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Technical Specification

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Assisted Global Positioning System (A-GPS) Performance
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3GPP

Postal address

3GPP support office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet
http://www.3gpp.org

Contents

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:
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- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
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1 Scope

The present document specifies the measurement procedures for the conformance test of the user equipment (UE) that supports Assisted Global Positioning System (A-GPS).

Tests are only applicable to those mobiles that are intended to support the appropriate functionality. To indicate the circumstances in which tests apply, this is noted in the ì*definition and applicability*î part of the test.

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.

- For a Release 1999 UE, references to 3GPP documents are to version 3.x.y.
- For a Release 4 UE, references to 3GPP documents are to version 4.x.y.
- For a Release 5 UE, references to 3GPP documents are to version 5.x.y.
- For a Release 6 UE, references to 3GPP documents are to version 6.x.y.

[1] 3GPP TR 21.905 "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 25.990 "Vocabulary".

[3] 3GPP TS 34.108 "Common Test Environments for User Equipment (UE) Conformance Testing".

[4] 3GPP TS 34.109 "Terminal logical test interface; Special conformance testing functions".

[5] 3GPP TS 25.331: "Radio Resource Control (RRC); Protocol Specification".

[6] 3GPP TS 25.171: "Requirements for support of A-GPS (FDD)".

[7] 3GPP TS 25.302: ì Services provided by the physical layerî .

[8] Navstar GPS Space Segment/Navigation User Interfaces, ICD-GPS 200, Rev. C.

[9] 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.

[10] S.K. Gupta, "Test and Evaluation Procedures for the GPS User Equipment", ION-GPS Red Book, Volume 1, p. 119.

[11] 3GPP TS 25.215: "Physical Layer ñ Measurements (FDD)".

3 Definitions, symbols, abbreviations and equations

Definitions, symbols, abbreviations and equations used in the present document are listed in TR 21.905 [1] and TR 25.990 [2].

Terms are listed in alphabetical order in this clause.

3.1 Definitions

For the purpose of the present document, the following additional terms and definitions apply:

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

3.2 Symbols

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

[Ö] Values included in square bracket must be considered for further studies, because it means that a decision about that value was not taken

3.3 Abbreviations

For the purpose of the present document, the following additional abbreviations apply:

A-GPS	Assisted - Global Positioning System
AWGN	Additive White Gaussian Noise
ECEF	Earth Centred, Earth Fixed
GPS	Global Positioning System
GSS	GPS System Simulator
HDOP	Horizontal Dilution Of Precision
LOS	Line Of Sight
OCNS	Orthogonal Channel Noise Simulator, a mechanism used to simulate the users or control signals on the other orthogonal channels of a downlink
SS	System Simulator; see Annex A for description
WLS	Weighted Least Square

3.4 Equations

For the purpose of the present document, the following additional equations apply:

FFS

4 General test conditions

4.1 GPS test conditions

4.1.1 GPS signals

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

4.1.2 UE location

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 (defined in TS 34.108 [3] clause 10.6). The Altitude of the UE shall be randomly selected between 0 m to 1 000 m above WGS-84 reference ellipsoid. These values shall have uniform random distributions.

4.2 UTRA test conditions

4.2.1 UTRA frequency band and frequency range

The tests in the present document are performed at mid range of the UTRA operating frequency band of the UE. The UARFCNs to be used for mid range are defined in TS 34.108 [3] clause 5.1.1. [Editorís note: if multiple bands are supported, do we repeat tests in each band? If not, which band do we choose?]

4.2.2 UTRA frequency

For all tests the UTRA frequency shall be offset with respect to the GPS carrier frequency by +0.025 PPM. [Editorís note: more detail is required here]

5 Performance requirements for A-GPS

5.1 General

This section defines the minimum performance requirements for both UE based and UE assisted FDD A-GPS terminals. If a terminal supports both modes then it shall be tested in both modes.

The requirements are defined for CELL_DCH and CELL_FACH states. The requirements for CELL_PCH and URA_PCH states are for further study.

5.1.1 Measurement parameters

5.1.1.1 UE based A-GPS measurement parameters

In case of UE-based A-GPS, the measurement parameters are contained in the RRC UE POSITIONING POSITION ESTIMATE INFO IE. The measurement parameter is the horizontal position estimate reported by the UE and expressed in latitude/longitude.

5.1.1.2 UE assisted A-GPS measurement parameters

In case of UE-assisted A-GPS, the measurement parameters are contained in the RRC UE POSITIONING GPS MEASURED RESULTS IE. The measurement parameters are the UE GPS Code Phase measurements, as specified in 3GPP TS 25.302 [7] and 3GPP TS 25.215 [11]. The UE GPS Code Phase measurements are converted into a horizontal position estimate using the procedure detailed in Annex B.

5.1.1.3 2D position error

The 2D position error is defined by the horizontal difference in meters between the ellipsoid point reported or calculated from the UE Measurement Report and the actual simulated position of the UE in the test case considered.

5.1.1.4 Response time

Max Response Time is defined as the time starting from the moment that the UE has received the final RRC measurement control message containing reporting criteria different from "No Reporting" sent before the UE sends the measurement report containing the position estimate or the GPS measured result, and ending when the UE starts sending the measurement report containing the position estimate or the GPS measured result on the Uu interface. The response times specified for all test cases are Time-to-First-Fix (TTFF) unless otherwise stated, i.e. the UE shall not re-use any information on GPS 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' specified in 3GPP TS 34.109 [4] clause 5.4 has been defined for the purpose of deleting this information.

