Quasi-Zenith Satellite System
Performance Standard
(PS-QZSS-003)

(March 17, 2022)

Cabinet Office

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Revision History(1/3)

Rev. No.	Date	Page	Revisions
001 Draft Edition	January 10,2017		Draft edition
	July 24,2017	23	Corrects description of DC-Report availability, Table 7.3.1-1 Definition of unhealthy conditions and 7.3.2 Service Availability by Each QZS.
	April 6,2018	19	Updates service area of CLAS, Figure 6.2-1.
	August 31, 2018	19	Adds description of service area on the altitude direction
		20	Adds remarks of CLAS positioning accuracy, Table 6.3-1
001	November 5, 2018	4	Updates 2.5. Abbreviations
		12	Adds remarks and figure 4.3-2 of 4.3.4 Almanac accuracy.
		18	Adds remarks and Table 5.5-1 Definition of unhealthy conditions
		20	Updates 6.1 Service Overview of CLAS
		22	Changes description of Table 6.4-1 Definition of unhealthy conditions
		22	Updates interruption conditions by adding Table 6.5-1 Definition of interruption conditions
002	August 20, 2020	22, 23	Adds remarks in Table 6.4-1 and Table 6.5-1
003	March 17, 2022	-	Updates Disclaimer of Liability
		1	Updates 1.Scope and 2.1 Applicable Documents
		2	Updates 2.2 Reference Documents
		3	Corrects descriptions in 2.3 Document Architecture
		3	Updates Table 2.3-1
		4	Updates 2.4 Terms and Definitions
		5, 6	Updates 2.5 Abbreviations
		7	Corrects descriptions in 3.1 System Architecture of QZSS
		8	Updates 3.1.1. Satellite System due to the modification of the four-QZS constellation
		8	Updates 3.1.2. Ground System of QZSS
		9	Corrects descriptions in 3.1.3 Satellite orbits
		9	Adds QZS1R orbit parameters in Table 3.1-2
		10	Corrects descriptions in Table 3.1-3 and Figure 3.1-2
		11	Updates Figure 4.2-1 due to the modification of the four-QZS constellation
		12	Corrects descriptions in 4.3.1 SIS Accuracy and 4.3.2 Ionosphere Parameter Accuracy
		13	Corrects descriptions in 4.3.3 UTC Accuracy and 4.3.4 Almanac Accuracy
		14	Corrects descriptions in 4.3.5 EOP Accuracy, 4.3.6 GGTO Accuracy

Revision History(2/3)

Rev. No.	Date	Page	Revisions
003	March 17, 2022	15	Corrects descriptions in 4.4.1 Constellation Service Availability
		15	Adds remarks in Table 4.4-1
		16	Corrects descriptions in 4.4.2 Service Availability by Each QZS and 4.5 Continuity
		17	Corrects descriptions in 4.6 Integrity
		18	Corrects descriptions in 5.1 Service Overview
		19	Adds remarks in Table 5.3-1
		20	Corrects descriptions in 5.4.1 Constellation Service Availability
		20	Updates 5.4.2 Service Availability by Each QZS and 5.4.3 Constellation Service Availability at High Elevation Angles due to the modification of the four-QZS constellation
		21	Updates 5.5 Continuity due to the modification of the four-QZS constellation
		21	Adds remarks in Table 5.5-1
		22	Updates 5.6 Integrity due to the modification of the four-QZS constellation
		22	Adds Table 5.6-1 Alarm Notification and Time to Alert(TTA)
		22	Corrects descriptions in 5.7 Time to First Fix(TTFF)
		23	Corrects descriptions in 6.1 Service Overview
		25	Corrects descriptions in 6.4.1 Constellation Service Availability and 6.4.2 Service Availability by Each QZS
		25	Updates 6.4.3 Constellation Service Availability at High Elevation Angles due to the modification of the four-QZS constellation
		26	Updates 6.5 Continuity due to the modification of the four-QZS constellation
		26	Updates Table 6.5-1
		27	Updates 6.6 Integrity due to the modification of the four-QZS constellation
		27	Adds Table 6.6-1 Alarm Notification and Time to Alert(TTA)
		27	Corrects descriptions in 6.7 Time to First Fix(TTFF)
		28	Corrects descriptions in 7.1 Service Overview and 7.2 Service Area of DC Report
		29	Corrects descriptions in 7.3.1 Constellation Service Availability and 7.3.2 Service Availability by Each QZS
		29	Updates 7.3.3 Constellation Service Availability at High Elevation Angles due to the modification of the four-QZS constellation

Revision History(3/3)

Rev. No.	Date	Page	Revisions
003	March 17, 2022	30	Corrects descriptions in 8.1 Service Overview, 8.2 Service Area, and 8.3 Availability of Q-ANPI
		31	Updates Figure 9.2-1 due to the modification of the four-QZS constellation
		31	Deletes 9.3 Accuracy, 9.4 Availability, and 9.5 Continuity in which the specifications are not described
		32-33	Adds 10. MADOCA-PPP Specifications

"TBD" in this document is an abbreviation of "To be determined." The items marked "TBD" have not been determined yet but will be determined in the future.

Table of Contents

1. Scope

This document provides service specifications with regard to following services of the Quasi-Zenith Satellite System (QZSS) :

(1) Satellite Positioning, Navigation and Timing Service (PNT)
(2) Sub-meter Level Augmentation Service (SLAS)
(3) Centimeter Level Augmentation Service (CLAS)
(4) Satellite Report for Disaster and Crisis Management (DC Report)
(5) QZSS Safety Confirmation Service (Q-ANPI)
(6) Positioning Technology Verification Service (PTV)
(7) Multi-GNSS Advanced Orbit and Clock Augmentation
– Precise Point Positioning (MADOCA-PPP)

2. Relevant Documents and Terms and Definitions

2.1. Applicable Documents

The cited parts of the following documents are recognized as being part of this document. This document may be updated when these applicable documents are updated.

(1) RTCM STANDARD 10403.2 DIFFERENTIAL GNSS (GLOBAL NAVIGATION SATELLITE SYSTEMS) SERVICE –VERSION3, RTCM SPECIAL COMMITTEE NO.104, 1-FEB-2013.

2.2. Reference Documents

The following documents have been referred on the creation of this document. This document might be updated when these reference documents are updated.

(1) Global Positioning System Standard Positioning Service Performance Standard, 5th Edition, April 2020

(2) IS-QZSS-PNT, Quasi-Zenith Satellite System Interface Specification - Satellite Positioning, Navigation and Timing Service

(3) IS-QZSS-L1S, Quasi-Zenith Satellite System Interface Specification - Sub-meter Level Augmentation Service

(4) IS-QZSS-L6, Quasi-Zenith Satellite System Interface Specification - Centimeter Level Augmentation Service

(5) IS-QZSS-DCR, Quasi-Zenith Satellite System Interface Specification - Satellite Report for Disaster and Crisis Management

(6) IS-QZSS-ANPI, Quasi-Zenith Satellite System Interface Specification - QZSS Safety Confirmation Service

(7) IS-QZSS-TV, Quasi-Zenith Satellite System Interface Specification - Positioning Technology Verification Service

(8) IS-QZSS-MDC, Quasi-Zenith Satellite System Interface Specification - Multi-GNSS Advanced Orbit and Clock Augmentation – Precise Point Positioning.

(9) SPR-MDC, Quasi-Zenith Satellite System Service Performance Report, MADOCA-PPP.

2.3. Document Architecture

The document architecture for the QZSS Performance Standard (PS-QZSS) and the QZSS Interface Specification (IS-QZSS) is described in Table 2.3-1.

PS-QZSS describes the scope, accuracy, availability, continuity and other performance characteristics of each service and IS-QZSSs describe the signal specifications, message specifications, user algorithms and other user interface specifications.

