Navigation Satellite System (A-GNSS) (3GPP TS 38.171 version 16.4.0 Release 16)



Reference RTS/TSGR-0438171vg40

Keywords

5G

ETSI

650 Route des Lucioles F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B Association à but non lucratif enregistrée à la Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from: <u>http://www.etsi.org/standards-search</u>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at <u>https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx</u>

If you find errors in the present document, please send your comment to one of the following services: https://portal.etsi.org/People/CommiteeSupportStaff.aspx

If you find a security vulnerability in the present document, please report it through our Coordinated Vulnerability Disclosure Program: https://www.etsi.org/standards/coordinated-vulnerability-disclosure

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2022. All rights reserved.

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECTTM, **PLUGTESTSTM**, **UMTSTM** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPPTM** and **LTETM** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2MTM** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**[®] and the GSM logo are trademarks registered and owned by the GSM Association.

Legal Notice

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Modal verbs terminology

In the present document "shall", "shall not", "should", "should not", "may", "need not", "will", "will not", "can" and "cannot" are to be interpreted as described in clause 3.2 of the <u>ETSI Drafting Rules</u> (Verbal forms for the expression of provisions).

"must" and "must not" are NOT allowed in ETSI deliverables except when used in direct citation.

ETSI TS 138 171 V16.4.0 (2022-08)

Contents

Intelle	ectual Property Rights	2
Legal	Notice	2
Moda	l verbs terminology	2
Forew	vord	5
1	Scope	7
2	References	7
3	Definitions, symbols and abbreviations	
3.1	Definitions	
3.2	Symbols	
3.3	Abbreviations	
3.4	Test tolerances	9
4	General	10
4.1	Introduction	10
4.2	Measurement parameters	10
4.2.1	UE based A-GNSS measurement parameters	10
4.2.2	UE assisted A-GNSS measurement parameters	10
4.3	Response time	10
4.4	Time assistance	10
4.4.1	Use of fine time assistance	11
4.5	RRC states	11
4.6	Error definitions	
5	A-GNSS minimum performance requirements (UE supports A-GPS L1 C/A only)	12
5.0	Introduction	
5.0	Sensitivity	
5.1.1		
5.1.1	Coarse time assistance	
	Minimum requirements (Coarse time assistance) Fine time assistance	
5.1.2 5.1.2.1		
	Minimum requirements (Fine time assistance) Nominal accuracy	
5.2		
5.2.1 5.3	Minimum requirements (nominal accuracy)	
	Dynamic range	
5.3.1	Minimum requirements (dynamic range)	
5.4	Multi-path scenario.	
5.4.1	Minimum requirements (multi-path scenario)	
5.5	Moving scenario and periodic update	
5.5.1	Minimum requirements (moving scenario and periodic update)	13
6	A-GNSS minimum performance requirements (UE supports other or additional GNSSs)	16
6.0	Introduction	16
6.1	Sensitivity	16
6.1.1	Coarse time assistance	16
6.1.1.1	Minimum requirements (Coarse time assistance)	17
6.1.2	Fine time assistance	
6.1.2.1		
6.2	Nominal accuracy.	
6.2.1	Minimum requirements (nominal accuracy)	
6.3	Dynamic range	
6.3.1	Minimum requirements (dynamic range)	
6.4	Multi-path scenario	
6.4.1	Minimum requirements (multi-path scenario)	
6.5	Moving scenario and periodic update	
6.5.1	Minimum requirements (moving scenario and periodic update)	
Anne	x A (normative): Test cases	23

A.1	Conformance tests	23
A.2	Requirement classification for statistical testing	23
Anne	ex B (normative): Test conditions	24
B.1	General	24
B.1.1	Parameter values	
B.1.2	Time assistance	
B.1.3	GNSS reference time	
B.1.4	Reference and UE locations	
B.1.5	Satellite constellation and assistance data	
B.1.5.		
B.1.5.		
B.1.6 B.1.7	Atmospheric delays	
Б.1./ В.1.8	E-UTRA or NR frequency and frequency error Information elements	
B.1.9		
B.1.1	6	
B.1.1		
B.1.12	•	
B.1.13		
B.1.13		
B.1.13		
B.1.13	3.3 Test frequencies for EN-DC band combinations	
Anne	ex C (normative): Propagation conditions	32
C.1	Static propagation conditions	32
C.2	Multi-path case	32
Anne	ex D (normative): Measurement sequence chart	34
D.1	General	
D.2	TTFF measurement sequence chart	34
D.3	Moving scenario and periodic update measurement sequence chart	
Anne	ex E (normative): Assistance data required for testing	
	Introduction	
E.2	GNSS assistance data	
	ex F (normative): Converting UE-assisted measurement reports into position estimates	
F.1	Introduction	
F.2	UE measurement reports	
F.3	WLS position solution.	
	•	
	ex G (informative): Change history	
Histo	ry	46

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should	indicates a recommendation to do something
should not	indicates a recommendation not to do something
may	indicates permission to do something
need not	indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can	indicates that something is possible
cannot	indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

will	indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
will not	indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
might	indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

3GPP TS 38.171 version 16.4.0 Release 16

6

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

- is (or any other verb in the indicative mood) indicates a statement of fact
- is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document establishes the minimum requirements for both UE based and UE assisted FDD or TDD A-GNSS terminals which have NG-RAN access via gNB (in SA NR, NR-DC or NE-DC NR operation mode [2]) or via ng-eNB (in EN-DC operation mode [2]) and which are supporting A-GNSS in 5GS via LPP [3] between UE and LMF as described in TS 38.305 [17].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.
- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multiconnectivity", Stage 2.
- [3] 3GPP TS 36.355: "Evolved Universal Terrestrial Radio Access (E-UTRA); LTE Positioning Protocol (LPP)".
- [4] 3GPP TS 38.215: "NR; Physical layer; Measurements".
- [5] ETSI TR 102 273-1-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 1: Uncertainties in the measurement of mobile radio equipment characteristics; Sub-part 2: Examples and annexes".
- [6] IS-GPS-200, Revision D, Navstar GPS Space Segment/Navigation User Interfaces, March 7th, 2006.
- P. Axelrad, R.G. Brown, "GPS Navigation Algorithms", in Chapter 9 of "Global Positioning System: Theory and Applications", Volume 1, B.W. Parkinson, J.J. Spilker (Ed.), Am. Inst. of Aeronautics and Astronautics Inc., 1996.
- [8] S.K. Gupta, "Test and Evaluation Procedures for the GPS User Equipment", ION-GPS Red Book, Volume 1, p. 119.
- [9] 3GPP TS 38.509: "5GS; Special conformance testing functions for User Equipment (UE)".
- [10] IS-GPS-705, Navstar GPS Space Segment/User Segment L5 Interfaces, September 22, 2005.
- [11] IS-GPS-800, Navstar GPS Space Segment/User Segment L1C Interfaces, September 4, 2008.
- [12] IS-QZSS, Quasi Zenith Satellite System Navigation Service Interface Specifications for QZSS, Ver.1.1, July 31, 2009.
- [13] Galileo OS Signal in Space ICD (OS SIS ICD), Issue 1.2, February 2014, European Union.
- [14] Global Navigation Satellite System GLONASS Interface Control Document, Version 5.1, 2008.
- [15] Specification for the Wide Area Augmentation System (WAAS), US Department of Transportation, Federal Aviation Administration, DTFA01-96-C-00025, 2001.

- BDS-SIS-ICD-B1I-3.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I (Version 3.0)", China Satellite Navigation Office, December 2019.
- [17] 3GPP TS 38.300: "NR; Overall description; Stage-2".
- [18] BDS-SIS-ICD-B1I-3.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1I (Version 3.0)", China Satellite Navigation Office, February 2019.
- [19] 3GPP TS 37.571-1: " User Equipment (UE) conformance specification for UE positioning; Part 1: Terminal conformance".
- [20] 3GPP TS 38.508-1: "5GS; User Equipment (UE) conformance specification; Part 1: Common test environment".
- [21] BDS-SIS-ICD-B1C-1.0: "BeiDou Navigation Satellite System Signal In Space Interface Control Document Open Service Signal B1C (Version 1.0)", December, 2017.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply:

EN-DC: E-UTRA-NR Dual Connectivity as defined in TS 37.340 [2].

en-gNB: as defined in TS 37.340 [2].

gNB: as defined in in TS 38.300 [17].

Horizontal Dilution Of Precision (HDOP): measure of position determination accuracy that is a function of the geometrical layout of the satellites used for the fix, relative to the receiver antenna

NE-DC: NR-E-UTRA Dual Connectivity as defined in TS 37.340 [2].

ng-eNB: as defined in TS 38.300 [17].

NR-DC: NR-NR Dual Connectivity as defined in TS 37.340 [2].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

B1I	BeiDou B1I navigation signal with carrier frequency of 1561.098 MHz.
B1C	BeiDou B1C navigation signal with carrier frequency of 1575.420 MHz.
E1	Galileo E1 navigation signal with carrier frequency of 1575.420 MHz.
E5	Galileo E5 navigation signal with carrier frequency of 1191.795 MHz.
E6	Galileo E6 navigation signal with carrier frequency of 1278.750 MHz.
G1	GLONASS navigation signal in the L1 sub-bands with carrier frequencies $1602 \text{ MHz} \pm \text{k} \times 562.5 \text{ kHz}$.
G2	GLONASS navigation signal in the L2 sub-bands with carrier frequencies 1246 MHz \pm k \times 437.5 kHz.
k	GLONASS channel number, $k = -713$.
L1 C/A	GPS or QZSS L1 navigation signal carrying the Coarse/Acquisition code with carrier frequency of 1575.420 MHz.
L1C	GPS or QZSS L1 Civil navigation signal with carrier frequency of 1575.420 MHz.
L2C	GPS or QZSS L2 Civil navigation signal with carrier frequency of 1227.600 MHz.
L5	GPS or QZSS L5 navigation signal with carrier frequency of 1176.450 MHz.
G	Geometry Matrix.

$ ho_{{\scriptscriptstyle GNSS_m},i}$ W	Measured pseudo-range of satellite <i>i</i> of GNSS _m . Weighting Matrix.
$1_{GNSS_m,i}$	Line of sight unit vector from the user to the satellite i of $GNSS_m$.
X	State vector of user position and clock bias.