5.2 Sensitivity

5.2.1 Sensitivity Coarse Time Assistance

5.2.1.1 Definition and applicability

Sensitivity with coarse time assistance is the minimum level of GPS satellite signals required for the UE to make an A-GPS position estimate to a specific accuracy and within a specific response time when the network only provides coarse time assistance.

The requirements and this test apply to all types of UTRA for the FDD UE that supports A-GPS.

5.2.1.2 Minimum requirements

The first fix position estimates shall meet the accuracy and response time requirements in table 5.2.1.2 for the parameters specified in table 5.2.1.1.

Table 5.2.1.1: Test parameters for Sensitivity Coarse Time Assistance

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GPS Coarse Time assistance accuracy	seconds	±2
GPS Signal for one satellite	dBm	-142
GPS Signal for remaining satellites	dBm	-147

Table 5.2.1.2: Minimum requirements for Sensitivity Coarse Time Assistance

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

The reference for this requirement is TS 25.171 [6] clause 5.1.1.1.

5.2.1.3 Test purpose

To verify the UEís first position estimate meets the minimum requirements under GPS satellite signal conditions that represent weak signal conditions and with only Coarse Time Assistance provided by the SS.

5.2.1.4 Method of test

5.2.1.4.1 Initial conditions

Test environment: [FFS]; see clause E.2.

1. Connect SS and GSS to the UE antenna connector or antenna connectors as shown in figure A.1 or A.2.
2. Set the test parameters as specified in table 5.2.1.3.
3. For UE based testing prepare assistance data as specified in TS 34.108 [3] clause 10.2 and 10.6 for UE based testing

   or

For UE assisted testing prepare assistance data as specified in TS 34.108 [3] clause 10.4 and 10.6 for UE assisted testing

4. Switch on the UE
5. Set up a call using the procedure in Annex D.2.

5.2.1.4.2 Procedure

1. Set up a Location Request using the procedure in Annex D.3
2. Send a RESET UE POSITIONING STORED INFORMATION message and assistance data as required to obtain a fix as specified in TS 34.108 [3] subclause 7.5.1 or 7.5.4
3. For UE based testing compare the results against the values in table 5.2.1.4

   or

   For UE assisted testing convert the GPS measured results to a 2D position using the method described in Annex B and then compare the results against the values in table 5.2.1.4.
4. [The remainder of the procedure is FFS]

5.2.1.5 Test Requirements

For the parameters specified in table 5.2.1.3 the UE shall meet the requirements and the success rate specified in table 5.2.1.4 with a confidence level of TBD%.

Table 5.2.1.3: Test parameters for Sensitivity Coarse Time Assistance

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1+TT to 1.6+TT
Propagation conditions	-	AWGN
GPS Coarse Time assistance accuracy	seconds	±2+TT
GPS Signal for one satellite	dBm	-142+TT
GPS Signal for remaining satellites	dBm	-147+TT

Table 5.2.1.4: Test requirements for Sensitivity Coarse Time Assistance

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

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test is defined in clause F.2 and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in clause F.4.

5.2.2 Sensitivity Fine Time Assistance

5.2.2.1 Definition and applicability

Sensitivity with fine time assistance is the minimum level of GPS satellite signals required for the UE to make an A-GPS position estimate to a specific accuracy and within a specific response time when the network provides fine time assistance in addition to coarse time assistance.

The requirements and this test apply to all types of UTRA for the FDD UE that supports A-GPS and that is capable of providing an enhanced performance when the network provides Fine Time Assistance.

5.2.2.2 Minimum requirements

The first fix position estimates shall meet the accuracy and response time requirements in table 5.2.2.2 for the parameters specified in table 5.2.2.1.

Table 5.2.2.1: Test parameters for Sensitivity Fine Time Assistance

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GPS Fine Time assistance accuracy	μs	±10
GPS Signal for all satellites	dBm	-147

Table 5.2.2.2: Minimum requirements for Sensitivity Fine Time Assistance

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

The reference for this requirement is TS 25.171 [6] clause 5.1.2.1.

5.2.2.3 Test purpose

To verify the UEís first position estimate meets the minimum requirements under GPS satellite signal conditions that represent weak signal conditions and with Fine Time Assistance provided by the SS.

5.2.2.4 Method of test

5.2.2.4.1 Initial conditions

Test environment: [FFS]; see clause E.2.

1. Connect SS and GSS to the UE antenna connector or antenna connectors as shown in figure A.1 or A.2.
2. Set the test parameters as specified in table 5.2.2.3.
3. For UE based testing prepare assistance data as specified in TS 34.108 [3] clause 10.3 and 10.6 for UE based testing

   or

   For UE assisted testing prepare assistance data as specified in TS 34.108 [3] clause 10.5 and 10.6 for UE assisted testing
4. Switch on the UE
5. Set up a call using the procedure in Annex D.2.

5.2.2.4.2 Procedure

1. Set up a Location Request using the procedure in Annex D.3
2. Send a RESET UE POSITIONING STORED INFORMATION message and assistance data as required to obtain a fix as specified in TS 34.108 [3] subclause 7.5.1 or 7.5.4
3. For UE based testing compare the results against the values in table 5.2.2.4

   or

For UE assisted testing convert the GPS measured results to a 2D position using the method described in Annex B and then compare the results against the values in table 5.2.2.4.

4. [The remainder of the procedure is FFS]

5.2.2.5 Test Requirements

For the parameters specified in table 5.2.2.3 the UE shall meet the requirements and the success rate specified in table 5.2.2.4 with a confidence level of TBD%.