Table 2.3-1 Document Architecture

Quasi-Zenith Satellite System Performance Standard	Quasi-Zenith Satellite System Interface Specification
PS-QZSS Quasi-Zenith Satellite System Performance Standard	IS-QZSS-PNT Quasi-Zenith Satellite System Interface Specification Satellite Positioning, Navigation and Timing Service
	IS-QZSS-L1S Quasi-Zenith Satellite System Interface Specification Sub-meter Level Augmentation Service
	IS-QZSS-L6 Quasi-Zenith Satellite System Interface Specification Centimeter Level Augmentation Service
	IS-QZSS-DCR Quasi-Zenith Satellite System Interface Specification Satellite Report for Disaster and Crisis Management
	IS-QZSS-ANPI Quasi-Zenith Satellite System Interface Specification QZSS Safety Confirmation Service
	IS-QZSS-TV Quasi-Zenith Satellite System Interface Specification Positioning Technology Verification Service
	IS-QZSS-MDC Quasi-Zenith Satellite System Interface Specification Multi-GNSS Advanced Orbit and Clock Augmentation – Precise Point Positioning

2.4. Terms and Definitions

Terms	Definitions
alert	An alert which notifies the users that the service is not available
almanac	A set of data that depicts the trajectory of each satellite.
clock offset	Offset between the ground system clock and satellite clock
Earth Centered Earth Fixed (ECEF) Coordinate System	Geographic coordinate system that rotates with the earth as follows: origin: the mass center of the earth x-axis: the direction of the Greenwich meridian y-axis: the direction of longitude 90E degrees z-axis: the direction of the North Pole
Earth Centered Inertial (ECI) Coordinate System	Geographic coordinate system that does not rotate with the earth as follows: origin: the mass center of the earth x-axis: the direction of the spring equinox y-axis: the direction of the right ascension 90 degrees z-axis: the direction of the celestial north pole
ephemeris	A set of data that depicts the precise trajectory of own satellite.
health	Health condition of each signal
navigation message	Messages transmitted by GNSS satellites for navigation
polar motion	Movement of the rotational axis of the Earth
Signal-In-Reference User Range Error (SIR-URE)	Range error depending on the satellite system and the ground system
time-of-week (TOW) count	The total seconds of a week at the beginning of the message

2.5. Abbreviations

-A-

-B-

-C-

CLAS	Centimeter Level Augmentation Service
CNAV	Civil NAVigation
CRC	Cyclic Redundancy Check

-D-

DC Report	Satellite Report for Disaster and Crisis Management

-E-

ECEF	Earth Centered Earth Fixed
ECI	Earth Centered Inertial
EOP	Earth Orientation Parameters

-F-

-G-

GEO	GEostationary Orbits
GGTO	Time Offset between GPST and GNSST
GNSS	Global Navigation Satellite System
GNSST	GNSS Time
GPS	Global Positioning System
GPST	GPS Time

-H-

-I-

ISF	Integrity Status Flag
IS-QZSS	QZSS Interface Specification

-J-

-K-

-L-

LNAV	Legacy NAVigation

-M-

MT	Message Type
mas	milliarcsecond

-N-

NICT	National Institute of Information and Communications Technology

-O-

-P-

PNT	Satellite Positioning, Navigation and Timing Service
PRN	Pseudorandom Noise
PS-QZSS	QZSS Performance Standard
PTV	Positioning Technology Verification Service

-Q-

QZO	Quasi-Zenith Orbits
QZS	Quasi-Zenith Satellite
QZSS	Quasi-Zenith Satellite System
QZSST	QZSS Time
Q-ANPI	QZSS Safety Confirmation Service

-R-

RF	Radio Frequency
RMS	Root Mean Square

-S-

SIR	Signal-In-Reference
SIR-URE	SIR User Range Error
SIS	Signal-In-Space
SIS-URE	SIS User Range Error
SIS-URRE	SIS User Range Rate Error
SLAS	Sub-meter Level Augmentation Service

-T-

TOW	Time Of Week
TTA	Time To Alert
TTFF	Time To First Fix

-U-

URA	User Range Accuracy
URE	User Range Error
UT1	Universal Time
UTC	Coordinated Universal Time

-V-

-W-

-X-

-Y-

-Z-

3. QZSS Overview

3.1. System Architecture

QZSS consists of the satellite system (four QZSs) and the ground system (master control stations, tracking stations and monitoring stations). The system architecture is depicted in Figure 3.1-1.

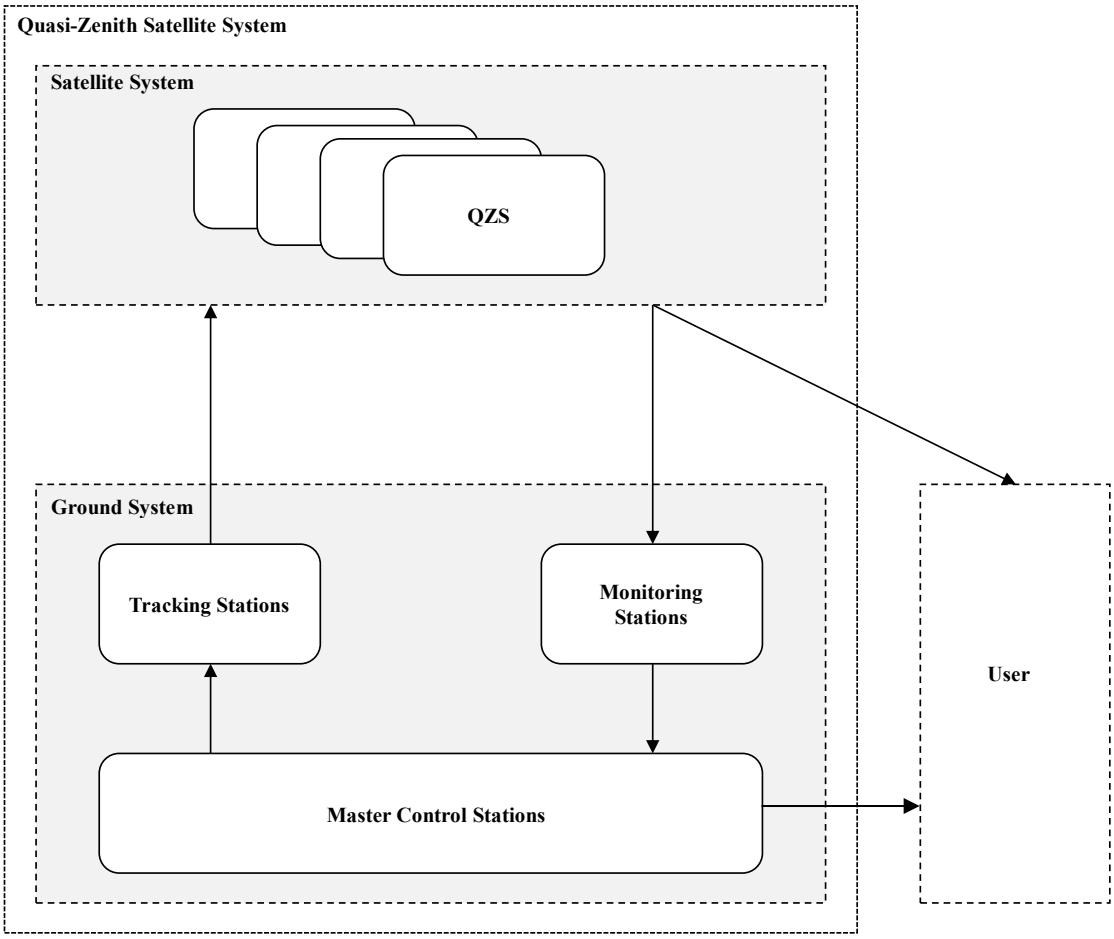

Figure 3.1-1 QZSS: System Architecture

3.1.1. Satellite System

The satellite system consists of three Quasi-Zenith Orbit (QZO) satellites (QZS1R,QZS2,QZS4) and one geostationary orbit (GEO) satellite (QZS3). These satellites transmit signals listed in Table 3.1-1 to provide several services. The Block of satellites indicates the development generation and the operation orbit of the satellite.

Table 3.1-1 List of Transmitted Signals

Signal name	QZS2,4,1R	QZS3	Service name	Center frequency
	Block II-Q	Block II-G		
	QZO	GEO		
	3 sats	1 sat		
L1C/A	Transmit	Transmit	PNT	1575.42 MHz
L1C	Transmit	Transmit	PNT	
L1S	Transmit	Transmit	SLAS	
			DC Report	
L2C	Transmit	Transmit	PNT	1227.60 MHz
L5	Transmit	Transmit	PNT	1176.45 MHz
L5S	Transmit	Transmit	PTV	
L6	Transmit	Transmit	CLAS	1278.75 MHz
			MADOCA-PPP	
S band	-	Transmit	Q-ANPI	2 GHz band

3.1.2. Ground System

The ground system consists of master control stations, tracking stations and monitoring stations.