3.3 Abbreviations

- ~ ~

- - - -

For the purposes of the present document, the following abbreviations apply:

5GS	5G System
A-GNSS	Assisted Global Navigation Satellite System
A-GPS	Assisted - Global Positioning System
AWGN	Additive White Gaussian Noise
BDS	BeiDou Navigation Satellite System
C/A	Coarse/Acquisition
DC	Dual Connectivity
DUT	Device Under Test
ECEF	Earth Centred, Earth Fixed
E-UTRA	Evolved UMTS Terrestrial Radio Access
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
EN-DC	E-UTRA-NR Dual Connectivity
FDD	Frequency Division Duplex
GEO	Geostationary Earth Orbit
GLONASS	GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (Engl.: Global Navigation Satellite System)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDOP	Horizontal Dilution Of Precision
ICD	Interface Control Document
IGSO	Inclined Geosynchronous Satellite Orbit
IS	Interface Specification
LMF	Location Management Function
LOS	Line Of Sight
LPP	LTE Positioning Protocol
MEO	Medium Earth Orbit
NE-DC	NR-E-UTRA Dual Connectivity
NR	NR Radio Access
NR-DC	NR-NR Dual Connectivity
QZSS	Quasi-Zenith Satellite System
RRC	Radio Resource Control
SBAS	Space Based Augmentation System
SFN	System Frame Number
SS	System Simulator
SV	Space Vehicle
TDD	Time Division Duplex
TOW	Time Of Week
TTFF	Time To First Fix
UE	User Equipment
WLS	Weighted Least Square
WGS-84	World Geodetic System 1984

3.4 Test tolerances

The requirements given in the present document make no allowance for measurement uncertainty. The test specification TS 37.571-1 [19] defines test tolerances. These test tolerances are individually calculated for each test. The test tolerances are then added to the limits in the present document to create test limits. The measurement results are compared against the test limits as defined by the shared risk principle.

Shared Risk is defined in ETR 273-1-2 [7], clause 6.5.

4 General

4.1 Introduction

The present document defines the minimum requirements for both UE based and UE assisted FDD or TDD A-GNSS terminals which have NG-RAN access via gNB (in SA NR, NR-DC or NE-DC operation mode [2]) or via ng-eNB (in EN-DC operation mode [2]) and which are supporting A-GNSS in 5GS via LPP [3] between UE and LMF as described in TS 38.305 [17].

4.2 Measurement parameters

4.2.1 UE based A-GNSS measurement parameters

In case of UE-based A-GNSS, the measurement parameters are contained in the *GNSS-LocationInformation* IE which is included in the *A-GNSS-ProvideLocationInformation* IE provided in the LPP message of type PROVIDE LOCATION INFORMATION. The measurement parameter in case of UE-based A-GNSS is the horizontal position estimate reported by the UE and expressed in latitude/longitude.

4.2.2 UE assisted A-GNSS measurement parameters

In case of UE-assisted A-GNSS, the measurement parameters are contained in the

GNSS-SignalMeasurementInformation IE which is included in the *A-GNSS-ProvideLocationInformation* IE provided in the LPP message of type PROVIDE LOCATION INFORMATION. The measurement parameters in case of UE-assisted A-GNSS are the UE GNSS code phase measurements, as specified in TS 38.215 [4]. The UE GNSS code phase measurements are converted into a horizontal position estimate using the procedure detailed in Annex F.

4.3 Response time

Max Response Time is defined as the time starting from the moment that the UE receives the LPP message of type REQUEST LOCATION INFORMATION, and ending when the UE starts sending the LPP message of type PROVIDE LOCATION INFORMATION. The response times specified for all test cases are TTFF unless otherwise stated, i.e. the UE shall not re-use any information on GNSS time, location or other aiding data that was previously acquired or calculated and stored internally in the UE. A dedicated test message 'RESET UE POSITIONING STORED INFORMATION' is defined in TS 38.509 [9] clause 5.6 for the purpose of deleting this information and is detailed in clause B.1.10.

4.4 Time assistance

Time assistance is the provision of GNSS time to the UE from the network via LPP messages. Currently two different GNSS time assistance methods can be provided by the network.

- a) Coarse time assistance is always provided by the network and provides current GNSS time to the UE. The time provided is within ±2 seconds of GNSS system time. It is signalled to the UE by means of the *gnss-DayNumber* and *gnss-TimeOfDay* fields in the *gnss-SystemTime* IE.
- b) Fine time assistance is optionally provided by the network and adds the provision to the UE of the relationship between the GNSS system time and the current E-UTRAN or NR time. The accuracy of this relationship is ±10 µs of the actual relationship. This addresses the case when the network can provide an improved GNSS time accuracy. It is signalled to the UE by means of the *gnss-SystemTime* IE and the *gnss-ReferenceTimeForCells* IE.

The specific GNSS system time is identified through the *gnss-TimeID* field of the *GNSS-SystemTime* IE. In case where several GNSSs are used in the tests, only one *gnss-TimeID* is used to determine the Time of Day. For all the constellations, the *gnss-TimeModels* IE shall be available at the SS, as specified in Annex E.

4.4.1 Use of fine time assistance

The use of fine time assistance to improve the GNSS performance of the UE is optional for the UE, even when fine time assistance is signalled by the network. Thus, there are a set minimum performance requirements defined for all UEs and additional minimum performance requirements that are valid for fine time assistance capable UEs only. These requirements are specified in clause 5.1.2 for UEs that support A-GPS L1 C/A only and in clause 6.1.2 for UEs that support other GNSSs.

4.5 RRC states

The minimum A-GNSS performance requirements are specified in clauses 5 and 6 for RRC_CONNECTED state. The test and verification procedures are separately defined in annex B.

4.6 Error definitions

The 2D position error is defined by the horizontal difference in meters between the ellipsoid point reported or calculated from the LPP message of type PROVIDE LOCATION INFORMATION and the actual position of the UE in the test case considered.

4.7 UEs supporting multiple constellations

Minimum performance requirements are defined for each global GNSS constellation (BDS, Galileo, GLONASS, GPS/Modernized GPS). UEs supporting multiple global constellations shall meet the minimum performance requirements for a combined scenario where each UE supported constellation is simulated.

NOTE: For test cases where signals from "GPS" and "Modernized GPS" are included, "GPS" and "Modernized GPS" are considered as a single constellation, unless otherwise specified.

4.8 UEs supporting multiple signals

For UEs supporting multiple signals, different minimum performance requirements may be associated with different signals. The satellite simulator shall generate all signals supported by the UE. Signals not supported by the UE do not need to be simulated. The relative power levels of each signal type for each GNSS are defined in Table 4.1. The individual test scenarios in clause 6 define the reference signal power level for each satellite. The power level of each signal type shall be set to the reference signal power level defined in each test scenario in clause 6 plus the relative power level defined in Table 4.1.

		BDS		Ga	lileo	GLO	NASS	GPS/Mo GI	dernized PS	QZ	SS	S	BAS
Signal power	B1I	D1	0 dB	E1	0 dB	G1	0 dB	L1 C/A	0 dB	L1 C/A	0 dB	L1	0 dB
levels		D2	+5 dB										
relative to	B1C	D1	0 dB	E6	+2 dB	G2	-6 dB	L1C	+1.5 dB	L1C	+1.5 dB		
reference				E5	+2 dB			L2C	-1.5 dB	L2C	-1.5 dB		
power levels								L5	+3.6 dB	L5	+3.6 dB		

Table 4.1: Relative signal power levels for each signal type for each GNSS

NOTE 1: For test cases which involve "Modernized GPS", the satellite simulator shall also generate the GPS L1 C/A signal if the UE supports "GPS" in addition to "Modernized GPS".

NOTE 2: The signal power levels in the Test Parameter Tables represent the total signal power of the satellite per channel not e.g. pilot and data channels separately.

NOTE 3: For test cases which involve "BDS", D1 represents MEO/IGSO satellites for B1I and B1C signal types and D2 represents GEO satellites for B1I signal type.

5 A-GNSS minimum performance requirements (UE supports A-GPS L1 C/A only)

5.0 Introduction

The minimum performance requirements specified in clause 5 apply for UEs that support A-GPS L1 C/A only. The requirements for UEs that support other or additional A-GNSSs are specified in clause 6.

The A-GNSS minimum performance requirements are defined by assuming that all relevant and valid assistance data is received by the UE in order to perform GPS L1 C/A measurements and/or position calculation. This clause does not include nor consider delays occurring in the various signalling interfaces of the network.

In the following clauses the minimum performance requirements are based on availability of the assistance data information and messages defined in annexes D and E.

5.1 Sensitivity

A sensitivity requirement is essential for verifying the performance of A-GNSS receiver in weak satellite signal conditions. In order to test the most stringent signal levels for the satellites the sensitivity test case is performed in AWGN channel. This test case verifies the performance of the first position estimate, when the UE is provided with only coarse time assistance and when it is additionally supplied with fine time assistance.

5.1.1 Coarse time assistance

In this test case 8 satellites are generated for the terminal. AWGN channel model is used.

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GNSS Coarse time assistance error	seconds	±2
range		
GPS L1 C/A Signal for one satellite	dBm	-142
GPS L1 C/A Signal for remaining	dBm	-147
satellites		

Table 5.1: Test parameters

5.1.1.1 Minimum requirements (Coarse time assistance)

The position estimates shall meet the accuracy and response time specified in Table 5.2.

Table 5.2: Minimum requirements (coarse time assistance)

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.1.2 Fine time assistance

This requirement is only valid for fine time assistance capable UEs. In this requirement 8 satellites are generated for the terminal. AWGN channel model is used.

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GNSS Coarse time assistance error range	seconds	±2
GPS L1 C/A Fine time assistance error	μs	±10
range		
GPS L1 C/A Signal for all satellites	dBm	-147

Table 5.3: Test parameters for fine time assistance capable terminals

5.1.2.1 Minimum requirements (Fine time assistance)

The position estimates shall meet the accuracy and response time requirements in Table 5.4.

Table 5.4: Minimum requirements for fine time assistance capable terminals

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.2 Nominal accuracy

Nominal accuracy requirement verifies the accuracy of A-GNSS position estimate in ideal conditions. The primarily aim of the test is to ensure good accuracy for a position estimate when satellite signal conditions allow it. This test case verifies the performance of the first position estimate.

In this requirement 8 satellites are generated for the terminal. AWGN channel model is used.

Table	5.5:	Test	parameters
-------	------	------	------------

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GNSS Coarse time assistance error	seconds	±2
range		
GPS L1 C/A Signal for all satellites	dBm	-130

5.2.1 Minimum requirements (nominal accuracy)

The position estimates shall meet the accuracy and response time requirements in Table 5.6.

Table 5.6: Minimum requirements

[Success rate	2-D position error	Max response time
	95 %	30 m	20 s

5.3 Dynamic range

The aim of a dynamic range requirement is to ensure that a GNSS receiver performs well when visible satellites have rather different signal levels. Strong satellites are likely to degrade the acquisition of weaker satellites due to their cross-correlation products. Hence, it is important in this test case to keep use AWGN in order to avoid loosening the requirements due to additional margin because of fading channels. This test case verifies the performance of the first position estimate.

In this requirement 6 satellites are generated for the terminal. AWGN channel model is used.

