Quasi-Zenith Satellite System

Service Performance Report for 1stH FY2023

Centimeter Level Augmentation Service (CLAS)

February 29, 2024

Quasi-Zenith Satellite System Services Inc. (QSS)

1. Evaluation Period

From April 1, 2023 to September 30, 2023 (UTC)

2. Evaluation Item

- Accuracy of static and kinematic positioning
- Availability
- Continuity
- Integrity

3. Evaluation Method

3.1. Accuracy of static and kinematic positioning

Positioning accuracy is based on a statistical value (95th percentile values), represented by dividing the CLAS service area into 12 areas (Figure.1).

In each area, several Continuously Operating Reference Stations (CORS) are assigned from GEONET (GNSS Earth Observation Network System) for evaluation (*1). Positioning accuracy for each area is calculated from the positioning results of all the evaluation stations included in each area.

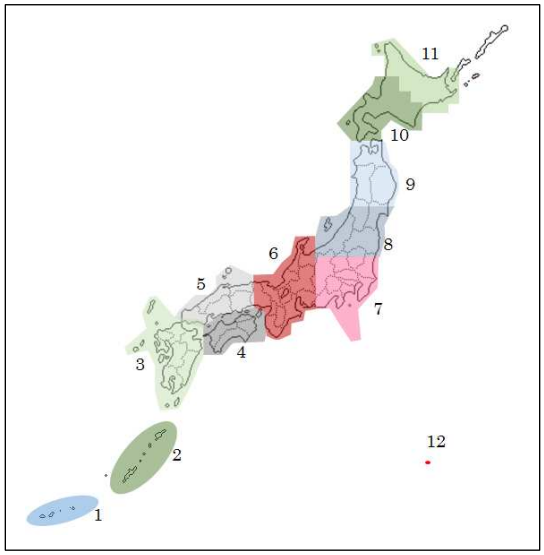


Figure.1 Evaluation Area Division

In the positioning calculation, the CLAS test library (CLASLIB; Centimeter Level Augmentation Service Test Library), an open-source toolkit for PPP-RTK (Precise Point Positioning - Real-Time Kinematic), and the archived L6 messages are utilized (*2).

As a reference position, a precise current coordinate for each reference station provided by the Geospatial Information Authority of Japan (GSI), called an “F3 solution” are used. As a positioning signal, GPS L1C/A-L2P, QZSS L1C/A-L2C, and Galileo E1b-E5a are utilized in the CLASLIB’s positioning calculation.

3.2. Availability

The availability metric for the L6D signal utilized in CLAS is evaluated every second for all evaluation period of 1stH FY2023 based on the definition of QZSS Performance Standard (PS-QZSS) Section 6.4.

3.3. Continuity

Continuity reports unscheduled interruptions that occur during the period.

The unscheduled interruption is the outage without a notification at least 48 hours in advance.

3.4. Integrity

Integrity reports integrity risks that occur during the period.

The integrity risk is the unhealthy condition without a timely alarm.

4. Evaluation Result

4.1. Accuracy

Table.1 and Table.2 show the monthly horizontal and vertical 95th percentile values of the static and kinematic positioning accuracy for each month, respectively.

In addition, Figure.1 and Figure.2 show the cumulative frequency distributions in all areas of the static and kinematic positioning accuracy, respectively.