The master control stations monitor and control the satellite system and the ground system. In addition, the data stream of each service are generated in these stations.

The tracking stations communicate the satellite system.

The monitoring stations receive the service signals transmitted by QZS, GPS and other GNSS.

3.1.3. Satellite Orbits

The QZO is highly inclined elliptical orbit. The orbital period of QZO is synchronized with the rotation of the Earth.

The parameters and operational ranges for QZO and GEO are summarized in Table 3.1-2 and Table 3.1-3. The typical ground track of QZO is depicted in Figure 3.1-2.

The orbit control maneuvers are performed about every 6 months (QZO) or about every 22-23 days (GEO). During these maneuvers, the PNT service from the maneuvered satellite is suspended.

Table 3.1-2 QZO Parameters and Operational Ranges(1/2)

Orbit parameter	QZS2,4	
	Nominal value	Operational range
Semi-major axis (A)	42,165 km	-
Eccentricity (e)	0.075	0.075 ± 0.015
Inclination (i)	41 degrees (Average of the service period (15 years))	41± 5 degrees
Argument of perigee (ω)	270 degrees	270 ± 2.5 degrees
Right ascension of the ascending node (Ω) (*)	247 and 347degrees (Mid-point of the service period (15 years) (7.5 years from the start of service))	-
Center of longitude (λ)	140 and 137.5 degrees east (Average of orbit control interval (approx. 6 months))	-

(*) Epoch: September 2025

Table 3.1-2 QZO Parameters and Operational Ranges(2/2)

Orbit parameter	QZS1R	
	Nominal value	Operational range
Semi-major axis (A)	42,165 km	-
Eccentricity (e)	0.075	0.075 ± 0.015
Inclination (i)	39 degrees (Average of the service period (15 years))	39± 5 degrees
Argument of perigee (ω)	270 degrees	270 ± 2.5 degrees
Right ascension of the ascending node (Ω) (*)	62 degrees (Mid-point of the service period (15 years) (7.5 years from the start of service))	-
Center of longitude (λ)	131.5 degrees east (Average of orbit control interval (approx. 6 months))	-

(*) Epoch: September 2025

Table 3.1-3 GEO Parameters and Operational Ranges

Orbit parameter	QZS3	
	Nominal value	Operational range
Longitude	127 degrees east	127 ± 0.1 degrees east
Latitude	0 degrees	0 ± 0.1 degrees

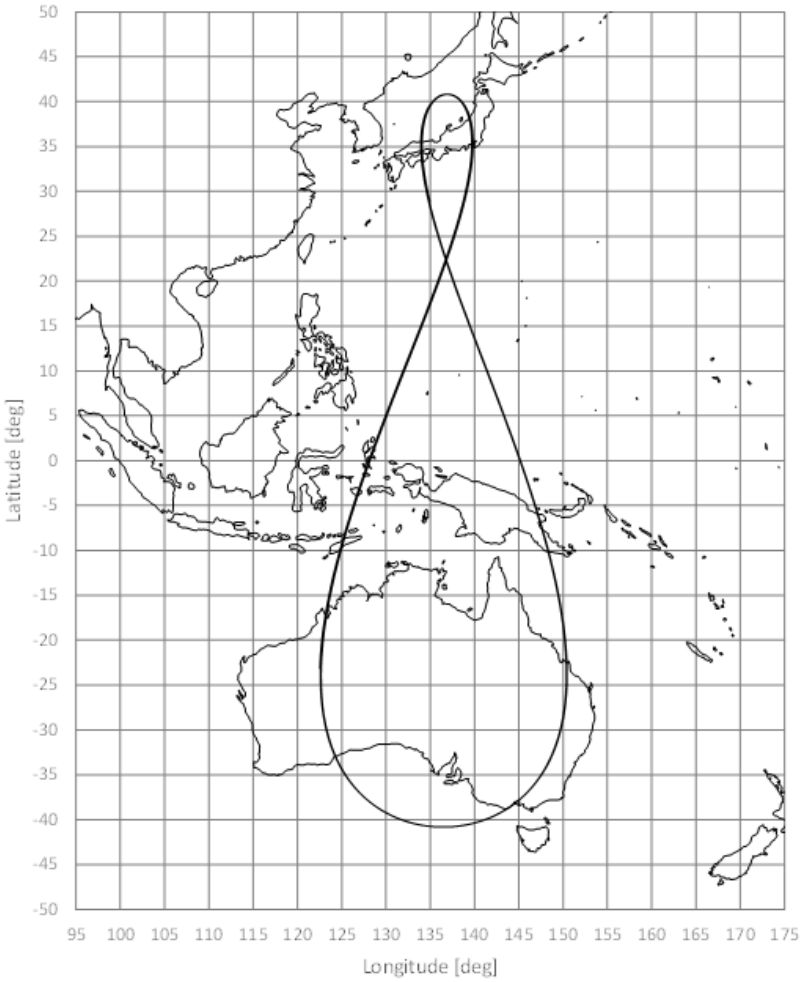

Figure 3.1-2 Typical QZO Ground Track

4. PNT Specifications

4.1. Service Overview

Satellite Positioning, Navigation and Timing Service (PNT) provides positioning signals (L1C/A signals, L1C signals, L2C signals and L5 signals) that have compatibility and interoperability with the signals of GPS Block III.

The user interface specifications are described in "IS-QZSS Satellite Positioning, Navigation and Timing Service (IS-QZSS-PNT)"(reference document (2))

4.2. Visible Area

Figure 4.2-1 shows the area where at least one QZS is visible with the elevation angle [deg], which is described on the lines. PNT signals can be received in the inside area of the line which corresponds to the elevation angle of 10 degrees.

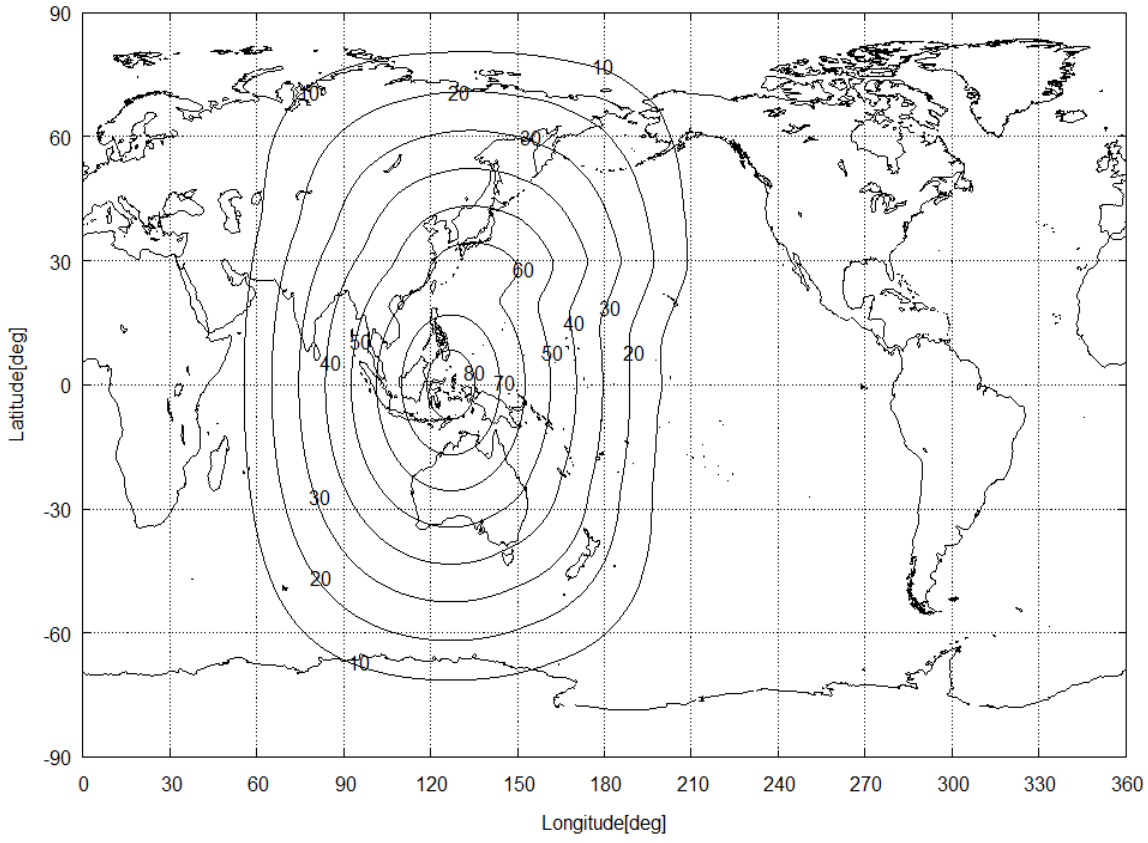

Figure 4.2-1 Visible Area (at least one QZS is visible)

4.3. Accuracy

4.3.1. SIS Accuracy

Signal-In-Space User Range Error (SIS-URE) shall satisfy the following condition:

- ≤ 2.6 m (95%) (Error(RMS) = 1.3 m)

This condition shall be applied to each signal and each satellite.