Table 5.2.2.3: Test parameters for Sensitivity Fine Time Assistance

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1+TT to 1.6+TT
Propagation conditions	-	AWGN
GPS Fine Time assistance accuracy	μs	±10+TT
GPS Signal for all satellites	dBm	-147+TT

Table 5.2.2.4: Test requirements for Sensitivity Fine Time Assistance

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

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test is defined in clause F.2 and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in clause F.4.

5.3 Nominal Accuracy

5.3.1 Definition and applicability

Nominal accuracy is the accuracy of the UEís A-GPS position estimate under ideal GPS signal conditions.

The requirements and this test apply to all types of UTRA for the FDD UE that supports A-GPS.

5.3.2 Minimum requirements

The first fix position estimates shall meet the accuracy and response time requirements in table 5.3.2 for the parameters specified in table 5.3.1.

Table 5.3.1: Test parameters for Nominal Accuracy

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1 to 1.6
Propagation conditions	-	AWGN
GPS Coarse Time assistance accuracy	seconds	±2
GPS Signal for all satellites	dBm	-130

Table 5.3.2: Minimum requirements for Nominal Accuracy

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

The reference for this requirement is TS 25.171 [6] clause 5.2.1.

5.3.3 Test purpose

To verify the UEís first position estimate meets the minimum requirements under GPS satellite signal conditions that represent ideal conditions.

5.3.4 Method of test

5.3.4.1 Initial conditions

Test environment: [FFS]; see clause E.2.

1. Connect SS and GSS to the UE antenna connector or antenna connectors as shown in figure A.1 or A.2.
2. Set the test parameters as specified in table 5.3.3.
3. For UE based testing prepare assistance data as specified in TS 34.108 [3] clause 10.2 and 10.6 for UE based testing

   or

   For UE assisted testing prepare assistance data as specified in TS 34.108 [3] clause 10.4 and 10.6 for UE assisted testing
4. Switch on the UE
5. Set up a call using the procedure in Annex D.2.

5.3.4.2 Procedure

1. Set up a Location Request using the procedure in Annex D.3
2. Send a RESET UE POSITIONING STORED INFORMATION message and assistance data as required to obtain a fix as specified in TS 34.108 [3] subclause 7.5.1 or 7.5.4
3. For UE based testing compare the results against the values in table 5.3.4

   or

   For UE assisted testing convert the GPS measured results to a 2D position using the method described in Annex B and then compare the results against the values in table 5.3.4.
4. [The remainder of the procedure is FFS]

5.3.5 Test Requirements

For the parameters specified in table 5.3.3 the UE shall meet the requirements and the success rate specified in table 5.3.4 with a confidence level of TBD%.

Table 5.3.3: Test parameters for Nominal Accuracy

Parameters	Unit	Value
Number of generated satellites	-	8
HDOP Range	-	1.1+TT to 1.6+TT
Propagation conditions	-	AWGN
GPS Coarse Time assistance accuracy	seconds	±2+TT
GPS Signal for all satellites	dBm	-130+TT

Table 5.3.4: Test requirements for Nominal Accuracy

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

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test is defined in clause F.2 and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in clause F.4.

5.4 Dynamic Range

5.4.1 Definition and applicability

Dynamic Range is the maximum difference in level of the GPS signals from a number of satellites that allows the UE to make an A-GPS position estimate with a specific accuracy and a specific response time.

The requirements and this test apply to all types of UTRA for the FDD UE that supports A-GPS.

5.4.2 Minimum requirements

The first fix position estimates shall meet the accuracy and response time requirements in table 5.4.2 for the parameters specified in table 5.4.1.

Table 5.4.1: Test parameters for Dynamic Range

Parameters	Unit	Value
Number of generated satellites	-	6
HDOP Range	-	1.4 to 2.1
GPS Coarse Time assistance accuracy	seconds	±2
Propagation conditions	-	AWGN
GPS Signal for 1st satellite	dBm	-129
GPS Signal for 2nd satellite	dBm	-135
GPS Signal for 3rd satellite	dBm	-141
GPS Signal for 4th satellite	dBm	-147
GPS Signal for 5th satellite	dBm	-147
GPS Signal for 6th satellite	dBm	-147

Table 5.4.2: Minimum requirements for Dynamic Range

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

The reference for this requirement is TS 25.171 [6] clause 5.3.1.

5.4.3 Test purpose

To verify the UEís first position estimate meets the minimum requirements under GPS satellite signal conditions that have a wide dynamic range. Strong satellites are likely to degrade the acquisition of weaker satellites due to their cross-correlation products.

5.4.4 Method of test

5.4.4.1 Initial conditions

Test environment: [FFS]; see clause E.2.

1. Connect SS and GSS to the UE antenna connector or antenna connectors as shown in figure A.1 or A.2.
2. Set the test parameters as specified in table 5.4.3.
3. For UE based testing prepare assistance data as specified in TS 34.108 [3] clause 10.2 and 10.6 for UE based testing

   or

   For UE assisted testing prepare assistance data as specified in TS 34.108 [3] clause 10.4 and 10.6 for UE assisted testing
4. Switch on the UE
5. Set up a call using the procedure in Annex D.2.