Parameters	Unit	Value
Number of generated satellites	-	6
HDOP Range	-	1.4 to 2.1
GNSS Coarse time assistance	seconds	±2
error range		
Propagation conditions	-	AWGN
GPS L1 C/A Signal for 1 st satellite	dBm	-129
GPS L1 C/A Signal for 2 nd satellite	dBm	-135
GPS L1 C/A Signal for 3 rd satellite	dBm	-141
GPS L1 C/A Signal for 4 th satellite	dBm	-147
GPS L1 C/A Signal for 5 th satellite	dBm	-147
GPS L1 C/A Signal for 6 th satellite	dBm	-147

Table 5.7: Test parameters

5.3.1 Minimum requirements (dynamic range)

The position estimates shall meet the accuracy and response time requirements in Table 5.8.

Table 5.8: Minimum requirements

Γ	Success rate	2-D position error	Max response time
	95 %	100 m	20 s

5.4 Multi-path scenario

The purpose of the test case is to verify the receiver's tolerance to multipath while keeping the test setup simple. This test case verifies the performance of the first position estimate.

In this requirement 5 satellites are generated for the terminal. Two of the satellites have one tap channel representing LOS signal. The three other satellites have two-tap channel, where the first tap represents LOS signal and the second reflected and attenuated signal as specified in Annex C.2.

Table 5.9: Test parameters

Parameters	Unit	Value		
Number of generated satellites (Satellites 1, 2 unaffected by multi-path)	-	5		
(Satellites 3, 4, 5 affected by multi-path)				
GNSS Coarse time assistance error range	seconds	±2		
HDOP Range	-	1.8 to 2.5		
GPS L1 C/A Signal for satellite 1, 2	dBm	-130		
GPS L1 C/A Signal for satellite 3, 4, 5	dBm	LOS signal of -130 dBm, multi- path signal of -136 dBm		

5.4.1 Minimum requirements (multi-path scenario)

The position estimates shall meet the accuracy and response time requirements in Table 5.10.

Table 5.10: Minimum requirements

Success rate	2-D position error	Max response time
95 %	100 m	20 s

5.5 Moving scenario and periodic update

The purpose of the test case is to verify the receiver's capability to produce GNSS measurements or location fixes on a regular basis, and to follow when it is located in a vehicle that slows down, turns or accelerates. A good tracking performance is essential for certain location services. A moving scenario with periodic update is well suited for verifying the tracking capabilities of an A-GNSS receiver in changing UE speed and direction. In the requirement the UE moves on a rectangular trajectory, which imitates urban streets. AWGN channel model is used. This test is not performed as a TTFF test.

In this requirement 5 satellites are generated for the terminal. The UE is requested to use periodical reporting with a reporting interval of 2 seconds.

The UE moves on a rectangular trajectory of 940 m by 1 440 m with rounded corner defined in Figure 5.1. The initial reference is first defined followed by acceleration to final speed of 100 km/h in 250 m. The UE then maintains the speed for 400 m. This is followed by deceleration to final speed of 25 km/h in 250 m. The UE then turn 90 degrees with turning radius of 20 m at 25 km/h. This is followed by acceleration to final speed of 100 km/h in 250 m. The sequence is repeated to complete the rectangle.

Parameter	Distance (m)	Speed (km/h)
I ₁₁ , I ₁₅ , I ₂₁ , I ₂₅	20	25
I ₁₂ , I ₁₄ , I ₂₂ , I ₂₄	250	25 to 100 and 100 to 25
I ₁₃	400	100
I ₂₃	900	100

Table 5.11: Trajectory Parameters

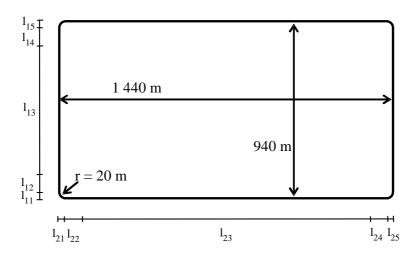




Table 5.12: Test Parameters

Parameters	Unit	Value	
Number of generated satellites	-	5	
HDOP Range	-	1.8 to 2.5	
Propagation condition	-	AWGN	
GPS L1 C/A signal for all	dBm	-130	
satellites			

5.5.1 Minimum requirements (moving scenario and periodic update)

The position estimates shall meet the accuracy requirement of Table 5.13 with the periodical reporting interval defined in Table 5.13 after the first reported position estimates.

NOTE: In the actual testing the UE may report error messages until it is able to acquire GNSS measured results or a position estimate. The test equipment shall only consider the first measurement report different from an error message as the first position estimate in the requirement in Table 5.13.

Table 5.13: Minimum requirements

Succe	ess Rate	2-D position error	Periodical reporting interval
9	5 %	100 m	2 s

6 A-GNSS minimum performance requirements (UE supports other or additional GNSSs)

6.0 Introduction

The minimum performance requirements specified in clause 6 apply for UEs that support other A-GNSSs than GPS L1 C/A, or multiple A-GNSSs which may or may not include GPS L1 C/A. The requirements for UEs that support A-GPS L1 C/A only are specified in clause 5.

The A-GNSS minimum performance requirements are defined by assuming that all relevant and valid assistance data is received by the UE in order to perform GNSS measurements and/or position calculation. This clause does not include nor consider delays occurring in the various signalling interfaces of the network.

In the following clauses the minimum performance requirements are based on availability of the assistance data information and messages defined in annexes D and E.

6.1 Sensitivity

A sensitivity requirement is essential for verifying the performance of A-GNSS receiver in weak satellite signal conditions. In order to test the most stringent signal levels for the satellites the sensitivity test case is performed in AWGN channel. This test case verifies the performance of the first position estimate, when the UE is provided with only coarse time assistance and when it is additionally supplied with fine time assistance.

6.1.1 Coarse time assistance

In this test case 6 satellites are generated for the terminal for single constellation and dual constellation, and 7 satellites are generated for triple constellation. AWGN channel model is used.

System	Parameters	Unit	Value	
	Number of generated satellites per system	-	See Table 6.2	
	Total number of generated satellites	-	6 or 7 ⁽²⁾	
	HDOP range		1.4 to 2.1	
	Propagation conditions	-	AWGN	
	GNSS coarse time assistance error range	seconds	±2	
BDS	Reference high signal power level	dBm	-136	
603	Reference low signal power level	dBm	-145	
Galileo	Reference high signal power level	dBm	-142	
Gailleo	Reference low signal power level	dBm	-147	
GLONASS	Reference high signal power level	dBm	-142	
GLONASS	Reference low signal power level	dBm	-147	
GPS ⁽¹⁾	Reference high signal power level	dBm	-142	
GF3 ⁽¹⁾	Reference low signal power level	dBm	-147	
NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE capabilities.				
	es apply only for case of triple constellation.			

Table 6.1: Test parameters

	Satellite allocation for each constellation				
GNSS-1 ⁽¹⁾ GNSS-2 GNSS-3					
Single constellation	High signal level	1	-	-	
Low signal level 5				-	
Dual constellation High signal level 1					
Low signal level 2 3 -					
Triple constellation High signal level 1				-	
Low signal level 2 2 2					
Note 1: GNSS-1, i.e. the system having the satellite with high signal level, shall be selected by the device manufacturer.					

Table 6.2: Power level and satellite allocation

6.1.1.1 Minimum requirements (Coarse time assistance)

The position estimates shall meet the accuracy and response time specified in Table 6.3.

Table 6.3: Minimum requirements (coarse time assistance)
--

System	Success rate	2-D position error	Max response time
All	95 %	100 m	20 s

6.1.2 Fine time assistance

This requirement is only valid for fine time assistance capable UEs. In this requirement 6 satellites are generated for the terminal for single constellation and dual constellation, and 7 satellites are generated for triple constellation. AWGN channel model is used.

System	System Parameters		Value		
	Number of generated satellites per system	-	See Table 6.5		
	-	6 or 7 ⁽²⁾			
Total number of generated satellites-6 or 7(2)HDOP range1.4 to 2.1					
	Propagation conditions - AWGN				
	GNSS coarse time assistance error range seconds ±2				
	GNSS fine time assistance error range µs ±10				
BDS	Reference signal power level dBm -147				
Galileo	Reference signal power level dBm -147				
GLONASS	Reference signal power level dBm -147				
GPS ⁽¹⁾					
NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE					
capabilities.					
NOTE 2: 7 satellites apply only for case of triple constellation.					

Table 6.5: Satellite allocation	Table	6.5:	Satellite	allocation
---------------------------------	-------	------	-----------	------------

		Satellite allocation for each constellation		
	GNSS-1	GNSS-1 GNSS-2 GNSS-3		
Single constellation	6	-	-	
Dual constellation	3	3	-	
Triple constellation	3	2	2	

6.1.2.1 Minimum requirements (Fine time assistance)

The position estimates shall meet the accuracy and response time requirements in Table 6.6.

 Table 6.6: Minimum requirements for fine time assistance capable terminals

Syste	m Success	rate 2-D position er	rror Max response time
All	95 %	100 m	20 s

6.2 Nominal accuracy

Nominal accuracy requirement verifies the accuracy of A-GNSS position estimate in ideal conditions. The primarily aim of the test is to ensure good accuracy for a position estimate when satellite signal conditions allow it. This test case verifies the performance of the first position estimate.

In this requirement 6 satellites are generated for the terminal for single constellation and dual constellation, and 7 satellites are generated for triple constellation. If SBAS is to be tested one additional satellite shall be generated. AWGN channel model is used. The number of simulated satellites for each constellation is as defined in Table 6.8.

System	Parameters	Unit	Value			
	Number of generated satellites per system	-	See Table 6.8			
	Total number of generated satellites - 6 or 7 ⁽²⁾ or 8 ⁽²⁾					
	HDOP Range - 1.4 to 2.1					
	Propagation conditions	-	AWGN			
	GNSS coarse time assistance error range	seconds	±2			
BDS	Reference signal power level for all satellites	dBm	-133			
Galileo	Reference signal power level for all satellites dBm -127					
GLONASS	Reference signal power level for all satellites dBm -131					
GPS ⁽¹⁾	Reference signal power level for all satellites dBm -128.5					
QZSS	Reference signal power level for all satellites dBm -128.5					
SBAS	BAS Reference signal power level for all satellites dBm -131					
NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE capabilities.						
NOTE 2: 7 satellites apply for case of single or dual constellation and SBAS is supported or case of triple constellation and SBAS is not supported.						
NOTE 3: 8 satellites apply only for case of triple constellation and SBAS is supported.						

Table 6.7: Test parameters

If QZSS is supported, one of the GPS satellites will be replaced by a QZSS satellite with respective signal support. If SBAS is supported, the SBAS satellite with the highest elevation will be added to the scenario.

Table 6.8: Satellite allocation

	Satellite allocation for each constellation				
GNSS 1 ⁽¹⁾ GNSS 2 ⁽¹⁾ GNSS 3 ⁽¹⁾ SBAS					
Single constellation	6			1	
Dual constellation	3	3		1	
Triple constellation	3	2	2	1	
NOTE 1: GNSS refers to global sy	stems i.e. BDS.	Galileo, GLON	ASS. GPS.		