4.3.2. Ionosphere Parameter Accuracy

QZSs transmit two types of ionosphere parameters: for wide area and Japan area as shown in Figure 4.3-1 and Table 4.3-1. The ionosphere parameter set for Japan area is customized to provide more accurate ionosphere correction information around Japan.

The average ionosphere URE in each area shall satisfy the following condition:

- ≤ 7.0 m (95%) (Error(RMS) = 3.5 m)

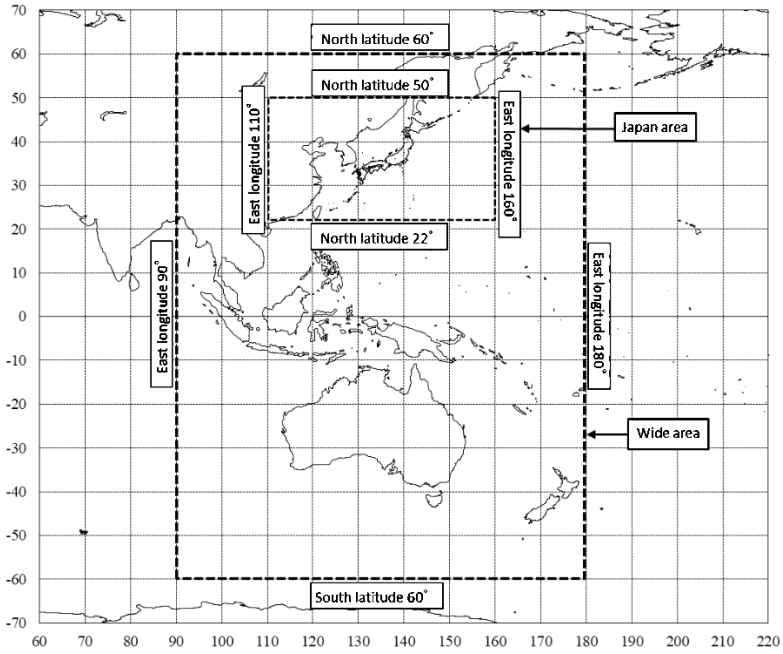

Figure 4.3-1 Target Areas of Ionosphere Parameters

Table 4.3-1 Target Areas of Ionosphere Parameters

Direction	Target area of ionosphere parameter for wide area	Target area of ionosphere parameter for Japan area
North	North latitude 60°	North latitude 50°
South	South latitude 60°	North latitude 22°
West	East longitude 90°	East longitude 110°
East	East longitude 180°	East longitude 160°

4.3.3. UTC Accuracy

QZSs transmit the time offset between QZSS time(QZSST) and UTC(NICT). It shall satisfy the following condition:

- ≤ 40 ns (95%) (Error(RMS) = 20 ns)

4.3.4. Almanac Accuracy

QZSs transmit the approximate orbit information of each QZS as almanac. It shall satisfy the following conditions(*):

(1) Almanac (LNAV (L1C/A))

- Positioning Accuracy: ≤ 10 km (3D-1σ)
- Clock offset Accuracy: ≤ 135 m (1σ)
- Clock drift Accuracy: ≤ 50 m/day (1σ)
- SIS-URE: ≤ 3.0 km (1σ)
- SIS-URRE: ≤ 0.3 m/s (1σ) (The orbit control period is not included.)
- SIS-URRE (maximum): 30 m/s (The orbit control period is included.)

(2) Midi almanac (CNAV2 (L1C), CNAV (L2C, L5))

Positioning Accuracy: ≤ 10 km (3D-1σ)
SIS-URE: ≤ 3.0 km (1σ)

- SIS-URRE: ≤ 0.3 m/s (1σ) (The orbit control period is not included.)
- SIS-URRE (maximum): 30 m/s (The orbit control period is included.)

(3) Reduced almanac (CNAV2 (L1C), CNAV (L2C, L5))

Reduced almanac accuracy is not defined.

(*) After the alert flag becomes “1”, the almanac accuracy is not guaranteed during the period depicted in Figure 4.3-2.

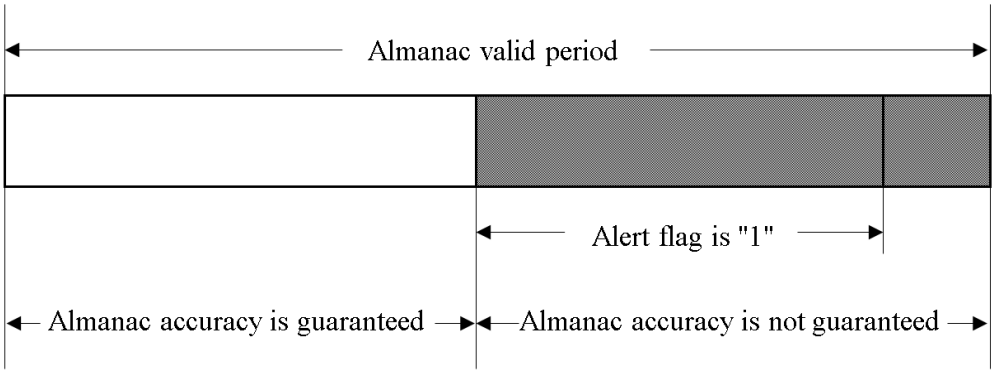

Figure 4.3-2 Almanac Accuracy (when the alert flag is “1”)

4.3.5. EOP Accuracy

QZSs transmit the polar motion parameter and the UT1-UTC parameter which are applied for the coordinate transformation between the Earth Centered Inertial (ECI) coordinate system and the Earth Centered Earth Fixed (ECEF) coordinate system as an earth orientation parameter (EOP). They shall satisfy the following conditions:

- Polar motion accuracy along X and Y axes:
  ≤ 1.0 mas (95%) (≈ 20 cm at QZS altitude) (Error(RMS) = 0.5 mas)

- UT1-UTC:
  ≤ 2.0 ms (95%) (≈ 666 cm at QZS altitude) (Error(RMS) = 1.0 ms)

4.3.6. GGTO Accuracy

QZSs transmit the time offset between QZSST and another GNSS time. It shall satisfy the following condition:

- ≤ 2.0 ns (95%) (Error(RMS) = 1.0 ns)

4.4. Availability

4.4.1. Constellation Service Availability

The constellation availability is the time ratio that the healthy PNT signals (L1C/A, L1C, L2C and L5) from at least three of four QZSs are transmitted. It shall satisfy the following condition:

- ≥ 0.99

The "healthy PNT signal" is defined as the conditions except the tabulated "unhealthy" conditions in Table 4.4-1.

Table 4.4-1 Definitions of Unhealthy and Interruption Conditions

<table>
<tr><td rowspan="6">Unhealthy / Interruption (*)</td><td>System maintenance</td><td colspan="2">● When the service is outage due to the scheduled system interruption such as orbit control or unloading.</td></tr>
<tr><td rowspan="5">System error</td><td colspan="2">● When a PNT signal is transmitted by non-standard PRN code.
● When a PNT signal cannot be continuously tracked for 1 second or longer (including the following situation: the signal power has decreased by 20 dB or more).
● When the error of the preamble or inspection bit (parity, CRC) occurs.
● When the default message is transmitted.
● When the ground system detects the error of the following parameters:
- Ionosphere parameter
- QZS almanac
- UTC parameter
- EOP parameter
- GGTO parameter
● When no alarm has been activated even when a service error as follows has occurred (**).</td></tr>
<tr><td rowspan="3">Service error</td><td>[RF error]
● Decrease in power of transmitted signal by 20 dB or more
● Signal distortion</td></tr>
<tr><td>[TOW error]
● Discontinuity of the TOW count</td></tr>
<tr><td>[SIS-URE error]
● When SIS-URE exceeds 4.42 times (when ISF = 0) or 5.73 times (when ISF = 1) the URA.
● When SIS-URE exceeds 9.65 m.</td></tr>
<tr><td>[UTC error]
● When the UTC time offset based on the UTC parameter exceeds 120 ns</td></tr>
<tr><td>Accuracy degradation</td><td colspan="2">● When the transmitted URA exceeds 9.65 m.</td></tr>
</table>

(*) The alert flag and the health bit are 1 in these cases except the (**) case.