5.4.4.2 Procedure

1. Set up a Location Request using the procedure in Annex D.3
2. Send a RESET UE POSITIONING STORED INFORMATION message and assistance data as required to obtain a fix as specified in TS 34.108 [3] subclause 7.5.1 or 7.5.4
3. For UE based testing compare the results against the values in table 5.4.4

   or

   For UE assisted testing convert the GPS measured results to a 2D position using the method described in Annex B and then compare the results against the values in table 5.4.4.
4. [The remainder of the procedure is FFS]

5.4.5 Test Requirements

For the parameters specified in table 5.4.3 the UE shall meet the requirements and the success rate specified in table 5.4.4 with a confidence level of TBD%.

Table 5.4.3: Test parameters for Dynamic Range

Parameters	Unit	Value
Number of generated satellites	-	6
HDOP Range	-	1.4+TT to 2.1+TT
GPS Coarse Time assistance accuracy	seconds	±2+TT
Propagation conditions	-	AWGN
GPS Signal for 1st satellite	dBm	-129+TT
GPS Signal for 2nd satellite	dBm	-135+TT
GPS Signal for 3rd satellite	dBm	-141+TT
GPS Signal for 4th satellite	dBm	-147+TT
GPS Signal for 5th satellite	dBm	-147+TT
GPS Signal for 6th satellite	dBm	-147+TT

Table 5.4.4: Test requirements for Dynamic Range

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

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test is defined in clause F.2 and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in clause F.4.

5.5 Multi-path Performance

5.5.1 Definition and applicability

Multi-path performance measures the accuracy and response time of the UEís A-GPS position estimate in a specific GPS signal multi-path environment.

The requirements and this test apply to all types of UTRA for the FDD UE that supports A-GPS.

5.5.2 Minimum requirements

The first fix position estimates shall meet the accuracy and response time requirements in table 5.5.2 for the parameters specified in table 5.5.1.

Table 5.5.1: Test parameters for Multi-path Performance

Parameters	Unit	Value
Number of generated satellites (Note)	-	5
GPS Coarse Time assistance accuracy	seconds	±2
HDOP Range	-	1.8 to 2.5
GPS signal for Satellite 1, 2 (Note)	dBm	-130
GPS signal for Satellite 3, 4, 5 (Note)	dBm	LOS signal of -130 dBm, multi-path signal of -136 dBm
Note: Satellites 1, 2 no multi-path. Satellites 3, 4, 5 multi-path defined in clause D.3.2.		

Table 5.5.2: Minimum requirements for Multi-path Performance

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

The reference for this requirement is TS 25.171 [6] clause 5.4.1.

5.5.3 Test purpose

To verify the UEís first position estimate meets the minimum requirements under GPS satellite signal conditions that represent simple multi-path conditions.

5.5.4 Method of test

5.5.4.1 Initial conditions

Test environment: [FFS]; see clause E.2.

1. Connect SS and GSS to the UE antenna connector or antenna connectors as shown in figure A.1 or A.2.
2. Set the test parameters as specified in table 5.5.3.
3. For UE based testing prepare assistance data as specified in TS 34.108 [3] clause 10.2 and 10.6 for UE based testing

   or

   For UE assisted testing prepare assistance data as specified in TS 34.108 [3] clause 10.4 and 10.6 for UE assisted testing
4. Switch on the UE
5. Set up a call using the procedure in Annex D.2.

5.5.4.2 Procedure

1. Set up a Location Request using the procedure in Annex D.3
2. Send a RESET UE POSITIONING STORED INFORMATION message and assistance data as required to obtain a fix as specified in TS 34.108 [3] subclause 7.5.1 or 7.5.4
3. For UE based testing compare the results against the values in table 5.5.4

   or

   For UE assisted testing convert the GPS measured results to a 2D position using the method described in Annex B and then compare the results against the values in table 5.5.4.
4. [The remainder of the procedure is FFS]

5.5.5 Test Requirements

For the parameters specified in table 5.5.3 the UE shall meet the requirements and the success rate specified in table 5.5.4 with a confidence level of TBD%.

Table 5.5.3: Test parameters for Multi-path Performance

Parameters	Unit	Value
Number of generated satellites (Note)	-	5
GPS Coarse Time assistance accuracy	seconds	±2+TT
HDOP Range	-	1.8+TT to 2.5+TT
GPS signal for Satellite 1, 2 (Note)	dBm	-130+TT
GPS signal for Satellite 3, 4, 5 (Note)	dBm	LOS signal of -130 +TT dBm, multi-path signal of -136+TT dBm
Note: Satellites 1, 2 no multi-path. Satellites 3, 4, 5 multi-path defined in clause D.3.2.		

Table 5.5.4: Test requirements for Multi-path Performance

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

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test is defined in clause F.2 and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in clause F.4.

5.6 Moving Scenario and Periodic Update Performance

5.6.1 Definition and applicability

Moving scenario and periodic update performance measures the accuracy of the UEís A-GPS position estimates and the periodic update capability of the UE in a moving scenario.

The requirements and this test apply to all types of UTRA for the FDD UE that supports A-GPS.

5.6.2 Minimum requirements

The position estimates, after the first reported position estimate, shall meet the accuracy requirement in table 5.6.2 with the periodical reporting interval of 2 seconds for the parameters specified in table 5.6.1.

NOTE: In the actual testing the UE may report error messages until it has been able to acquire GPS measured results or a position estimate. The SS shall only consider the first measurement report different from an error message as the first position estimate in the requirement in table 5.6.2.

Table 5.6.1: Test parameters for Moving Scenario and Periodic Update Performance

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

Table 5.6.2: Minimum requirements for Moving Scenario and Periodic Update Performance

Success Rate	2-D position error
95 %	100 m

The reference for this requirement is TS 25.171 [6] clause 5.5.1.