NOTE 1: GNSS refers to global systems i.e. BDS, Galileo, GLONASS, GP

6.2.1 Minimum requirements (nominal accuracy)

The position estimates shall meet the accuracy and response time requirements in Table 6.9.

Table 6.9: Minimum requirements

System	Success rate	2-D position error	Max response time
All	95 %	15 m	20 s

6.3 Dynamic range

The aim of a dynamic range requirement is to ensure that a GNSS receiver performs well when visible satellites have rather different signal levels. Strong satellites are likely to degrade the acquisition of weaker satellites due to their cross-correlation products. Hence, it is important in this test case to keep use AWGN in order to avoid loosening the requirements due to additional margin because of fading channels. This test case verifies the performance of the first position estimate.

In this requirement 6 satellites are generated for the terminal for single constellation and dual constellation, and 7 satellites are generated for triple constellation. Two different reference power levels, denoted as "high" and "low" are used for each GNSS. The allocation of "high" and "low" power level satellites depends on the number of supported GNSSs and it is defined in Table 6.11. AWGN channel model is used.

System	Parameters	Unit	Value		
	Number of generated satellites per system	-	See Table 6.11		
	Total number of generated satellites	-	6 or 7 ⁽²⁾		
	HDOP Range - 1.4 to 2.1				
	Propagation conditions	-	AWGN		
	GNSS coarse time assistance error range	seconds	±2		
	Reference high signal power level	dBm	-133.5		
BDS	Reference low signal power level	dBm	-145		
Galileo Reference high signal power level dBm -12			-127.5		
Reference low signal power level dBm -147					
CLONASS Reference high signal power level dBm -131.5			-131.5		
GLONASS Reference low signal power level		dBm	-147		
GPS ⁽¹⁾	Reference high signal power level	dBm	-129		
Reference low signal power level dBm -147					
NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE capabilities.					
NOTE 2: 7 satellites apply only for case of triple constellation.					

Table 6.11: Power level and satellite allocation

		Satellite allocation for each constellation		constellation
		GNSS 1 ⁽¹⁾	GNSS 2 ⁽¹⁾	GNSS 3 ⁽¹⁾
Single constellation	High signal level	2		
-	Low signal level	4		
Dual constellation	High signal level	1	1	
	Low signal level	2	2	
Triple constellation	High signal level	1	1	1
	Low signal level	2	1	1
NOTE 1: GNSS refere	s to global systems i.e	e. BDS, Galileo,	GLONASS, GP	S.

6.3.1 Minimum requirements (dynamic range)

The position estimates shall meet the accuracy and response time requirements in Table 6.12.

Table 6.12: Minimum requirements

System	Success rate	2-D position error	Max response time
All	95 %	100 m	20 s

6.4 Multi-path scenario

The purpose of the test case is to verify the receiver's tolerance to multipath while keeping the test setup simple. This test case verifies the performance of the first position estimate.

In this requirement 6 satellites are generated for the terminal for single constellation and dual constellation, and 7 satellites are generated for triple constellation. Some of the satellites have a one tap channel representing the LOS signal. The other satellites have a two-tap channel, where the first tap represents the LOS signal and the second represents a reflected and attenuated signal as specified in Annex C.2. The number of satellites generated for each GNSS as well as the channel model used depends on the number of systems supported by the UE and is defined in Table 6.14. The channel model as specified in Annex C.2 further depends on the generated signal.

System	Parameters	Unit	Value			
	Number of generated satellites per system	-	See Table 6.14			
	Total number of generated satellites	-	6 or 7 ⁽²⁾			
	HDOP range		1.4 to 2.1			
	Propagation conditions	-	AWGN			
	GNSS coarse time assistance error range	seconds	±2			
BDS Reference signal power level		dBm	-133			
Galileo	Reference signal power level	dBm	-127			
GLONASS Reference signal power level		dBm	-131			
GPS ⁽¹⁾ Reference signal power level		dBm	-128.5			
NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE						
capabilities.						
NOTE 2: 7 satellit	tes apply only for case of triple constellation.		NOTE 2: 7 satellites apply only for case of triple constellation.			

Table	6.13:	Test	param	neter
-------	-------	------	-------	-------

Table 6.14: Channel model allocation

		Channel model allocation for eac constellation		n for each
		GNSS-1	GNSS-2	GNSS-3
Single constellation	One-tap channel	2		
	Two-tap channel	4		
Dual constellation	One-tap channel	1	1	
	Two-tap channel	2	2	
Triple constellation	One-tap channel	1	1	1
	Two-tap channel	2	1	1

6.4.1 Minimum requirements (multi-path scenario)

The position estimates shall meet the accuracy and response time requirements in Table 6.15.

Table 6.15: Minimum requirements

System	Success rate	2-D position error	Max response time
All	95 %	100 m	20 s

6.5 Moving scenario and periodic update

The purpose of the test case is to verify the receiver's capability to produce GNSS measurements or location fixes on a regular basis, and to follow when it is located in a vehicle that slows down, turns or accelerates. A good tracking performance is essential for certain location services. A moving scenario with periodic update is well suited for verifying the tracking capabilities of an A-GNSS receiver in changing UE speed and direction. In the requirement the UE moves on a rectangular trajectory, which imitates urban streets. AWGN channel model is used. This test is not performed as a TTFF test.

In this requirement 6 satellites are generated for the terminal for single constellation and dual constellation, and 7 satellites are generated for triple constellation. The UE is requested to use periodical reporting with a reporting interval of 2 seconds.

The UE moves on a rectangular trajectory of 940 m by 1 440 m with rounded corner defined in Figure 6.1. The initial reference is first defined followed by acceleration to final speed of 100 km/h in 250 m. The UE then maintains the

speed for 400 m. This is followed by deceleration to final speed of 25 km/h in 250 m. The UE then turn 90 degrees with turning radius of 20 m at 25 km/h. This is followed by acceleration to final speed of 100 km/h in 250 m. The sequence is repeated to complete the rectangle.

Parameter	Distance (m)	Speed (km/h)
l ₁₁ , l ₁₅ , l ₂₁ , l ₂₅	20	25
I ₁₂ , I ₁₄ , I ₂₂ , I ₂₄	250	25 to 100 and 100 to 25
I ₁₃	400	100
I ₂₃	900	100

Table 6.16: Trajectory Parameters

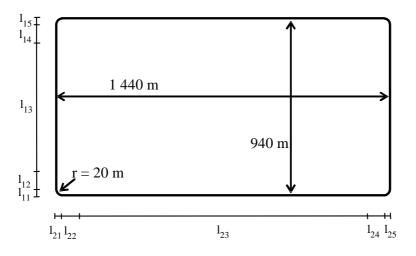




Table 6.17: Test Parameters

System	Parameters	Unit	Value	
	Number of generated satellites per system	-	See Table 6.18	
	Total number of generated satellites	-	6 or 7 ⁽²⁾	
	HDOP Range per system	-	1.4 to 2.1	
	Propagation conditions	-	AWGN	
	GNSS coarse time assistance error range	seconds	±2	
BDS	Reference signal power level for all satellites	dBm	-133	
Galileo	Reference signal power level for all satellites	dBm	-127	
GLONASS Reference signal power level for all satellites		dBm	-131	
GPS ⁽¹⁾ Reference signal power level for all satellites dBm -128.5		-128.5		
NOTE 1: "GPS" here means GPS L1 C/A, Modernized GPS, or both, dependent on UE				
capabilities.				
NOTE 2: 7 sa	atellites apply only for case of triple constellation.			

Table 6.18: Satellite allocation

	Satellite allocation for each constellation		
	GNSS 1 ⁽¹⁾	GNSS 2 ⁽¹⁾	GNSS 3 ⁽¹⁾
Single constellation	6		
Dual constellation	3	3	
Triple constellation	3	2	2
NOTE 1: GNSS refers to global systems i.e. BDS, Galileo, GLONASS, GPS.			

6.5.1 Minimum requirements (moving scenario and periodic update)

The position estimates shall meet the accuracy requirement of Table 6.19 with the periodical reporting interval defined in Table 6.19 after the first reported position estimates.

NOTE: In the actual testing the UE may report error messages until it is able to acquire GNSS measured results or a position estimate. The test equipment shall only consider the first measurement report different from an error message as the first position estimate in the requirement in Table 6.19.

Table 6.19:	Minimum	requirements
-------------	---------	--------------

System	Success rate	2-D position error	Periodical reporting interval
All	95 %	50 m	2 s

Annex A (normative): Test cases

A.1 Conformance tests

The conformance tests for E-UTRA A-GNSS specified in TS 37.571-1 [19]. Statistical interpretation of the requirements is described in clause A.2.

A.2 Requirement classification for statistical testing

Requirements in the present document are either expressed as absolute requirements with a single value stating the requirement, or expressed as a success rate. There are no provisions for the statistical variations that will occur when the parameter is tested.

Annex B lists the test parameters needed for the tests. The test will result in an outcome of a test variable value for the DUT inside or outside the test limit. Overall, the probability of a "good" DUT being inside the test limit(s) and the probability of a "bad" DUT being outside the test limit(s) should be as high as possible. For this reason, when selecting the test variable and the test limit(s), the statistical nature of the test is accounted for.

When testing a parameter with a statistical nature, a confidence level has to be set. The confidence level establishes the probability that a DUT passing the test actually meets the requirement and determines how many times a test has to be repeated. The confidence levels are defined for the final tests in TS 37.571-1 [19].

Annex B (normative): Test conditions

B.1 General

This annex specifies the additional parameters that are needed for the test cases specified in clauses 5 and 6 and applies to all tests unless otherwise stated.

B.1.1 Parameter values

Additionally, amongst all the listed parameters (see annex E), the following values for some important parameters are to be used in the LPP Request Location Information message.

Information element	Value - TTFF tests (except nominal accuracy test)	Value - TTFF tests (nominal accuracy test)	Value - Periodic tests
periodicalReporting	Not present	Not present	Present
> reportingAmount	N/A	N/A	'ra-Infinity' (Infinite) ⁽¹⁾
> reportingInterval	N/A	N/A	'ri2' (2 seconds)
qos			
> horizontalAccuracy			
>> accuracy (test cases in clause 5)	19 (51.2 m)	10 (15.9 m)	19 (51.2 m)
>> accuracy (test cases in clause 6)	19 (51.2 m)	6 (7.7 m)	13 (24.5 m)
> responseTime	20 (seconds)	20 (seconds)	Not present
NOTE 1: Infinite means during the complete test time.			

Table B.1: Parameter values

In the Sensitivity test case with Fine Time Assistance, the following parameter values are used in the LPP Provide Assistance Data message.