(**) The alert flag and/or the health bit are NOT 1 in this case.

4.4.2. Service Availability by Each QZS

The service availability by each QZS is the time ratio that the healthy PNT signals from a specific satellite is available. It shall satisfy the following condition:

- QZO satellite: ≥ 0.95
- GEO satellite: ≥ 0.80

4.5. Continuity

The continuity is the probability that the healthy PNT signals will continue to be available without an unscheduled interruption over a specified time interval. It shall satisfy the following condition in any one hour:

- $\geq 1\text{-}2\times10^{-4}$ /hour

This condition shall be applied to each PNT signal and each satellite.

Interruption is defined as a loss of the availability of each PNT signal of each QZS as well as the discontinuity of the data stream within the valid period. The interruption conditions of the PNT signals are defined in Table 4.4-1

When the scheduled interruption event is notified at least 48 hours prior to the outage through official notifications of QZSS service providers, the interruption event can be removed from the computation of continuity statistics.

4.6. Integrity

The integrity risk of PNT is the probability that a service error defined in Table 4.4-1 occurs without a timely alarm. It shall satisfy the following condition in any one hour:

- $\leq 1\times10^{-5}$ /hour (when integrity status flag (ISF) is “0”)
- $\leq 1\times10^{-8}$ /hour (when ISF is “1”)

This condition shall be applied to each signal and each satellite.

The Time to Alert (TTA) is the time from the onset of a service error until an alert arrives at the receiver’s antenna. It shall satisfy the conditions in Table 4.6-1:

Table 4.6-1 Alarm Notification and Time to Alert (TTA)

Service error item	Alarm notification	Time to Alert (TTA)
RF error	Non-standard PRN code	8.0 sec
TOW error	Non-standard PRN code	8.0 sec
SIS-URE error	Non-standard PRN code	5.2 sec
UTC error	Alert flag	30 sec

5. SLAS Specifications

5.1. Service Overview

Sub-meter Level Augmentation Service (SLAS) provides sub-meter level augmentation information as L1S signals. SLAS adopts Differential GNSS (DGNSS) method.

The user interface specifications are described in “IS-QZSS Sub-meter Level Augmentation Service (IS-QZSS-L1S)” (reference document (3) .)

SLAS augments the following signals.

- QZSS : L1C/A
- GPS : L1C/A

5.2. Service Area

SLAS will be available in the area depicted in Figure 5.2-1.

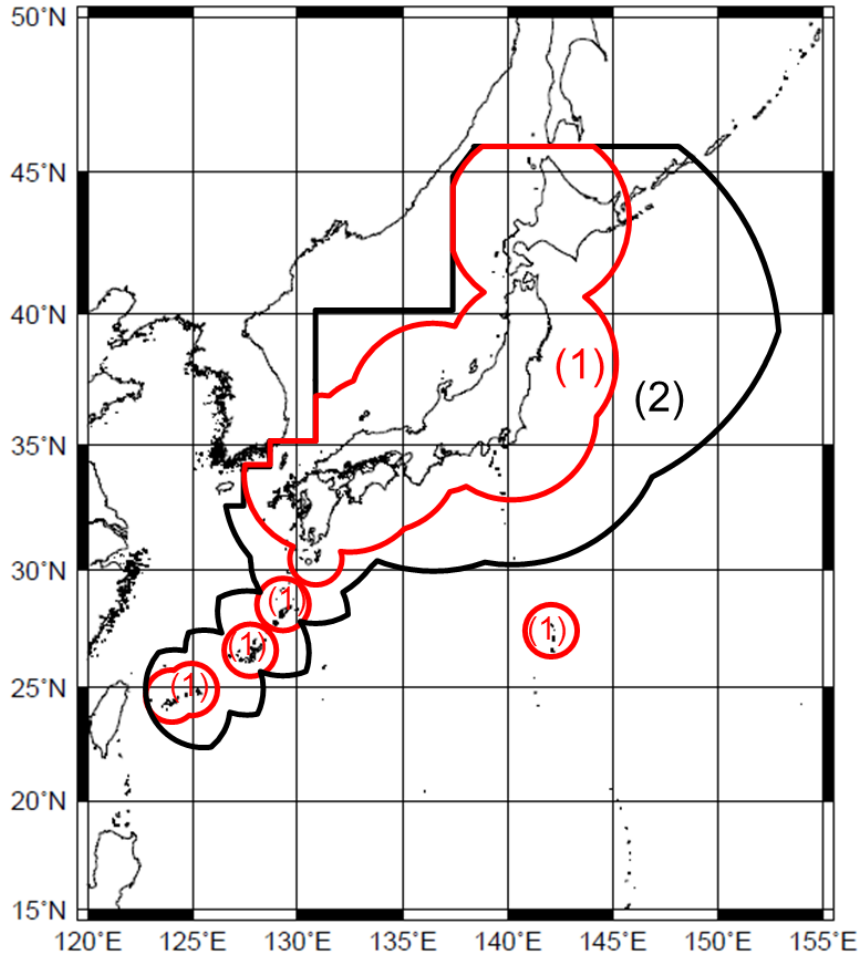

Figure 5.2-1 Service Area of the Sub-meter Level Augmentation Service (SLAS)

5.3. Accuracy

SLAS positioning accuracy is shown in Table 5.3-1.

Table 5.3-1 Positioning Accuracy

Zone	Positioning Error		Remark
	Horizontal	Vertical	
Zone (1)	≤ 1.0m(95%) (0.58m(RMS))	≤ 2.0m(95%) (1.02m(RMS))	(*)
Zone (2)	≤ 2.0m(95%) (1.16m(RMS))	≤ 3.0m(95%) (1.53m(RMS))	(*)

(*)Usage assumptions to achieve the accuracy are as follows:

- Elevation mask angle : 10 degrees
- User range error caused by receiver noise(**) and multipath: ≤ 0.87 m(95%)

  (**) Receiver noise includes Inter System Biases (ISBs) caused by the combination of satellite signals characteristics, reference receiver characteristics and user receiver characteristics. These multiple error elements result in post correction relative offset error between QZSS and GPS L1C/A signals for SLAS. In addition, post correction relative range biases between the QZSS satellite types (QZO and GEO) or between those of each QZS should also be considered.

5.4. Availability

5.4.1. Constellation Service Availability

The constellation availability is the time ratio that the healthy L1S(SLAS) signals from at least three of four QZSs are transmitted. It shall satisfy the following condition:

- ≥ 0. 9997

The "healthy L1S(SLAS) signal" is defined as the conditions except the tabulated "unhealthy" conditions in Table 5.4-1.

Table 5.4-1 Definition of Unhealthy Conditions

Unhealthy	System maintenance	● When the service is outage due to the scheduled system interruption.	
	System error	● When an L1S(SLAS) signal is transmitted with CRC error. ● When an L1S(SLAS) signal is suspended for 4 seconds or longer.	
		Service error	[URE error] ● URE of augmented satellites (*) exceed the range (±12.96m)(**).

(*) PRN Mask (MT48) of the augmented satellite is "1".

(**) Satellite health (MT51) of the satellite with the URE error is "1".

5.4.2. Service Availability by Each QZS

The service availability by each QZS is the time ratio that the healthy L1S(SLAS) signal from a specific satellite is available. It shall satisfy the following condition:

- ≥ 0. 97

5.4.3. Constellation Service Availability at High Elevation Angles

The constellation service availability at high elevation angles is the time ratio that the healthy L1S(SLAS) signal from any QZS at an elevation angle of 60 degrees or more is available. It shall satisfy the following condition:

- ≥ 0.83

5.5. Continuity

The continuity is the probability that the healthy L1S(SLAS) signal will continue to be available without an unscheduled interruption over a specified time interval. It shall satisfy the following condition in any one hour:

- $\geq 1\text{-}2 \times 10^{-4}$ /hour

This condition shall be applied to each satellite.