5.6.3 Test purpose

To verify the UEís position estimates, after the first reported position estimate, meet the minimum requirements under GPS satellite signal conditions that simulate a moving scenario. A good tracking performance, with regular position estimate reporting is essential for certain location services

5.6.4 Method of test

5.6.4.1 Initial conditions

Test environment: [FFS]; see clause E.2.

The UE is requested to use periodical reporting with a reporting interval of 2 seconds.

The GPS signals simulate the UE moving on a rectangular trajectory of 940 m by 1 440 m with rounded corners defined in figure 5.6.1 and table 5.6.3. 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.

Table 5.6.3: Trajectory Parameters for Moving Scenario and Periodic Update Performance test case

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

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Figure 5.6.1: Rectangular Trajectory for Moving Scenario and Periodic Update Performance test case

1. Connect SS and GSS to the UE antenna connector or antenna connectors as shown in figure A.1 or A.2.
2. Set the test parameters as specified in table 5.6.4.
3. For UE based testing prepare assistance data as specified in TS 34.108 [3] clause 10.2 and 10.6 for UE based testing

   or

   For UE assisted testing prepare assistance data as specified in TS 34.108 [3] clause 10.4 and 10.6 for UE assisted testing
4. Switch on the UE
5. Set up a call using the procedure in Annex D.2.

5.6.4.2 Procedure

1. Set up a Location Request using the procedure in Annex D.3
2. Send a RESET UE POSITIONING STORED INFORMATION message [Editorís note: in TS 34.108 [3] clause 7.5.2 there is no RESET message. I think this is an error in 25.171] and assistance data as required to obtain a fix as specified in TS 34.108 [3] subclause 7.5.2 or 7.5.5
3. Ignore any error messages that the UE may report until it has been able to acquire the GPS signals and reports the first GPS measured result or position estimate
4. Discard the first measured result or position estimate
5. For UE based testing compare the subsequent results against the value in table 5.6.5

   or

For UE assisted testing convert the subsequent GPS measured results to 2D positions using the method described in Annex B and then compare the results against the value in table 5.6.5.

6. [The remainder of the procedure is FFS]

5.6.5 Test Requirements

For the parameters specified in table 5.6.4, after the first reported position estimate, the UE shall meet the accuracy requirement and the success rate specified in table 5.6.5 with a periodical reporting interval of 2 seconds and with a confidence level of TBD%.

Table 5.6.4: Test parameters for Moving Scenario and Periodic Update Performance

Parameters	Unit	Value
Number of generated satellites	-	5
HDOP Range	-	1.8+TT to 2.5+TT
Propagation condition	-	AWGN
GPS signal for all satellites	dBm	-130+TT

Table 5.6.5: Test requirements for Moving Scenario and Periodic Update Performance

Success Rate	2-D position error
95 %	100+TT m

NOTE: If the above Test Requirement differs from the Minimum Requirement then the Test Tolerance applied for this test is non-zero. The Test Tolerance for this test is defined in clause F.2 and the explanation of how the Minimum Requirement has been relaxed by the Test Tolerance is given in clause F.4.

NOTE: In the actual testing the UE may report error messages until it has been able to acquire GPS 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 5.6.5.

Annex A (informative): Connection Diagrams

Definition of Terms

System Simulator or SS ñ A device or system, that is capable of generating simulated Node B signalling and analysing UE signalling responses on one RF channel, in order to create the required test environment for the UE under test. It will also include the following capabilities:

1. Control of the UE Tx output power through TPC commands
2. Measurement of signalling timing and delays
4. Ability to simulate UTRAN signalling

GPS System Simulator or GSS ñ A device or system, that is capable of generating simulated GPS satellite transmissions in order to create the required test environment for the UE under test. It will also include the following capabilities:

1. Control of the output power of individual satellites and the simulation of atmospheric delays and multi-path
2. Generation of appropriate assistance data to be transmitted to the UE via the SS.
3. Ability to synchronise with UTRAN timing in the SS

Test System ñ A combination of devices brought together into a system for the purpose of making one or more measurements on a UE in accordance with the test case requirements. The following diagrams are all examples of Test Systems.

Note: The above terms are logical definitions to be used to describe the test methods used in this document, in practice, real devices called 'System Simulators' may also include additional measurement capabilities or may only support those features required for the test cases they are designed to perform.

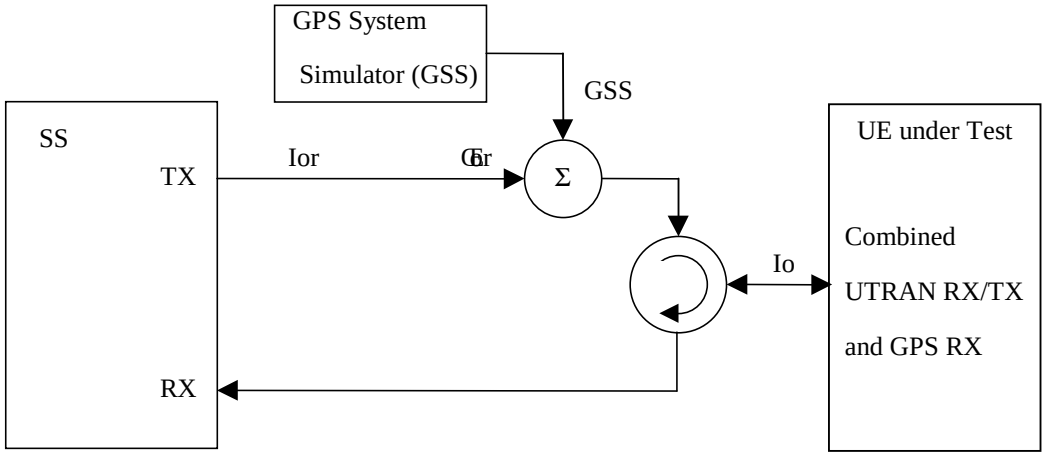

Figure A.1: Connection for A-GPS Performance requirements tests for UE with combined UTRAN / GPS antenna