Table B.2: Parameters for Fine Time Assistance tes	t
--	---

Information element	Value
GNSS-ReferenceTimeForOneCell	
> networkTime	
>> frameDrift	0
> referenceTimeUnc	24 (11.11 μs)

B.1.2 Time assistance

For every Test Instance in each TTFF test case, the IE *gnss-TimeOfDay* shall have a random offset, relative to GNSS system time, within the error range of Coarse Time Assistance defined in the test case. This offset value shall have a uniform random distribution.

In addition, for every Fine Time Assistance Test Instance the IE *networkTime* shall have a random offset, relative to the true value of the relationship between the two time references, within the error range of Fine Time Assistance defined in the test case. This offset value shall have a uniform random distribution.

For the Moving Scenario and Periodic Update Test Case the IE gnss-TimeOfDay shall be set to the nominal value.

B.1.3 GNSS reference time

For every Test Instance in each TTFF test case, the GNSS reference time shall be advanced so that, at the time the fix is made, it is at least 2 minutes later than the previous fix.

B.1.4 Reference and UE locations

There is no limitation on the selection of the reference location, consistent with achieving the required HDOP for the Test Case. For each test instance the reference location shall change sufficiently such that the UE shall have to use the new assistance data. The uncertainty of the semi-major axis is 3 km. The uncertainty of the semi-minor axis is 3 km. The orientation of major axis is 0 degrees. The uncertainty of the altitude information is 500 m. The confidence factor is 68 %.

For every Test Instance in each TTFF test case, the UE location shall be randomly selected to be within 3 km of the Reference Location. The Altitude of the UE shall be randomly selected between 0 m to 500 m above WGS-84 reference ellipsoid. These values shall have uniform random distributions.

For test cases which include satellites from regional systems, such as QZSS and SBAS, the reference location shall be selected within the defined coverage area of the systems.

B.1.5 Satellite constellation and assistance data

B.1.5.1 UE supports A-GPS L1 C/A only

In the case of test cases in clause 5 (UE supports A-GPS L1 C/A only), the GPS satellite constellation shall consist of 24 satellites. Almanac assistance data shall be available for all these 24 satellites. At least 9 of the satellites shall be visible to the UE (that is above 5 degrees elevation with respect to the UE). Other assistance data shall be available for 9 of these visible satellites. In each test, signals are generated for only a sub-set of these satellites for which other assistance data is available. The number of satellites in this sub-set is specified in the test. The satellites in this sub-set shall be calculated using this sub-set of satellites. The selection of satellites for this sub-set shall be selected consistent with achieving the required HDOP for the test.

B.1.5.2 UE supports other A-GNSSs

In the case of test cases in clause 6 (UE supports other GNSSs), the satellite constellation shall consist of 35 satellites for BDS (5 GEO, 27 MEO, 3 IGSO); 27 satellites for Galileo; 24 satellites for GLONASS; 27 satellites for GPS/Modernized GPS; 3 satellites for QZSS; 2 satellites for SBAS. Almanac assistance data shall be available for all these satellites. At least 7 of the satellites per BDS, Galileo, GLONASS, GPS/Modernized GPS constellation shall be visible to the UE (that is, above 15 degrees elevation with respect to the UE). At least 1 of the satellites for QZSS shall be within 15 degrees of zenith; and at least 1 of the satellites for SBAS shall be visible to the UE. For BDS with reference location in Asia, at least 1 of the visible satellites shall be a GEO (above 15 degrees elevation with respect to the UE). All other satellites for single constellation and dual constellation and 7 satellites. In each test, signals are generated for only 6 satellites for single constellation and dual constellation and 7 satellites. The simulated satellites for BDS, Galileo, GLONASS GPS/Modernized GPS shall be selected from the visible satellites for each constellation consistent with achieving the required HDOP for the test. For BDS with reference location in Asia, 1 of the satellites for Some addition and Satellites for BDS, Galileo, GLONASS GPS/Modernized GPS shall be selected from the visible satellites for each constellation consistent with achieving the required HDOP for the test. For BDS with reference location in Asia, 1 of the simulated satellites shall be a GEO.

B.1.6 Atmospheric delays

Typical Ionospheric and Tropospheric delays shall be simulated, and the corresponding values inserted into the GNSS-Ionospheric Model IE.

B.1.7 E-UTRA or NR frequency and frequency error

In all test cases with E-UTRA frequency, the E-UTRA frequency used shall be the mid-range for the E-UTRA In all test cases other than Sensitivity in clause 5.1 with E-UTRA frequency, the E-UTRA frequency used shall be the mid-range for the E-UTRA operating band. The E-UTRA frequency with respect to the GNSS carrier frequency shall be offset by +0.025 PPM.

In all test cases other than Sensitivity in clause 5.1 with NR, the NR frequency used shall be as specified in TS 38.508-1 [20], clause 4.3.1. The NR frequency with respect to the GNSS carrier frequency shall be offset by + 0.025 PPM.

For verifying the sensitivity requirements in clause 5.1 with NR single carrier, the sensitivity tests shall be performed at least in each frequency band listed in Table B.1.7-1. The frequency bands listed in Table B.1.7-1 have been identified to be at high risk of generating interference in the GNSS bands due to mechanisms consisting of harmonics, cross band isolation, and receiver harmonic mixing. Other frequency bands may also impact GNSS sensitivity performance and thus be tested. For the frequency bands listed in Table B.1.7-1, the NR frequency and channel configuration shall be selected to ensure second order harmonics and other distortion will fall into the GNSS receiver bands as defined in clause B.1.13.2 for the particular GNSS. If the DUT does not support any of the frequency bands listed in Table B.1.7-1 the sensitivity tests in clause 5.1 can be performed in any frequency band supported by the DUT.

Table B.1.7-1: Minimum set of NR operating bands for verifying GNSS sensitivity

	NR operating bands	n14
--	--------------------	-----

B.1.8 Information elements

The information elements that are available to the UE in all the test cases are listed in annex E.

B.1.9 GNSS signals

The GNSS signal is defined at the A-GNSS antenna connector of the UE. For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

B.1.10 RESET UE POSITIONING STORED INFORMATION Message

In order to ensure each Test Instance in each TTFF test is performed under TTFF conditions, a dedicated test message (*RESET UE POSITIONING STORED INFORMATION*) defined in TS 38.509 [9] clause 5.6 shall be used.

When the UE receives the '*RESET UE POSITIONING STORED INFORMATION*' message, with the IE *UE POSITIONING TECHNOLOGY* set to AGNSS it shall:

- discard any internally stored GNSS reference time, reference location, and any other aiding data obtained or derived during the previous test instance (e.g. expected ranges and Doppler);
- accept or request a new set of reference time or reference location or other required information, as in a TTFF condition;
- calculate the position or perform GNSS measurements using the 'new' reference time or reference location or other information.

B.1.11 GNSS system time offsets

If more than one GNSS is used in a test, the accuracy of the GNSS-GNSS Time Offsets used at the SS shall be better than 3 ns.

B.1.12 Sensors

The minimum performances shall be met without the use of any data coming from sensors that can aid the positioning.

B.1.13 EN-DC band combinations for testing A-GNSS sensitivity

B.1.13.1 EN-DC band combination groups

For the A-GNSS sensitivity requirements in EN-DC operation mode with uplink assigned to E-UTRA and NR frequency bands, the requirements in clause 6.1 can be verified by one EN-DC band combination in each of the

applicable Frequency Group Combination specified in Table B.1.13.1-1. The A-GNSS sensitivity requirements for the remaining applicable EN-DC band combinations in each Frequency Group Combination are considered to have been verified by using the one EN-DC band combination in each Frequency Group Combination. The Frequency Groups are defined in Table B.1.13.1-2.

The applicable EN-DC band combinations for verifying A-GNSS sensitivity requirements in EN-DC operation mode are specified in clause B.1.13.2.

Table B.1.13.1-1: EN-DC band combination groups for verifying A-GNSS sensitivity requirements in EN-DC operation mode

Frequency Group Combination	EN-DC Band Combinations
Group VHF-VHF	NA
Group VHF-LB	NA
Group VHF-MLB	NA
Group VHF-MB	NA
Group VHF-HB	NA
Group VHF-UHB1	NA
Group VHF-UHB2	NA
Group LB-VHF	NA
Group LB-LB	DC_5A_n12A
	DC_5A_n71A
	DC_8A_n20A
	DC_8A_n28A
	DC_12A_n5A
	DC_20A_n8A
	DC_20A_n28A
	DC_28A_n5A
	DC_28A_n8A DC_71A_n5A
	DC_20A_n83A
Group LB-MLB	DC_20A_183A DC_20A_n50A
	DC_20A_n51A
	DC_28A_n51A
	DC_28A_n50A
Group LB-MB	DC_5A_n2A
	DC_5A_n66A
	DC_8A_n1A
	DC_8A_n3A
	DC_8A_n34A
	DC_8A_n39A
	DC_12A_n2A
	DC_12A_n25A
	DC_12A_n66A DC_18A_n3A
	DC_18A_113A DC_20A_n1A
	DC_20A_n3A DC_26A_n25A
	DC_28A_n3A
	DC_71A_n66A
	DC_8A_n80A
	DC_20A_n80A
Group LB-HB	DC_5A_n7A
	DC_5A_n38A
	DC_5A_n40A
	DC_8A_n40A
	DC_8A_n41A
	DC_12A_n7A
	DC_12A_n38A DC_12A_n41A
	DC_12A_n41A DC_20A_n7A
	DC_20A_117A DC_20A_n38A
	DC_20A_1136A DC_20A_n41A
	DC_26A_n41A DC_26A_n41A
	DC_28A_n7A
	DC_28A_n40A

	DC_28A_n41A
	DC_207_11417A DC_71A_n38A
Group LB-UHB1	DC_5A_n48A
	DC_5A_n78A
	DC_8A_n77A
	DC_8A_n78A
	DC_12A_n78A
	DC_12A_n77A
	DC_18A_n78A DC_19A_n77A
	DC_19A_n78A
	DC_20A_n77A
	DC_20A_n78A
	DC_26A_n77A
	DC_26A_n78A
	DC_28A_n77A
	DC_28A_n78A
	DC_71A_n48A
	DC_71A_n78A
Group LB-UHB2	DC_5A_n79A
	DC_8A_n79A
	DC_18A_n79A
	DC_19A_n79A
	DC_26A_n79A
	DC_28A_n79A
Group MLB-VHF	NA
Group MLB-LB	DC_11A_n28A
Group MLB-MLB	NA
Group MLB-MB	DC_11A_n3A
Group MLB-HB	 NA
Group MLB-UHB1	DC_11A_n77A
	DC_11A_n78A
	DC_21A_n77A
	DC_21A_n78A
Group MLB-UHB2	DC_11A_n79A
	DC_21A_n79A
Group MB-VHF	NA
Group MB-LB	DC_1A_n5A
	DC_1A_n8A
	DC_1A_n20A
	DC_1A_n28A
	DC_1A_n71A
	DC_2A_n5A
	DC_2A_n12A DC_2A_n71A
	DC_2A_n7TA DC_3A_n5A
	DC_3A_n8A
	DC_3A_n20A
	DC_3A_n28A
	DC_3A_n71A
	DC_66A_n5A
	DC_66A_n12A
	DC_66A_n71A
	DC_3A_n82A
Group MB-MLB	DC_1A_n50A
	DC 1A n51A
	DC_3A_n50A
	DC_3A_n51A