Interruption is defined as a loss of the availability of the L1S(SLAS) signal of each QZS as well as the discontinuity of the data stream within the valid period. The interruption conditions of the L1S(SLAS) signal are defined in Table 5.5-1.

When the scheduled interruption event is notified at least 48 hours prior to the outage through official notifications of QZSS service providers, the interruption event can be removed from the computation of continuity statistics.

Table 5.5-1 Definition of Interruption Conditions

Interruption	System maintenance	● When the service is outage due to the scheduled system interruption.	
	System error	● When any of MT 48,49,or 50 in an L1S(SLAS) signal is not transmitted twice or more continuously.(*)	
		Service error	[URE error] ● URE of augmented satellites (**) exceed the range (±12.96m)(***).

(*) This means that an L1S signal is not transmitted for 31 seconds or more.

(**) PRN Mask (MT48) of the augmented satellite is “1”.

(***) Satellite health (MT51) of the satellite with the URE error is “1”.

5.6. Integrity

The integrity risk of SLAS is the probability that a service error defined in Table 5.4-1 occurs without a timely alarm. It shall satisfy the following condition in any one hour:

- $\leq 1.0 \times 10^{-5}$ /hour

This condition shall be applied to each satellite.

The Time To Alert (TTA) is the time from the onset of a service error until the alert arrives at the receiver's antenna. It shall satisfy the conditions in Table 5.6-1:

Table 5.6-1 Alarm Notification and Time to Alert (TTA)

Service error item	Alarm notification	Time to Alert (TTA)
URE error	Satellite Health (MT51)	10 sec

5.7. Time to First Fix (TTFF)

The TTFF is the time from the reception of the L1S(SLAS) signal at a receiver until MT48, MT49 and MT50 messages are received. It shall satisfy the following condition:

- ≤ 30 sec (95%)

6. CLAS Specifications

6.1. Service Overview

Centimeter Level Augmentation Service (CLAS) provides centimeter level augmentation information as L6 signals. CLAS adopts Real-Time Kinematic (RTK) Precise Point Positioning (PPP) method defined in RTCM STANDARD 10403.2 Section 3.5.12 “State Space Messages” in the applicable documents(1) .

The user interface specifications are described in “IS-QZSS Centimeter Level Augmentation Service (IS-QZSS-L6)” (reference document (4) .)

CLAS augments the following signals[1].

- QZSS : L1C/A, L1C, L2C, L5
- GPS : L1C/A, L1C, L2P, L2C, L5
- Galileo : E1B, E5a

6.2. Service Area

CLAS will be available in the area depicted in Figure 6.2-1.

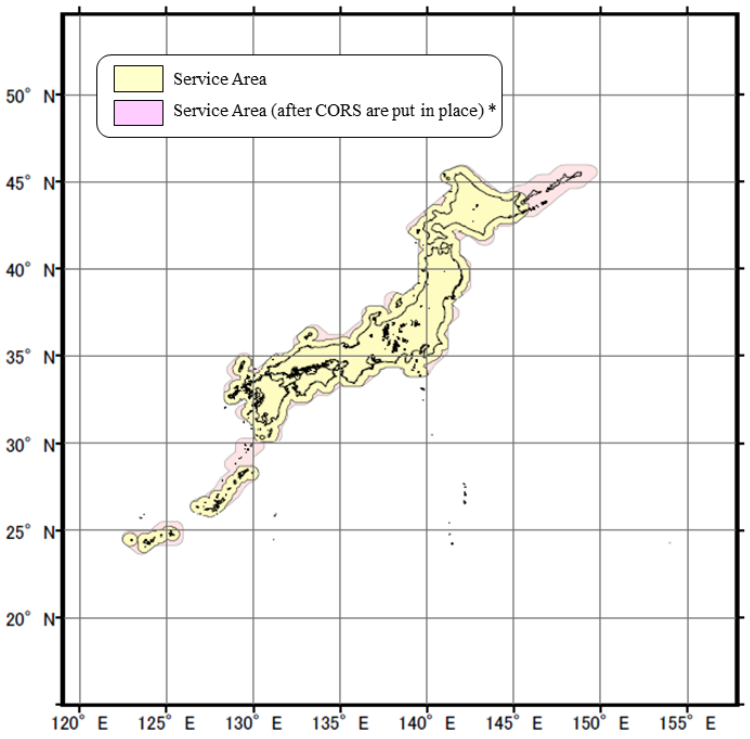

Fig. 6.2-1 Service Area of the Centimeter Level Augmentation Service (CLAS)

*Around islands such as Northern Territories and Tokara Islands,
and regions with an altitude of 2000 meters or more

[1] Augmentation for GLONASS(L1(CDMA), L2(CDMA)) will be available in future.

6.3. Accuracy

CLAS Positioning accuracy is shown in Table. 6.3-1.

Table. 6.3-1 Positioning Accuracy

Positioning Type	Positioning Error		Remark
	Horizontal	Vertical	
Static	≤ 6cm(95%) (3.47cm(RMS))	≤ 12cm(95%) (6.13cm(RMS))	(*)(**)
Kinematic	≤ 12cm(95%) (6.94cm(RMS))	≤ 24cm(95%) (12.25cm(RMS))	(*)(**)

(*) The augmentation information shall satisfy the following condition.

・SIR-URE ≤ 0.08 m (95%)

(**) Usage assumptions to achieve the accuracy are as follows :

・All the augmented satellites (GNSSs) are used in the PPP-RTK positioning.

・A minimum number of satellites with no cycle slips : ≥ 5

・Elevation mask angle : 15 degrees

・Average Dilution of Precision (DOP) by augmented satellites :

≤ 1.1 for Horizontal

≤ 1.8 for Vertical

・Multipath :

≤ 0.34 m (RMS) for pseudorange per augmented satellite

≤ 0.75 cm (RMS) for carrier phase per augmented satellite

・Receiver noise :

≤ 0.30 cm (RMS) for carrier phase per augmented satellite

・Antenna phase center variation (PCV) error :

≤ 0.30 cm (RMS) for each frequency

6.4. Availability

6.4.1. Constellation Service Availability

The constellation availability is the time ratio that the healthy L6(CLAS) signals from at least three of four QZSs are transmitted. It shall satisfy the following condition:

- ≥ 0. 99

The "healthy L6(CLAS) signal" is defined as the conditions except the tabulated "unhealthy" conditions in Table 6.4-1.

Table 6.4-1 Definition of Unhealthy Conditions

Unhealthy	System maintenance	● When the service is outage due to the scheduled system interruption(*).	
	System error	● When an L6(CLAS) signal is transmitted by a non-standard PRN code. ● When the null message is transmitted for 3 seconds or longer(**).	
		Service error	[SIR-URE error] ● SIR-URE of more than ±0.468m at 3 or more augmented satellites among at least 2 GNSS(*). [Augmented satellite number error] ● When the number of augmented satellites is less than 5 at all locations in the service area(*).

(*) The alert flag is "1" in these cases.

(**) The specification of the null message is described in the section 4.1.2.3 of IS-QZSS-L6.

6.4.2. Service Availability by Each QZS

The service availability by each QZS is the time ratio that the healthy L6(CLAS) signal from a specific satellite is available. It shall satisfy the following condition:

- ≥ 0.97

6.4.3. Constellation Service Availability at High Elevation Angles

The constellation service availability at high elevation angles is the time ratio that the healthy L6(CLAS) signal from any QZS at an elevation angle of 60 degrees or more is available. It shall satisfy the following condition:

- ≥ 0.83

6.5. Continuity

The continuity is the probability that the healthy L6(CLAS) signal will continue to be available without an unscheduled interruption over a specified time interval. It shall satisfy the following condition in any one hour:

- $\geq 1\text{-}2 \times 10^{-4}$ /hour

This condition shall be applied to each satellite.

Interruption is defined as a loss of the availability of the L6(CLAS) signal of each QZS as well as the discontinuity of the data stream within the valid period. The interruption conditions of the L6(CLAS) signal are defined in Table 6.5-1.

When the scheduled interruption event is notified at least 48 hours prior to the outage through official notifications of QZSS service providers, the interruption event can be removed from the computation of continuity statistics.