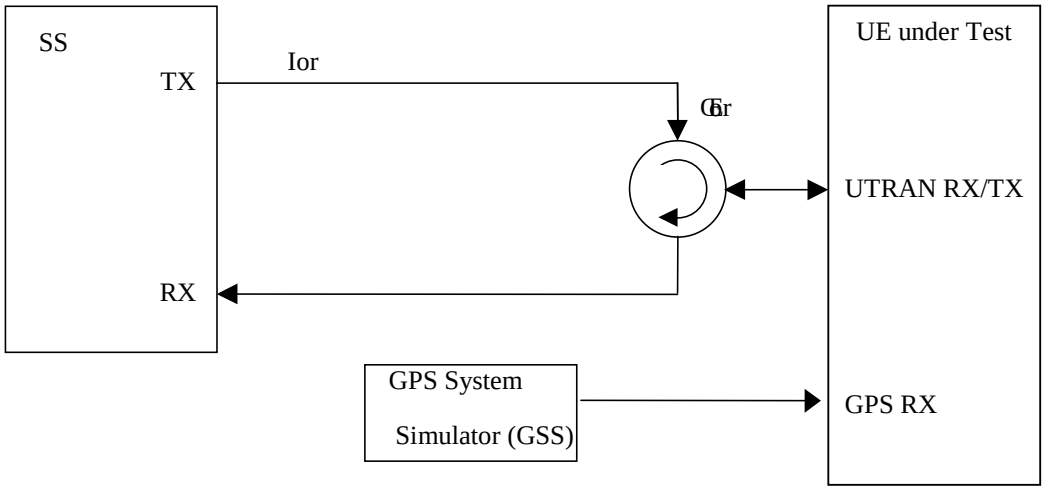

Figure A.2: Connection for A-GPS Performance requirements tests for UE with separate UTRAN and GPS antennas

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

B.1 Introduction

To convert the UE measurement reports in case of UE-assisted mode of A-GPS 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 [8], [9] and [10].

B.2 UE measurement reports

In case of UE-assisted A-GPS, the measurement parameters are contained in the RRC UE POSITIONING GPS MEASURED RESULTS IE (subclause 10.3.7.93 in 3GPP TS 25.331 [5]). The measurement parameters required for calculating the UE position are:

1) Reference Time: The UE has two choices for the Reference Time:
   a) "UE GPS timing of cell frames";
   b) "GPS TOW msec".
2) Measurement Parameters: 1 to <maxSat>:
   a) "Satellite ID (SV PRN)";
   b) "Whole GPS chips";
   c) "Fractional GPS Chips";
   d) "Pseudorange RMS Error".

Additional information required at the system simulator:

1) "UE positioning GPS reference UE position" (subclause 10.3.8.4c in 3GPP TS 25.331 [5]):
   Used for initial approximate receiver coordinates.
2) "UE positioning GPS navigation model" (subclause 10.3.7.94 in 3GPP TS 25.331 [5]):
   Contains the GPS ephemeris and clock correction parameters as specified in [8]; used for calculating the satellite positions and clock corrections.
3) "UE positioning GPS ionospheric model" (subclause 10.3.7.92 in 3GPP TS 25.331 [5]):
   Contains the ionospheric parameters which allow the single frequency user to utilize the ionospheric model as specified in [8] for computation of the ionospheric delay.

B.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 1 ms (the length of the C/A code period). 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: Formation of weighting matrix

The UE reported "Pseudorange RMS Error" values are used to calculate the weighting matrix for the WLS algorithm [9]. According to 3GPP TS 25.331 [5], 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 "Pseudorange RMS Error" values:

$$\mathbf{W} = \mathrm{diag}\left\{1/w_1^2, 1/w_2^2, \cdots, 1/w_n^2\right\}$$

Step 3: WLS position solution

The WLS position solution is described in reference [9] and usually requires the following steps:

1) Computation of satellite locations at time of transmission using the ephemeris parameters and user algorithms defined in [8] section 20.3.3.4.3.

2) Computation of clock correction parameters using the parameters and algorithms as defined in [8] section 20.3.3.3.3.1.

3) Computation of atmospheric delay corrections using the parameters and algorithms defined in [8] section 20.3.3.5.2.5 for the ionospheric delay, and using the Gupta model in reference [10] p. 121 equation (2) for the tropospheric delay.