DC_1A_n3A DC_2A_n66A DC_3A_n1A DC_3A_n34A DC_66A_n2A DC_66A_n25A DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_3A_n1A DC_3A_n34A DC_66A_n2A DC_66A_n25A DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_3A_n34A DC_66A_n2A DC_66A_n25A DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_3A_n34A DC_66A_n2A DC_66A_n25A DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_66A_n25A DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_1A_n80A DC_2A_n2A2 DC_66A_n66A2
DC_2A_n2A2 DC_66A_n66A2
DC_66A_n66A2
0C_3A_n3A2
0C_3A_n84A
DC_1A_n7A
DC_1A_n38A
DC_1A_n40A
DC_1A_n41A
DC_2A_n7A
DC_2A_n38A
0C_2A_n41A
0C_3A_n7A
DC_3A_n38A
0C_3A_n40A
0C_3A_n41A
0C_4A_n38A
0C_4A_n41A
DC_25A_n41A
DC_39A_n40A
0C_39A_n41A
DC_66A_n7A
DC_66A_n38A
DC_66A_n41A
DC_1A_n77A
DC_1A_n78A
0C_2A_n48A
DC_2A_n78A
DC_3A_n77A
DC_3A_n78A
DC_4A_n78A
DC_39A_n78A
DC_66A_n48A
0C_66A_n78A
0C_1A_n79A
DC_3A_n79A
DC_39A_n79A
IA
DC_7A_n5A
DC_7A_n8A
0C_7A_n20A
DC_7A_n28A
DC 7A n71A
0C_30A_n5A
0C_41A_n28A
0C_7A_n51A
DC_7A_n1A
DC_7A_n3A
DC_7A_n66A
DC_30A_n2A
DC_30A_n66A
DC_40A_n1A
DC_40A_NTA DC_41A_n3A
DC_7A_n80A
0C_38A_n3A
DC_7A_n40A
DC_40A_n41A
DC_7A_n7A2
DC_41A_n41A
DC_40A_n77A DC_40A_n78A

7A n78A		
38A n78A		
_36A_1178A _41A_n78A		
7A_n77A		
_///		
40A_n79A		
_ 1 0A_m3A _41A_n79A		
s second order intermodulation		
products.		
This sub-group generates third order intermodulation		
products.		
This sub-group generates second and third order		
intermodulation products.		

Table B.1.13.1-2: Definition of Frequency Groups

Frequency Group	Frequency Range (MHz)
VHF	400.0 - 458.0
LB	662.0 - 916.0
MLB	1426.0 - 1518.0
MB	1626.0 - 2025.0
HB	2300.0 - 2690.0
UHB1	3300.0 - 4201.0
UHB2	4400.0 - 5000.0

B.1.13.2 Applicable EN-DC band combinations for verifying A-GNSS sensitivity requirements

The A-GNSS sensitivity requirements in clause 6.1 when in EN-DC operation mode shall be verified for EN-DC band combinations that can generate second or third order intermodulation products falling into the following GNSS receiver bands for the particular GNSS (where supported by the UE):

- GPS L1 C/A: 1574.3970 1576.4430 MHz
- Galileo E1 / GPS L1C: 1573.3740 1577.4660 MHz
- GLONASS G1: 1597.5515 1605.8860 MHz
- BDS B1I: 1559.0520 1563.1440 MHz

For each frequency group combination in Table B.1.13.2-1 only one EN-DC band combination needs to be tested for the supported GNSS.

Frequency Group	EN-DC band combinations		
Combination	GPS L1 / Galileo E1	GLONASS G1	BDS B1
Group LB-LB	DC_20A_n28A	DC_8A_n28A	DC_5A_n12A
	DC_28A_n5A	DC_20A_n28A	DC_12A_n5A
	DC_20A_n83A	DC_28A_n8A	DC_20A_n28A

		DC 204 - 224	
		DC_20A_n83A	DC_28A_n5A
	NA	NA	DC_20A_n83A NA
Group LB-MLB	NA	NA	NA
Group LB-MB			
Group LB-HB	DC_5A_n40A	DC_8A_n41A	DC_5A_n40A
	DC_28A_n40A	DC_28A_n40A	DC_28A_n40A
Group LB-UHB1	DC_8A_n77A	DC_5A_n78A	DC_8A_n77A
	DC_8A_n78A	DC_8A_n77A	DC_8A_n78A
	DC_20A_n77A	DC_8A_n78A DC_20A_n77A	
	DC_20A_n78A	DC_20A_1177A DC_20A_1178A	
		DC_26A_n77A	
		DC_26A_n78A	
Group LB-UHB2	NA	NA	NA
Group MLB-LB	NA	NA	NA
Group MLB-MLB	NA	NA	NA
Group MLB-MB	NA	NA	NA
Group MLB-HB	NA	NA	NA
Group MLB-UHB1	NA TO A	NA Do 110 700	NA TOA
Group MLB-UHB2	DC_11A_n79A	DC_11A_n79A	DC_11A_n79A
	DC_21A_n79A	DC_21A_n79A	DC_21A_n79A
Group MB-LB	NA	NA	NA
Group MB-MLB	NA	NA	NA
Group MB-MB	DC_1A_n3A	DC_1A_n3A	DC_1A_n3A
	DC_2A_n66A	DC_2A_n66A	DC_2A_n66A
	DC_3A_n1A	DC_3A_n1A	DC_3A_n1A
	DC_66A_n2A	DC_66A_n2A	DC_66A_n2A
	DC_66A_n25A	DC_66A_n25A	DC_66A_n25A
	DC_1A_n80A	DC_1A_n80A	DC_1A_n80A
	DC_3A_n84A	DC_3A_n84A	DC_3A_n84A
Group MB-HB	DC_1A_n40A	DC_1A_n7A	DC_1A_n7A
Group MB-UHB1	DC_1A_n77A	DC_1A_n77A	DC_1A_n77A
	DC_1A_n78A	DC_1A_n78A	DC_1A_n78A
	DC_2A_n78A	DC_2A_n78A	DC_2A_n78A
	DC_3A_n77A	DC_3A_n77A	DC_3A_n77A
	DC_3A_n78A DC_4A_n78A	DC_3A_n79A DC_4A_n78A	DC_3A_n79A DC_4A_n78A
	DC_4A_n78A DC_39A_n78A	DC_4A_n78A DC_39A_n78A	DC_4A_n78A DC_39A_n78A
	DC_39A_n78A DC_66A_n78A	DC_39A_n78A DC_66A_n78A	
Group MB-UHB2	DC_3A_n79A	NA	DC_66A_n78A DC_3A_n79A
Group HB-LB	NA	DC_7A_n8A	NA
Group HB-MLB	NA	NA	NA
Group HB-MB	DC_40A_n1A NA	DC_40A_n1A NA	DC_40A_n1A NA
Group HB-HB			
Group HB-UHB1 A:	DC_40A_n77A	DC_40A_n77A	DC_40A_n77A
B:	DC_7A_n78A	DC_7A_n78A	DC_7A_n78A
	DC_38A_n78A	DC_38A_n78A	DC_38A_n78A
0	DC_41A_n78A	DC_41A_n78A	DC_41A_n78A
C:	DC_7A_n77A	DC_7A_n77A	DC_7A_n77A
	DC_41A_n77A	DC_41A_n77A	DC_41A_n77A
Group HB-UHB2	NA	NA	NA

B.1.13.3 Test frequencies for EN-DC band combinations

For verifying the sensitivity requirements in clause 6.1 in EN-DC operation mode, the E-UTRA and NR frequency and channel configuration shall be selected to ensure the intermodulation products fall into the GNSS receiver bands as defined in clause B.1.13.2 for the particular GNSS.

Annex C (normative): Propagation conditions

C.1 Static propagation conditions

The propagation for the static performance measurement is an Additive White Gaussian Noise (AWGN) environment. No fading and multi-paths exist for this propagation model.

C.2 Multi-path case

Doppler frequency difference between direct and reflected signal paths is applied to the carrier and code frequencies. The Carrier and Code Doppler frequencies of LOS and multi-path for GNSS signal are defined in table C.1.

Initial relative delay [m]	Carrier Doppler frequency of tap [Hz]	Code Doppler frequency of tap [Hz]	Relative mean power [dB]
0	Fd	Fd / N	0
Х	Fd - 0.1	(Fd-0.1) /N	Y
NOTE: Discrete Doppler frequency is used for each tap.			

Table C.1: Multipath case

Where the X and Y depends on the GNSS signal type and is shown in Table C.2, and N is the ratio between the transmitted carrier frequency of the signals and the transmitted chip rate as shown in Table C.3 (where k in Table C.3 is the GLONASS frequency channel number).

System	Signals	X [m]	Y [dB]
BDS	B1I	75	-4.5
603	B1C	125	-4.5
	E1	125	-4.5
Galileo	E5a	15	-6
	E5b	15	-6
GLONASS	G1	275	-12.5
GLUNASS	G2	275	-12.5
	L1 C/A	150	-6
GPS/Modernized GPS	L1C	125	-4.5
	L2C	150	-6
	L5	15	-6

Table C.2: Parameter values

Table C.3: Ratio between carrier frequency and chip rate

System	Signals	N
BDS	B1I	763
603	B1C	1540
	E1	1540
Galileo	E5a	115
	E5b	118
GLONASS	G1	3135.03 + k · 1.10
GLONASS	G2	2438.36 + k · 0.86
	L1 C/A	1540
GPS/Modernized GPS	L1C	1540
	L2C	1200
	L5	115

The initial carrier phase difference between taps shall be randomly selected between 0 and 2π . The initial value shall have uniform random distribution.

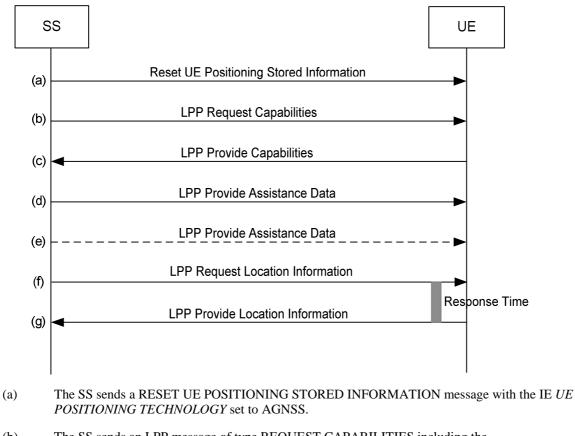
Annex D (normative): Measurement sequence chart

D.1 General

The measurement Sequence Charts that are required in all the test cases, are defined in this clause.