Table 6.5-1 Definition of Interruption Conditions

Interruption	System maintenance	● When the Service is outage due to the scheduled system interruption(*).	
	System error	● When an L6(CLAS) signal is transmitted by a non-standard PRN code. ● When MT4073,3 in an L6 signal is not transmitted twice or more continuously. ● When any of MT4073,2 or MT4073,4-6 or MT4073,8-9 or MT4073,11-12 in an L6 signal is not transmitted twice or more continuously.	
		Service error	[SIR-URE error] ● SIR-URE of more than ±0.468m at 3 or more augmented satellites among at least 2 GNSS(*). [Augmented satellite number error] ● When the number of augmented satellites is less than 5 at all locations in the service area(*).

(*) The alert flag is "1" in these cases.

6.6. Integrity

The integrity risk of CLAS is the probability that a service error defined in Table 6.4-1 occurs without a timely alarm. It shall satisfy the following condition in any one hour:

- $\leq 1.0 \times 10^{-5}$ /hour

This condition shall be applied to each satellite.

The Time To Alert (TTA) is the time from the onset of a service error until the alert arrives at the receiver's antenna. It shall satisfy the conditions in Table 6.6-1:

Table 6.6-1 Alarm Notification and Time to Alert (TTA)

Service error item	Alarm notification	Time to Alert (TTA)
SIR-URE error	Alert flag	9.2 sec
Augmented satellite number error	Alert flag	9.2 sec

6.7. Time to First Fix (TTFF)

The TTFF is the time from the reception of L6(CLAS) signals at a receiver until the first positioning computation result is obtained with the resolved carrier phase integer ambiguities. It shall satisfy the following condition:

- ≤ 60 sec (95%)

7. DC Report Specifications

7.1. Service Overview

Satellite Report for Disaster and Crisis Management (DC Report) provides disaster, evacuation and other information as a message of L1S signals.

The user interface specifications are described in "IS-QZSS DC Report (IS-QZSS-DCR)" (reference document (5) .)

7.2. Service Area

DC report will be available in the area depicted in Figure 7.2-1 where at least one QZS is visible at an elevation angle of 10 degrees or more. The contents of the DC report messages are described in the reference document (5) .

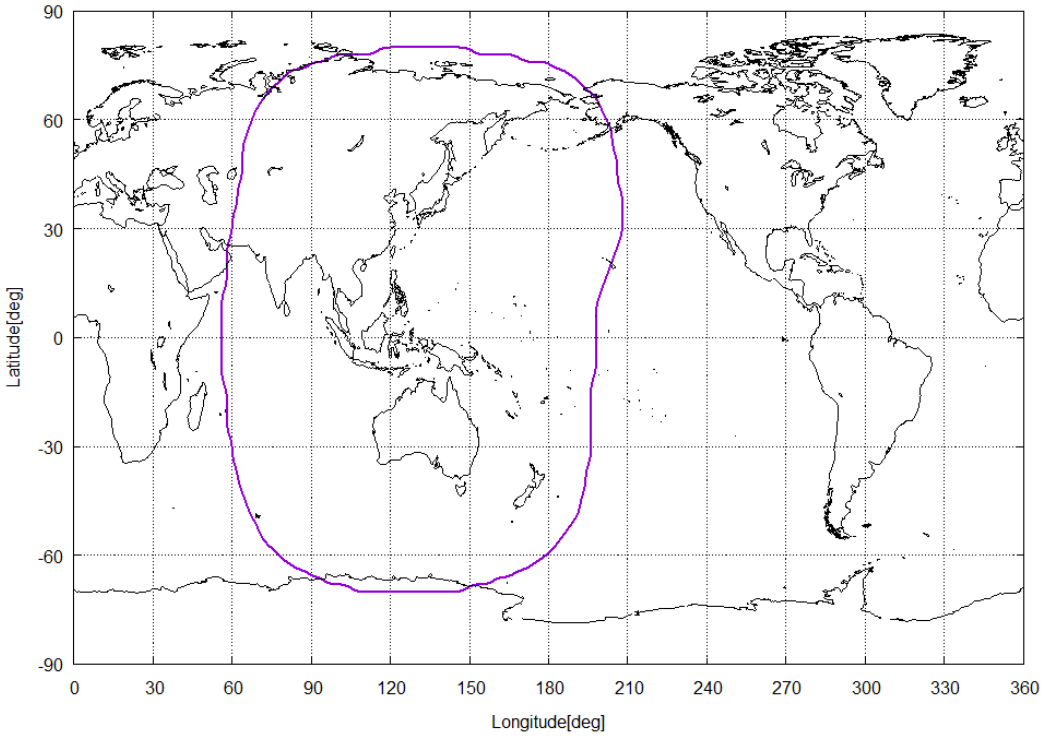

Figure 7.2-1 Service Area of the DC Report

7.3. Availability

7.3.1. Constellation Service Availability

The constellation availability is the time ratio that the healthy L1S(DC Report) signals from at least three of four QZSs are transmitted. It shall satisfy the following condition:

- ≥ 0.999

The "healthy L1S(DC report) signal" is defined as the conditions except the tabulated "unhealthy" conditions in Table 7.3-1.

Table 7.3-1 Definition of Unhealthy Conditions

Unhealthy	System maintenance	● When the service is outage due to the scheduled system interruption.
	System error	● When an L1S(DC report) signal is transmitted with CRC error.

7.3.2. Service Availability by Each QZS

The service availability by each QZS is the time ratio that the healthy L1S(DC report) signal from a specific satellite is available. It shall satisfy the following condition:

- ≥ 0. 97

7.3.3. Constellation Service Availability at High Elevation Angles

The constellation service availability at high elevation angles is the time ratio that the healthy L1S(DC report) signal from any QZS at an elevation angle of 60 degrees or more is available. It shall satisfy the following condition:

- ≥ 0.83

8. Q-ANPI Specifications

8.1. Service Overview

QZSS Safety Confirmation Service (Q-ANPI) provides emergency shelter information using S-band mobile satellite communication of the QZSS.

In emergency shelters, when disasters occur, emergency shelter administrators collect safety status information of evacuees and management information of the emergency shelter, then send them from the transmitting terminal to the Cabinet Office via QZS (GEO). The Cabinet Office collects information and shares it to disaster prevention agencies.

The user interface specifications are described in "IS-QZSS Safety Confirmation Service (IS-QZSS-ANPI)" (reference document (6) .)

8.2. Service Area

Q-ANPI will be available in the area depicted in Figure 8.2-1.

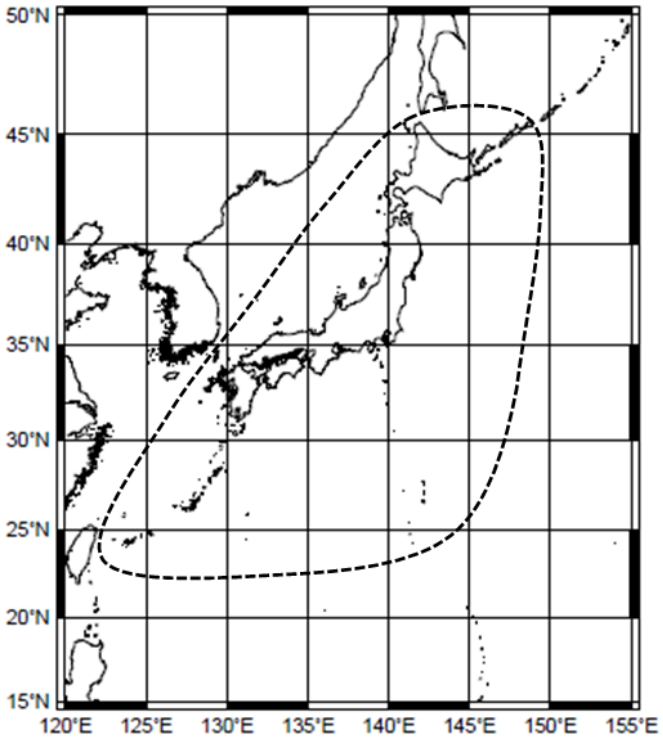

Figure 8.2-1 Service Area of the Q-ANPI

8.3. Availability

Service availability is the time ratio that communications between user terminals and the QZSS ground system through QZS (GEO) are available. It shall satisfy the following condition:

- ≥ 0.97

9. PTV Specifications

9.1. Service Overview

The positioning technology verification service (PTV) provides an environment for verifying positioning information with new technology as L5S signals.