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 [8] and [9].

   c) Calculate difference between predicted and measured pseudo-ranges $\Delta\boldsymbol{\rho}$

   d) Calculate the "Geometry Matrix" **G** as defined in [9]:

$$\mathbf{G} \equiv \begin{bmatrix} -\hat{\mathbf{l}}_1^T & 1 \\ -\hat{\mathbf{l}}_2^T & 1 \\ \vdots & \vdots \\ -\hat{\mathbf{l}}_n^T & 1 \end{bmatrix} \text{ with } \hat{\mathbf{l}}_i \equiv \frac{\mathbf{r}_{si} - \hat{\mathbf{r}}_u}{\left|\mathbf{r}_{si} - \hat{\mathbf{r}}_u\right|}$$ where $\mathbf{r}_{si}$ is the Satellite position vector for SV_i (calculated in 1) above), and $\hat{\mathbf{r}}_u$ is the estimate of the user location.

e) Calculate the WLS solution according to [9]:

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

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 4: Transformation from Cartesian coordinate system to Geodetic coordinate system

The state vector $\hat{\mathbf{x}}$ calculated in Step 3 contains the UE position in ECEF Cartesian coordinates together with the UE receiver clock bias. 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 φ , longitude λ and altitude h on the WGS84 reference ellipsoid.

Step 5: Calculation of "2-D Position Errors"

The latitude φ / longitude λ obtained after Step 4 is used to calculate the 2-D position error.

Annex C (normative): Propagation Conditions

C.1 General

C.2 Propagation Conditions for GPS Signals

C.2.1 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.2.2 Multi-path conditions

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 GPS L1 signal are defined in table D.2.2.1.

Table D.2.2.1: Multi-path Conditions for GPS Signals

Initial relative Delay [GPS chip]	Carrier Doppler frequency of tap [Hz]	Code Doppler frequency of tap [Hz]	Relative mean Power [dB]
0	Fd	Fd / N	0
0.5	Fd - 0.1	(Fd-0.1) /N	-6
NOTE: Discrete Doppler frequency is used for each tap.			

$N = f_{GPSL1}/f_{chip}$, where f_{GPSL1} is the nominal carrier frequency of the GPS L1 signal and f_{chip} is the GPS L1 C/A code chip rate.

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

Annex D (normative): Set up procedures

D.1 General

This normative annex specifies the set up procedures that shall be used for each test case

D.2 UTRAN Call set up

[FFS]

D.3 Location Request set up

[FFS]

Annex E (normative): Environmental conditions

E.1 General

This normative annex specifies the environmental requirements of the UE. Within these limits the requirements of the present documents shall be fulfilled.

E.2 Environmental requirements

The requirements in this clause apply to all types of UE(s)

E.2.1 Temperature

The UE shall fulfil all the requirements in the full temperature range of:

Table E.2.1.1

+15°C to + 35°C	for normal conditions (with relative humidity of 25 % to 75 %)
–10°C to + 55°C	for extreme conditions (see IEC publications 68-2-1 and 68-2-2)

Some tests in the present document may be performed also in extreme temperature conditions. These test conditions are denoted as TL (temperature low, -10*C) and TH (temperature high, +55*C).

E.2.2 Voltage

The UE shall fulfil all the requirements in the full voltage range, i.e. the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shutdown voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified below.

Table E.2.2.1

Power source	Lower extreme voltage	Higher extreme voltage	Normal conditions voltage
AC mains	0.9 * nominal	1.1 * nominal	nominal
Regulated lead acid battery	0.9 * nominal	1.3 * nominal	1.1 * nominal
Non regulated batteries: - LeclanchÈ / lithium - Mercury/nickel & cadmium	 0.85 * nominal 0.90 * nominal	 Nominal Nominal	 Nominal Nominal

Some tests in the present document may be performed also in extreme voltage conditions. These test conditions are denoted as VL (lower extreme voltage) and VH (higher extreme voltage).

Annex F (normative): General test conditions and declarations

The requirements of this clause apply to all applicable tests in the present document.

In all the relevant clauses in this clause all 2 D position error measurements shall be carried out according to the general rules for statistical testing in clause F.6.

F.1 Acceptable uncertainty of Test System

The maximum acceptable uncertainty of the Test System is specified below for each test, where appropriate. The Test System shall enable the stimulus signals in the test case to be adjusted to within the specified range, and the equipment under test to be measured with an uncertainty not exceeding the specified values. All ranges and uncertainties are absolute values, and are valid for a confidence level of 95 %, unless otherwise stated.

A confidence level of 95 % is the measurement uncertainty tolerance interval for a specific measurement that contains 95 % of the performance of a population of test equipment.

It should be noted that the uncertainties in clause F.1 apply to the Test System operating into a nominal 50 ohm load and do not include system effects due to mismatch between the DUT and the Test System.

F.1.1 Measurement of test environments

The measurement accuracy of the UE test environments defined in annex E, Test environments shall be.

- Pressure ±5 kPa.
- Temperature ±2 degrees.
- Relative Humidity ±5 %.
- DC Voltage ±1,0 %.
- AC Voltage ±1,5 %.
- Vibration 10 %.
- Vibration frequency 0,1 Hz.

The above values shall apply unless the test environment is otherwise controlled and the specification for the control of the test environment specifies the uncertainty for the parameter.

F.1.2 A-GPS Performance requirements

Table F.1.2: Maximum Test System Uncertainty for A-GPS Performance tests

Clause	Maximum Test System Uncertainty	Derivation of Test System Uncertainty
5.2.1 Sensitivity Coarse Time Assistance	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Relative GPS signal level FFS Position error FFS Response time FFS	FFS
5.2.2 Sensitivity Fine Time Assistance	HDOP FFS Coarse Time Assistance FFS Fine Time Assistance FFS Absolute GPS signal level FFS Position error FFS Response time FFS	FFS
5.3 Nominal Accuracy	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Position error FFS Response time FFS	FFS
5.4 Dynamic Range	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Relative GPS signal level FFS Position error FFS Response time FFS	FFS
5.5 Multi-path Performance	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Relative GPS signal level FFS Position error FFS Response time FFS	FFS
5.6 Moving Scenario and Periodic Update Performance	HDOP FFS Absolute GPS signal level FFS Position error FFS	FFS

F.2 Test Tolerances (This clause is informative)

The Test Tolerances defined in this clause have been used to relax the Minimum Requirements in the present document to derive the Test Requirements.