D.2 TTFF measurement sequence chart

The measurement sequence chart for the TTFF test cases, for both UE-assisted and UE-based GNSS, is defined in this clause.



- (b) The SS sends an LPP message of type REQUEST CAPABILITIES including the *A-GNSS-RequestCapabilities* IE set to TRUE.
- (c) The UE sends an LPP message of type PROVIDE CAPABILITIES including the *A-GNSS-ProvideCapabilities* IE with the *AssistanceDataSupportList* included, indicating the assistance data supported by the UE.
- (d) (e) The SS provides the assistance data that are supported by the UE and available as defined in Annex E and Table E.1 in one or more LPP messages of type PROVIDE ASSISTANCE DATA.
- (f) The SS sends an LPP message of type REQUEST LOCATION INFORMATION including the information elements defined in Table D.1.
- (g) The UE sends an LPP message of type PROVIDE LOCATION INFORMATION including either the *GNSS-SignalMeasurementInformation* or *GNSS-LocationInformation* IE, dependent on the test case (UE-assisted or UE-based, respectively).

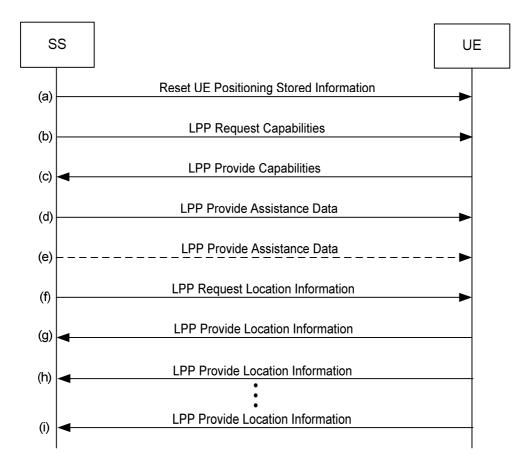
Steps (a) to (g) are repeated for each test instance.

Information Element	Value/remark	Comment
RequestLocationInformation		
> commonIEsRequestLocationInformation		
>> locationInformationType	'locationEstimateRequired' or 'locationMeasurementsRequired'	Depending on test case and UE capabilities, i.e., UE- based or UE-assisted
>> additionalInformation	'onlyReturnInformationRequested'	
>> qos		
>>> horizontalAccuracy	As defined in Annex B.1.1	
>>> verticalCoordinateRequest	FALSE	
>>> responseTime	'20'	20 seconds
> a-gnss-RequestLocationInformation		
>> gnss-PositioningInstructions		
>>> gnssMethods		
>>>> gnss-ids	According to UE capabilities	
>>> fineTimeAssistanceMeasReq	FALSE	
>>> adrMeasReq	FALSE	
>>> multiFreqMeasReq	TRUE or FALSE	Depending on UE capabilities
>>> assistanceAvailability	FALSE	

Table D.1: LPP Request Location Information content for TTFF test cases.

D.3 Moving scenario and periodic update measurement sequence chart

The measurement sequence chart for the moving scenario and periodic update test case, for both UE-assisted and UE-based GNSS, is defined in this clause.



- (a) The SS sends a RESET UE POSITIONING STORED INFORMATION message with the IE UE *POSITIONING TECHNOLOGY* set to AGNSS.
- (b) The SS sends an LPP message of type REQUEST CAPABILITIES including the *A-GNSS-RequestCapabilities* IE set to TRUE.
- (c) The UE sends an LPP message of type PROVIDE CAPABILITIES including the A-GNSS-ProvideCapabilities IE with the AssistanceDataSupportList included, indicating the assistance data supported by the UE.
- (d) (e) The SS provides the assistance data that are supported by the UE and available as defined in Annex E and table E.1 in one or more LPP messages of type PROVIDE ASSISTANCE DATA.
- (f) The SS sends an LPP message of type REQUEST LOCATION INFORMATION including the information elements defined in Table D.2.
- (g) (i) The UE provides LPP messages of type PROVIDE LOCATION INFORMATION including either the GNSS-SignalMeasurementInformation or GNSS-LocationInformation IE, dependent on the test case (UEassisted or UE-based, respectively) until the moving trajectory is completed.
- NOTE: The UE may report error messages at step (g) until it is able to acquire GNSS signals.

Information Element	Value/remark	Comment
RequestLocationInformation		
> commonIEsRequestLocationInformation		
>> locationInformationType	'locationEstimateRequired' or 'locationMeasurementsRequired'	Depending on test case and UE capabilities, i.e., UE- based or UE-assisted
>> periodicalReporting		
>>> reportingAmount	'ra-Infinity'	As defined in Annex B.1.1
>>> reportingInterval	ʻri2'	As defined in Annex B.1.1
>> additionalInformation	'onlyReturnInformationRequested'	
>> qos		
>>> horizontalAccuracy	As defined in Annex B.1.1	
>>> verticalCoordinateRequest	FALSE	
> a-gnss-RequestLocationInformation		
>> gnss-PositioningInstructions		
>>> gnssMethods		
>>>> gnss-ids	According to UE capabilities	
>>> fineTimeAssistanceMeasReq	FALSE	
>>> adrMeasReq	FALSE	
>>> multiFreqMeasReq	FALSE	
>>> assistanceAvailability	FALSE	

Table D.2: LPP Request Location Information content for moving scenario and periodic update test case.

Annex E (normative): Assistance data required for testing

E.1 Introduction

This annex defines the assistance data IEs available at the SS in all test cases. The assistance data shall be given for satellites as defined in B.1.5.

The information elements are given with reference to TS 36.355 [3], where the details are defined.

Table E.1 defines the assistance data elements which shall be provided to the UE in the tests (steps (d) and (e) in the message sequence according to annexes D.2 and D.3). The assistance data provided depends on the mode being used in the test case, the assistance data supported by the UE (indicated in step (c) in the message sequence according to annexes D.2 and D.3) and the GNSSs supported by the UE. Assistance data IEs not supported by the UE shall not be sent. Assistance data IEs supported by the UE but not listed in Table E.1 shall not be sent.

Table E.1: Assistance data to be provided to the UE

Assistance data IE supported		Mode used in test case		
by UE	UE-based	UE-assisted, GNSS- AcquisitionAssistance supported by UE	UE-assisted, GNSS- AcquisitionAssistance not supported by UE	
GNSS-Reference Time	Yes	Yes	Yes	
GNSS-ReferenceLocation	Yes	No	Yes	
GNSS-IonosphericModel	Yes	No	No	
GNSS-TimeModelList	Yes ⁽¹⁾	No	Yes ⁽¹⁾	
GNSS-NavigationModel	Yes	No	Yes	
GNSS-AcquisitionAssistance	No	Yes	No	
GNSS-Almanac	No	No	Yes	
GNSS-UTC-Model	Yes ⁽³⁾	Yes ⁽³⁾	Yes ⁽³⁾	
GNSS-AuxiliaryInformation	Yes ⁽²⁾	Yes ⁽²⁾	Yes ⁽²⁾	
NOTE 1: In case more than a single GNSS is supported by the UE.				

NOTE 2: In case the UE supports GLONASS, and/or more than one GPS signal, and/or BDS B1C.

NOTE 3: In case more than a single GNSS is supported by the UE and the UE supports GLONASS.

E.2 GNSS assistance data

a) GNSS-ReferenceTime IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Information Element	All tests except Sensitivity Fine Time Assistance	Sensitivity Fine Time Assistance test
GNSS-ReferenceTime		
> gnss-SystemTime		
>> gnss-TimelD	Yes	Yes
>> gnss-DayNumber	Yes	Yes
>> gnss-TimeOfDay	Yes	Yes
>> gnss-TimeOfDayFrac-msec	Yes	Yes
>> notificationOfLeapSecond	Yes if	Yes if
	gnss-TimeID = 'glonass'	gnss-TimeID = 'glonass'
>> gps-TOW-Assist	Yes if gnss-TimeID = 'gps'	Yes if gnss-TimeID = 'gps'
> referenceTimeUnc	Yes	No
> gnss-ReferenceTimeForOneCell	No	Yes
>> networkTime		Yes
>>> secondsFromFrameStructureStart		Yes
>>> fractionalSecondsFromFrameStructureStart		Yes
>>> frameDrift		Yes
>>> cellID		Yes
>>> CHOICE eUTRA		
>>>> physCellId		Yes
>>>> cellGlobalIdEUTRA		Yes
>>>> earfcn/earfcn-v9a0		Yes
>>> CHOICE nr-r15		
>>>> nrPhysCellId-r15		Yes
>>>> nrCellGlobalID-r15		Yes
>>>> nrARFCN-r15		Yes
>> referenceTimeUnc		Yes

Table E.2: GNSS-ReferenceTime IE

b) GNSS-ReferenceLocation IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.3: GNSS-ReferenceLocation IE

Name of the IE	Fields of the IE
GNSS-ReferenceLocation	threeDlocation

c) GNSS-IonosphericModel IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.4: GNSS-IonosphericModel IE

Name of the IE	Fields of the IE	
GNSS-IonosphericModel	KlobucharModelParameter	
	NeQuickModelParameter ⁽¹⁾	
	KlobucharModel2Parameter ⁽²⁾	
NOTE 1: Only required if GNSSs supported include Galileo.		
NOTE 2: Only required if GNSSs supported include BDS B1C.		

d) **GNSS-TimeModelList IE.** This information element is only required for multi system tests, and is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.5: GNSS-TimeModelList IE

Name of the IE	Fields of the IE
GNSS-TimeModelList	
	gnssTOID For each GNSS included in the test.
	deltaT

e) GNSS-NavigationModel IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.6: GNSS-NavigationModel IE

Name of the IE	Fields of the IE
GNSS-NavigationModel	

Table E.7: GNSS Clock and Orbit Model choices

GNSS	Clock and Orbit Model choice
BDS B1I	Model-6
BDS B1C	Model-7
Galileo	Model-1
GLONASS	Model-4
GPS L1 C/A	Model-2
Modernized GPS	Model-3
QZSS QZS-L1 C/A	Model-2
QZSS QZS-L1C/L2C/L5	Model-3
SBAS	Model-5

f) GNSS-AcquisitionAssistance IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.8: GNSS-AcquisitionAssistance IE

Name of the IE	Fields of the IE
GNSS-AcquisitionAssistance	

g) GNSS-Almanac IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.9: GNSS-Almanac IE

Name of the IE	Fields of the IE
GNSS-Almanac	

Table E.10: GNSS Almanac choices

GNSS	Almanac Model choice
BDS B1I	Model-7
BDS B1C	Model-3, 4
Galileo	Model-1
GLONASS	Model-5
GPS L1 C/A	Model-2
Modernized GPS	Model-3, 4
QZSS QZS-L1 C/A	Model-2
QZSS QZS-L1C/L2C/L5	Model-3, 4
SBAS	Model-6

h) GNSS-UTC-Model IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.11: GNSS-UTC-Model IE

Name of the IE	Fields of the IE
GNSS-UTC-Model	

Table E.12: GNSS UTC Model choices

GNSS	UTC Model choice
BDS B1I	Model-5
BDS B1C	Model-2
Galileo	Model-1
GLONASS	Model-3
GPS L1 C/A	Model-1
Modernized GPS	Model-2
QZSS QZS-L1 C/A	Model-1
QZSS QZS-L1C/L2C/L5	Model-2
SBAS	Model-4

i) GNSS-AuxiliaryInformation IE. This information element is defined in clause 6.5.2.2 of TS 36.355 [3].