Table.1 Monthly 95th Percentile Values of Static Positioning Accuracy

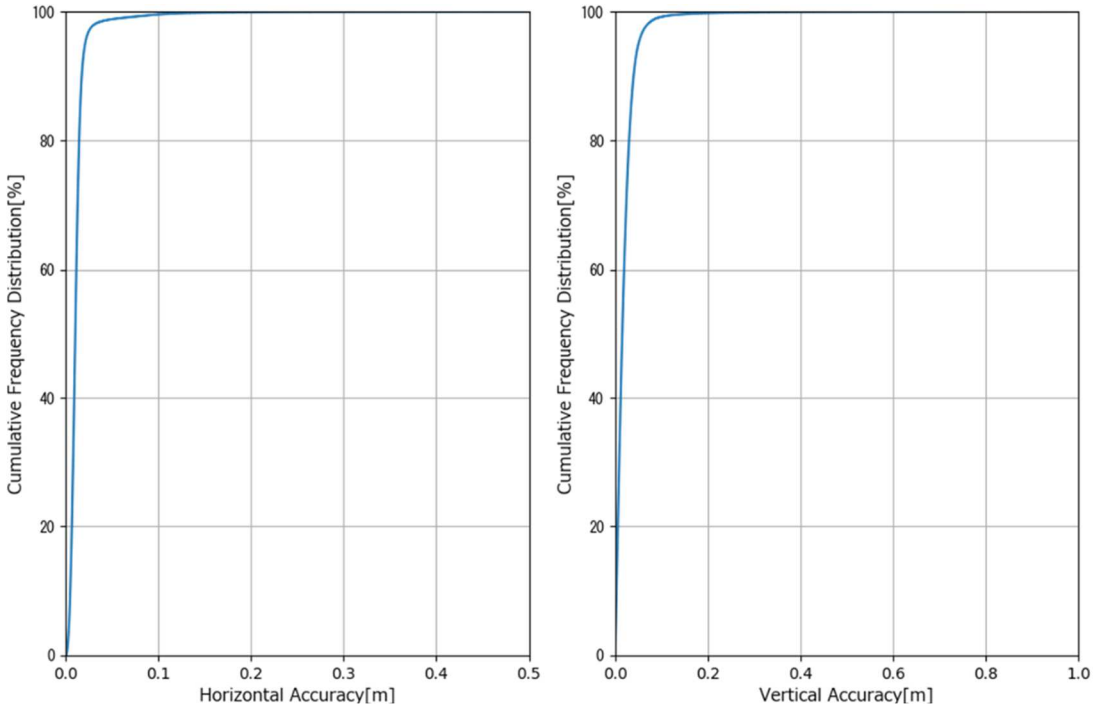
Area	Positioning Accuracy (95%) [cm]											
	April		May		June		July		August		September	
	H	V	H	V	H	V	H	V	H	V	H	V
1	1.6	2.4	1.5	2.3	1.3	2.5	1.4	3.8	1.5	4.4	1.5	3.0
2	2.3	4.7	2.0	4.2	2.1	4.9	1.8	5.1	1.9	5.0	2.2	5.5
3	1.8	6.1	1.8	7.1	1.8	7.4	1.8	7.2	1.6	8.1	1.7	7.3
4	1.5	3.8	1.9	4.1	2.1	4.4	1.7	4.0	1.9	4.7	1.7	4.4
5	2.4	4.5	2.6	4.4	7.1	9.7	2.5	5.6	3.1	6.4	2.0	4.1
6	1.8	3.7	1.9	3.4	5.8	8.1	2.8	5.4	2.5	5.5	1.8	5.2
7	2.0	4.3	2.1	4.0	2.4	4.8	2.1	4.5	1.7	4.3	2.0	4.3
8	1.8	3.8	1.9	3.5	2.3	4.5	2.4	6.4	2.0	5.6	1.9	5.2
9	2.4	3.2	2.3	3.1	2.4	3.4	2.1	3.9	1.7	3.8	1.9	4.1
10	2.1	5.0	2.1	4.7	2.1	4.7	2.2	5.8	2.4	6.0	2.0	5.4
11	2.3	4.6	2.1	3.8	2.3	4.0	2.7	5.3	2.4	5.1	1.9	5.0
12	16.1	12.7	6.8	3.9	1.1	1.5	8.0	6.6	1.6	3.8	17.2	16.7
total	2.1	4.6	2.0	4.3	2.3	5.0	2.1	5.5	2.0	5.6	1.9	5.2