The user interface specifications are described in "IS-QZSS Positioning Technology Verification Service (IS-QZSS-TV)" (reference document (7) .)

9.2. Service Area

PTV will be available in the area depicted in Figure 9.2-1 where at least one QZS is visible at an elevation angle of 10 degrees or more.

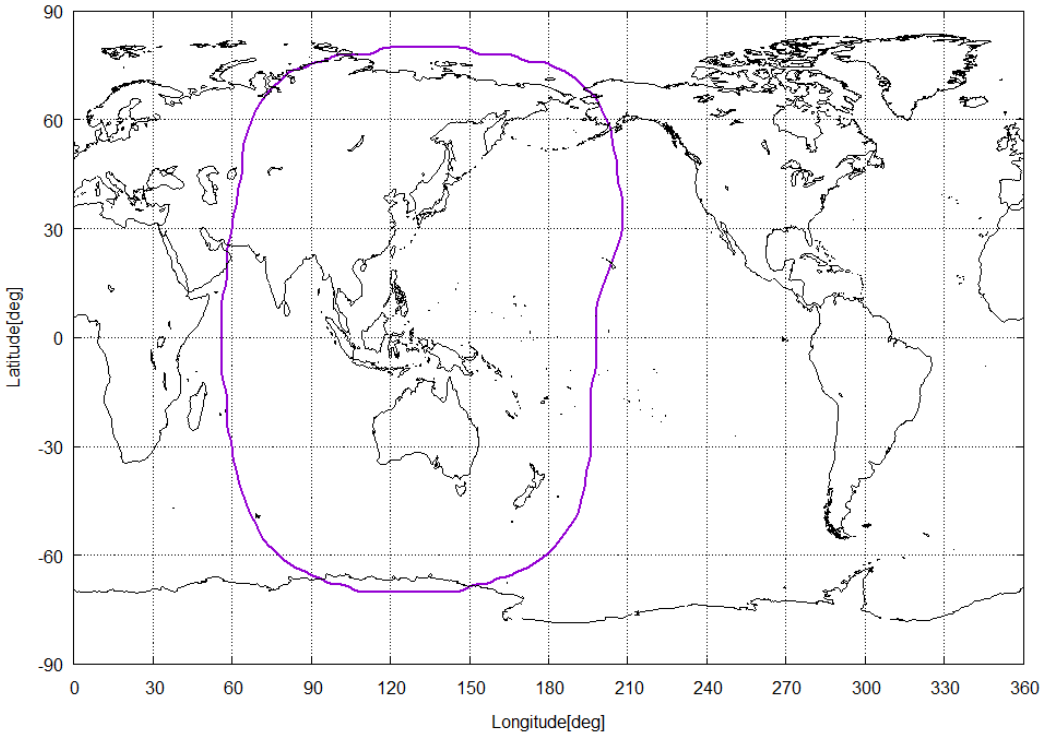

Figure 9.2-1 Service Area of the PTV

10. MADOCA-PPP Specifications

10.1. Service Overview

Multi-GNSS Advanced Orbit and Clock Augmentation – Precise Point Positioning (MADOCA-PPP) provides correction data for Precise Point Positioning (PPP) users via L6(MADOCA-PPP) signals. For applying PPP method and/or PPP-Ambiguity Resolution (AR) method, the globally applicable error corrections on satellite orbit, clock offset and code/phase biases are broadcasted.

The user interface specifications are described in "IS-QZSS Multi-GNSS Advanced Orbit and Clock Augmentation–Precise Point Positioning Positioning (IS-QZSS-MDC)" (reference document (8)) and "IS-QZSS Centimeter Level Augmentation Service (IS-QZSS-L6)" (reference document (4) .)

MADOCA-PPP augments the following signals.

- QZSS : L1C/A, L1C/B, L1C, L2C, L5
- GPS : L1C/A, L1P, L1C, L2C, L2P, L5
- GLONASS : G1, G2
- Galileo : E1, E5a

10.2. Service Area

MADOCA-PPP is available in the area depicted in Figure 10.2-1 where at least one QZS is visible at an elevation angle of 10 degrees or more and at least twenty augmented satellites are visible at an elevation angle of 10 degrees or more.

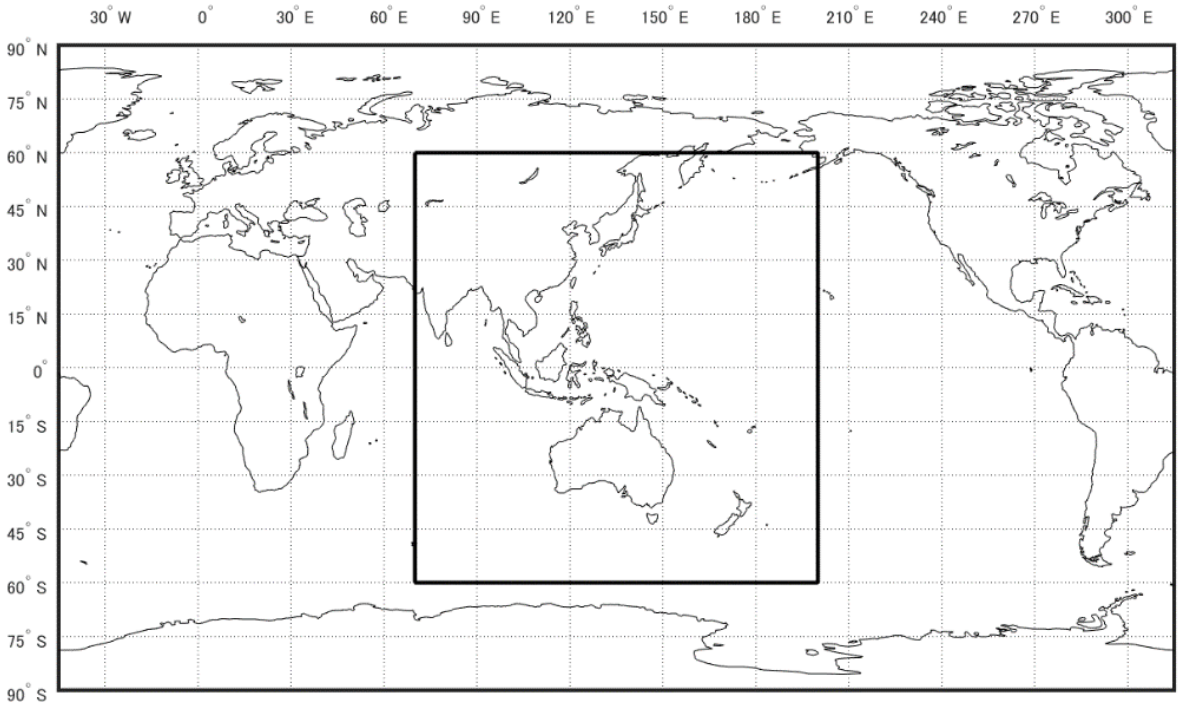

Figure 10.2-1 Service Area of the MADOCA-PPP

10.3. Convergence Time

The convergence time is the time from the reception of the augmentation messages via the L6(MADOCA-PPP) signal at a receiver until the PPP computation result which satisfies the following accuracy is obtained :

- Horizontal Accuracy ≤ 30 cm (95%)
- Vertical Accuracy ≤ 50 cm (95%)

The convergence time shall satisfy the following condition(*):

- Convergence Time ≤ 1800 sec (Performance Report: See reference document(9))
  (*) Assumptions:
  - Environment: Open-sky
  - Antenna and Receiver: Dual-frequency, for surveying

10.4. Service Unhealthy Conditions

The "healthy L6(MADOCA-PPP) signal" is defined as the conditions except the tabulated "unhealthy" conditions in Table 10.4-1.

The scheduled interruption event is notified at least 48 hours prior to the outage through official notifications of QZSS service providers.

Table 10.4-1 Definition of Unhealthy Conditions

Unhealthy	System maintenance	● When the service is outage due to the scheduled system interruption(*).	
	System error	● When an L6 (MADOCA-PPP) signal is transmitted by a non-standard PRN code. ● When the null message(**) is transmitted for 3 seconds or longer(*).	
		Service error	● When the number of augmented satellites is less than 12 at all locations in the service area(*)(***).

(*) The alert flag is "1" in these cases.

(**) The specification of the null message is described in the reference documents(8) .

(***) Even in this situation, the augmentation message (the number of augmented satellites ≤ 11) is transmitted.