The Test Tolerances are derived from Test System uncertainties, regulatory requirements and criticality to system performance. As a result, the Test Tolerances may sometimes be set to zero.

The test tolerances should not be modified for any reason e.g. to take account of commonly known test system errors (such as mismatch, cable loss, etc.).

F.2.1 A-GPS Performance requirements

Table F.2.1: Test Tolerances for A-GPS Performance tests

Clause	Test Tolerance
5.2.1 Sensitivity Coarse Time Assistance	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Relative GPS signal level FFS Position error FFS Response time FFS
5.2.2 Sensitivity Fine Time Assistance	HDOP FFS Coarse Time Assistance FFS Fine Time Assistance FFS Absolute GPS signal level FFS Position error FFS Response time FFS
5.3 Nominal Accuracy	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Position error FFS Response time FFS
5.4 Dynamic Range	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Relative GPS signal level FFS Position error FFS Response time FFS
5.5 Multi-path Performance	HDOP FFS Coarse Time Assistance FFS Absolute GPS signal level FFS Relative GPS signal level FFS Position error FFS Response time FFS
5.6 Moving Scenario and Periodic Update Performance	HDOP FFS Absolute GPS signal level FFS Position error FFS

F.3 Interpretation of measurement results

The measurement results returned by the Test System are compared ñ without any modification ñ against the Test Requirements as defined by the shared risk principle.

The Shared Risk principle is defined in ETR 273-1-2 clause 6.5.

The actual measurement uncertainty of the Test System for the measurement of each parameter shall be included in the test report.

The recorded value for the Test System uncertainty shall be, for each measurement, equal to or lower than the appropriate figure in clause F.1 of the present document.

If the Test System for a test is known to have a measurement uncertainty greater than that specified in clause F.1, it is still permitted to use this apparatus provided that an adjustment is made value as follows.

Any additional uncertainty in the Test System over and above that specified in clause F.1 shall be used to tighten the Test Requirement ñ making the test harder to pass. (This may require modification of stimulus signals). This procedure will ensure that a Test System not compliant with clause F.1does not increase the chance of passing a device under test where that device would otherwise have failed the test if a Test System compliant with clause F.1 had been used.

F.4 Derivation of Test Requirements (This clause is informative)

The Test Requirements in the present document have been calculated by relaxing the Minimum Requirements of the core specification using the Test Tolerances defined in clause F.2. When the Test Tolerance is zero, the Test

Requirement will be the same as the Minimum Requirement. When the Test Tolerance is non-zero, the Test Requirements will differ from the Minimum Requirements, and the formula used for this relaxation is given in table F.4.

Table F.4.1: Derivation of Test Requirements (A-GPS tests)

Test	Minimum Requirement in TS 25.171	Test Tolerance (TT)	Test Requirement in TS 34.XXX
5.2.1 Sensitivity Coarse Time Assistance	HDOP 1.1 to 1.6 Coarse Time Assistance +/-2 s Absolute GPS signal level -142 dBm Relative GPS signal level -5 db Position error 100 m Response time 20 s	FFS	Formulas: FFS
5.2.2 Sensitivity Fine Time Assistance	HDOP 1.1 to 1.6 Coarse Time Assistance +/-2 s Fine Time Assistance 10 us Absolute GPS signal level -147 dBm Position error 100 m Response time 20 s	FFS	Formulas: FFS
5.3 Nominal Accuracy	HDOP 1.1 to 1.6 Coarse Time Assistance +/-2 s Absolute GPS signal level -130 dBm Position error 30 m Response time 20 s	FFS	Formulas: FFS
5.4 Dynamic Range	HDOP 1.4 to 2.1 Coarse Time Assistance +/-2 s Absolute GPS signal level -129 dBm Relative GPS signal level -6 to -18dB Position error 100 m Response time 20 s	FFS	Formulas: FFS
5.5 Multi-path Performance	HDOP 1.8 to 2.5 Coarse Time Assistance +/-2 s Absolute GPS signal level -130 dBm Relative GPS signal level -6 dB Position error 100 m Response time 20 s	FFS	Formulas: FFS
5.6 Moving Scenario and Periodic Update Performance	HDOP 1.8 to 2.5 Absolute GPS signal level -130 dBm Position error 100 m	FFS	Formulas: FFS

F.5 Acceptable uncertainty of Test Equipment (This clause is informative)

This informative clause specifies the critical parameters of the components of an overall Test System (e.g. Signal generators, Signal Analysers etc.) which are necessary when assembling a Test System that complies with clause F.1 Acceptable Uncertainty of Test System. These Test Equipment parameters are fundamental to the accuracy of the overall Test System and are unlikely to be improved upon through System Calibration.

F.5.1 A-GPS Performance measurements

Table F.5.1: Equipment accuracy for A-GPS performance measurements

Clause	Equipment accuracy	Test conditions
5.2.1 to 5.6	FFS	FFS

F.6 General rules for statistical testing

F.6.1 Statistical testing of 2 D position error

[FFS]

Annex G (informative): Change history

T Meeting	Doc-1st-Level	CR	Rev	Subject	Cat	Version - Current	Version -New	Doc-2nd-Level
T#26				Initial draft of specification			1.0.0	