Table E.13: GNSS-AuxiliaryInformation IE

Name of the IE	Fields of the IE		
GNSS-AuxiliaryInformation			

Annex F (normative): Converting UE-assisted measurement reports into position estimates

42

F.1 Introduction

To convert the UE measurement reports in case of UE-assisted mode of A-GNSS into position errors, a transformation between the "measurement domain" (code-phases, etc.) into the "state" domain (position estimate) is necessary. Such a transformation procedure is outlined in the following clauses. The details can be found in [6-8] and [10-16].

F.2 UE measurement reports

In case of UE-assisted A-GNSS, the measurement parameters are contained in the LPP *GNSS-SignalMeasurementInformation* IE (clause 6.5.2.6 in TS 36.355 [3]). The measurement parameters required for calculating the UE position are:

- 1) Reference Time: The UE has two choices for the Reference Time:
 - a) "networkTime";
 - b) "gnss-TOD-msec".
- 2) Measurement Parameters for each GNSS and GNSS signal: 1 to 64:
 - a) " svID ";
 - b) "codePhase";
 - c) "integerCodePhase";
 - d) "codePhaseRMSError".

Additional information required at the SS:

- 1) "GNSS-ReferenceLocation" (clause 6.5.2.2 in TS 36.355 [3]): Used for initial approximate receiver coordinates.
- "GNSS-NavigationModel" (clause 6.5.2.2 in TS 36.355 [3]): Contains the GNSS ephemeris and clock correction parameters as specified in the relevant ICD of each supported GNSS; used for calculating the satellite positions and clock corrections.
- "GNSS-IonosphericModel" (clause 6.5.2.2 in TS 36.355 [3]): Contains the ionospheric parameters which allow the single frequency user to utilize the ionospheric model as specified in the relevant ICD of each supported GNSS for computation of the ionospheric delay.

F.3 WLS position solution

The WLS position solution problem is concerned with the task of solving for four unknowns; x_u , y_u , z_u the receiver coordinates in a suitable frame of reference (usually ECEF) and b_u the receiver clock bias. It typically requires the following steps:

Step 1: Formation of pseudo-ranges

The observation of code phase reported by the UE for each satellite SV_i is related to the pseudo-range/c modulo the "gnss-CodePhaseAmbiguity". For the formation of pseudo-ranges, the integer number of milliseconds to be added to each code-phase measurement has to be determined first. Since 1 ms corresponds to a travelled distance of 300 km, the number of integer ms can be found with the help of reference location and satellite ephemeris. The distance between the reference location and each satellite SV_i is calculated and the integer number of milli-seconds to be added to the UE code phase measurements is obtained.

Step 2: Correction of pseudo-ranges for the GNSS-GNSS time offsets

In the case that the UE reports measurements for more than a single GNSS, the pseudo-ranges are corrected for the time offsets between the GNSSs relative to the selected reference time using the GNSS-GNSS time offsets available at the SS:

$$\rho_{GNSS_m,i} \equiv \rho_{GNSS_m,i} - c \cdot (t_{GNSS_k} - t_{GNSS_m}),$$

where $\rho_{GNSS_m,i}$ is the measured pseudo-range of satellite *i* of GNSS_m. The system time t_{GNSS_k} of GNSS_k is the reference time frame, and $(t_{GNSS_k} - t_{GNSS_m})$ is the available GNSS-GNSS time offset, and *c* is the speed of light.

Step 3: Formation of weighting matrix

The UE reported "codePhaseRMSError" values are used to calculate the weighting matrix for the WLS algorithm [7]. According to TS 36.355 [3], the encoding for this field is a 6 bit value that consists of a 3 bit mantissa, X_i and a 3 bit exponent, Y_i for each SV_i:

$$w_i = RMSError = 0.5 \times \left(1 + \frac{X_i}{8}\right) \times 2^{Y_i}$$

The weighting Matrix **W** is defined as a diagonal matrix containing the estimated variances calculated from the "codePhaseRMSError" values:

$$\mathbf{W} = \operatorname{diag}\left\{ / w_{GNSS_{1},1}^{2}, 1 / w_{GNSS_{1},2}^{2}, \dots, 1 / w_{GNSS_{1},n}^{2}, \dots, 1 / w_{GNSS_{m},1}^{2}, 1 / w_{GNSS_{m},2}^{2}, \dots, 1 / w_{GNSS_{m},n}^{2} \right\}$$

Step 4: WLS position solution

The WLS position solution is described in reference [7] and usually requires the following steps:

- Computation of satellite locations at time of transmission using the ephemeris parameters and user algorithms defined in the relevant ICD of the particular GNSS. The satellite locations are transformed into WGS-84 reference frame, if needed.
- 2) Computation of clock correction parameters using the parameters and algorithms as defined in the relevant ICD of the particular GNSS.
- 3) Computation of atmospheric delay corrections using the parameters and algorithms defined in the relevant ICD of the particular GNSS for the ionospheric delay, and using the Gupta model in reference [8] p. 121 equation (2) for the tropospheric delay. For GNSSs which do not natively provide ionospheric correction models (e.g., GLONASS), the ionospheric delay is determined using the available ionospheric model adapted to the particular GNSS frequency.
- 4) The WLS position solution starts with an initial estimate of the user state (position and clock offset). The Reference Location is used as initial position estimate. The following steps are required:
 - a) Calculate geometric range (corrected for Earth rotation) between initial location estimate and each satellite included in the UE measurement report.
 - b) Predict pseudo-ranges for each measurement including clock and atmospheric biases as calculated in 1) to 3) above and defined in the relevant ICD of the particular GNSS and [7].
 - c) Calculate difference between predicted and measured pseudo-ranges $\Delta \rho$

d) Calculate the "Geometry Matrix" G as defined in [7]:

$$\mathbf{G} = \begin{bmatrix} -\mathbf{\hat{1}}_{GNSS_{1},1}^{T} & \mathbf{1} \\ -\mathbf{\hat{1}}_{GNSS_{1},2}^{T} & \mathbf{1} \\ \vdots & \vdots \\ -\mathbf{\hat{1}}_{GNSS_{1},n}^{T} & \mathbf{1} \\ \vdots & \vdots \\ -\mathbf{\hat{1}}_{GNSS_{m},1}^{T} & \mathbf{1} \\ -\mathbf{\hat{1}}_{GNSS_{m},2}^{T} & \mathbf{1} \\ \vdots & \vdots \\ -\mathbf{\hat{1}}_{GNSS_{m},2}^{T} & \mathbf{1} \\ \vdots & \vdots \\ -\mathbf{\hat{1}}_{GNSS_{m},2}^{T} & \mathbf{1} \end{bmatrix}$$
 with $\mathbf{\hat{1}}_{GNSS_{m},i} \equiv \frac{\mathbf{r}_{s_{GNSS_{m},i}} - \mathbf{\hat{r}}_{u}}{|\mathbf{r}_{s_{GNSS_{m},i}} - \mathbf{\hat{r}}_{u}|}$ where $\mathbf{r}_{s_{GNSS_{m},i}}$ is the satellite position vector for SV_{i}

of GNSS_m (calculated in 1) above), and $\hat{\mathbf{r}}_{u}$ is the estimate of the user location.

e) Calculate the WLS solution according to [7]:

$$\Delta \hat{\mathbf{x}} = \left(\mathbf{G}^T \mathbf{W} \mathbf{G} \right)^{-1} \mathbf{G}^T \mathbf{W} \Delta \boldsymbol{\rho}$$

f) Adding the $\Delta \hat{\mathbf{x}}$ to the initial state estimate gives an improved estimate of the state vector:

$$\hat{\mathbf{x}} \rightarrow \hat{\mathbf{x}} + \Delta \hat{\mathbf{x}}$$
 .

5) This new state vector $\hat{\mathbf{x}}$ can be used as new initial estimate and the procedure is repeated until the change in $\hat{\mathbf{x}}$ is sufficiently small.

Step 5: Transformation from Cartesian coordinate system to Geodetic coordinate system

The state vector $\hat{\mathbf{x}}$ calculated in Step 4 contains the UE position in ECEF Cartesian coordinates together with the UE receiver clock bias relative to the selected GNSS system time. Only the user position is of further interest. It is usually desirable to convert from ECEF coordinates x_u , y_u , z_u to geodetic latitude $\varphi \square$, longitude λ and altitude h on the WGS-84 reference ellipsoid.

Step 6: Calculation of "2-D Position Errors"

The latitude ϕ / longitude λ obtained after Step 5 is used to calculate the 2-D position error.

Annex G (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2018-11	RAN4#89	R4-1814423				TS baseline created from TS 36.171.	0.1.0
2018-11	RAN4#89	R4-1814424				Updates from e-mail discussion	0.2.0
2018-12	RAN#82	RP-182325				V1.0.0 is submitted to RAN for 1-step approval	1.0.0
2018-12	RAN#82					Approved by plenary – Rel-15 spec under change control	15.0.0
2019-03	RAN#83	RP-190402	0001	1	F	CR on A-GNSS in 38.171	15.1.0
2019-12	RAN#86	RP-193002	8000	1	F	CR to TS 38.171: Corrections to A-GNSS requirements with NR	15.2.0
2020-03	RAN#87	RP-200409	0009	1	F	Update of the Note 1 in the Power level and satellite allocation table for the Sensitivity Coarse time assistance requirements	15.3.0
2020-03	RAN#87	RP-200409	0010		F	Editorial change to TS 37.571-1 title	15.3.0
2020-06	RAN#88	RP-201055	0011	1	В	CR for TS38.171, Introduction of BDS B1C in A-GNSS	16.0.0
2021-06	RAN#92	RP-211077	0012		F	Addition of missing data for BDS B1C	16.1.0
2021-09	RAN#93	RP-211925	0015		F	Big CR to TS 38.171 on requirements maintenance (Rel-16)	16.2.0
2021-12	RAN#94	RP-212853	0016		F	Frequency bands for testing of A-GNSS sensitivity requirements	16.3.0
2022-06	RAN#96	RP-221653	0017		F	CR on TS 38.171 requirements for support of A-GNSS	16.4.0

History

Document history				
V16.0.0	July 2020	Publication		
V16.1.0	September 2021	Publication		
V16.2.0	November 2021	Publication		
V16.3.0	March 2022	Publication		
V16.4.0	August 2022	Publication		