* H=Horizontal, V=Vertical

Table.2 Monthly 95th Percentile Values of Kinematic Positioning Accuracy

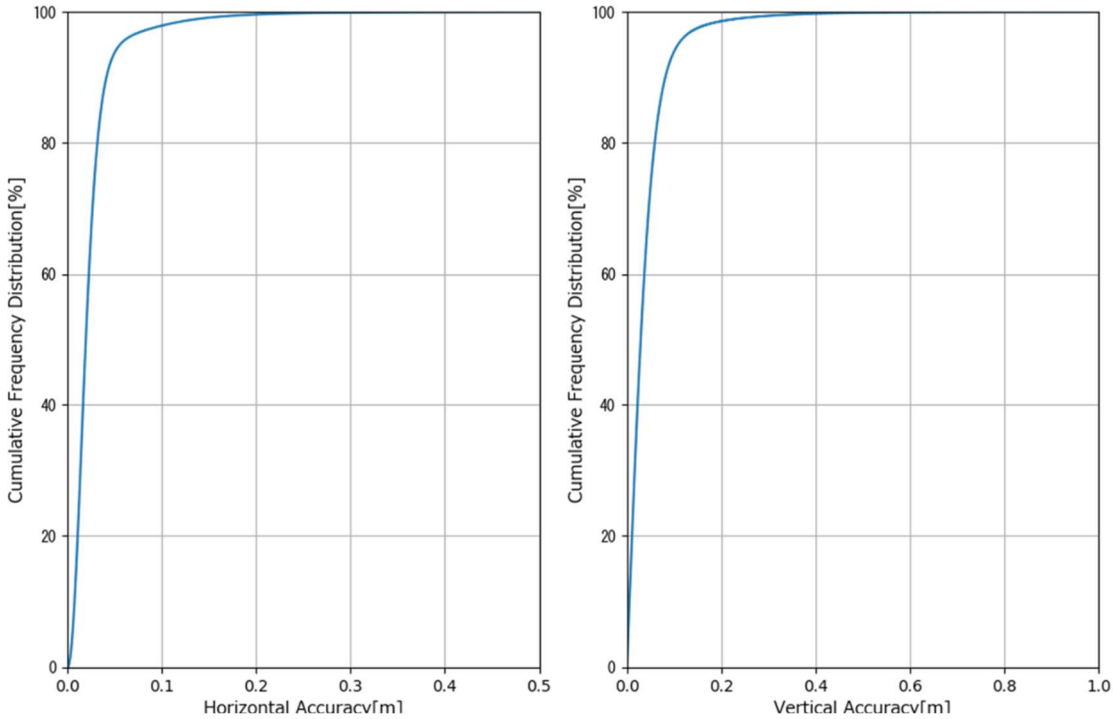
Area	Positioning Accuracy (95%) [cm]											
	April		May		June		July		August		September	
	H	V	H	V	H	V	H	V	H	V	H	V
1	6.1	11.3	4.0	8.4	3.8	7.6	3.6	7.3	4.6	9.2	5.9	10.9
2	14.1	21.8	9.2	15.2	11.6	17.7	6.1	12.5	11.4	19.3	11.2	19.8
3	5.4	11.7	5.6	12.7	10.7	17.6	5.4	12.9	6.0	14.5	5.8	13.0
4	3.9	8.0	4.4	8.9	9.9	16.0	4.3	9.6	5.6	11.6	4.4	9.5
5	4.6	8.9	5.7	10.2	12.1	18.3	5.3	11.4	6.5	12.0	4.3	8.8
6	4.1	7.8	4.7	9.5	12.4	18.7	6.5	12.3	6.2	12.3	4.3	9.1
7	5.1	9.1	5.0	9.4	9.7	15.2	5.9	11.9	5.5	11.4	4.6	9.2
8	4.3	8.4	4.6	9.2	10.5	16.7	6.3	12.8	5.5	12.2	4.5	10.3
9	5.2	7.9	4.8	8.2	8.0	11.9	5.2	10.0	5.2	10.0	4.9	9.4
10	4.6	8.9	4.4	8.7	5.3	10.1	5.2	10.7	4.7	10.4	4.5	9.6
11	5.5	8.2	4.8	7.7	5.6	9.2	5.7	9.9	5.4	9.5	4.8	8.8
12	24.7	36.6	14.1	16.4	3.7	7.0	15.9	19.9	10.9	16.4	23.4	33.2
total	5.4	9.6	4.9	9.6	8.9	13.8	5.4	11.1	5.6	11.6	5.1	10.4

* H=Horizontal, V=Vertical



(a)Horizontal Accuracy (b) Vertical Accuracy

Figure.1 Cumulative Frequency Distribution of Static Positioning in all areas



(a)Horizontal Accuracy (b) Vertical Accuracy

Figure.2 Cumulative Frequency Distribution of Kinematic Positioning in all areas

4.2. Availability

Table.3 shows the availability for the evaluation period.

Table.3 Availability

Metric			Specification	Availability
Constellation Service Availability			≧0.99	1.000
Service Availability by Each QZS	SVN002 (PRN194)	QZO	≧0.97	1.000
	SVN003 (PRN199)	GEO		1.000
	SVN004 (PRN195)	QZO		1.000
	SVN005 (PRN196)	QZO		0.999
Constellation Service Availability at High Elevation Angles		Northern limit[*3]	≧0.83	0.895
		Southern limit[*3]		1.000

4.3. Continuity

Table 4 shows the continuity for the evaluation period.

Table.4 Continuity

Satellite	Integrity
SVN002 (PRN194)	No unscheduled interruptions occurred during the period.
SVN003 (PRN199)	No unscheduled interruptions occurred during the period.
SVN004 (PRN195)	No unscheduled interruptions occurred during the period.
SVN005 (PRN196)	Unscheduled interruptions occurred on [Jun. 19, 2023] (NAQU 2023100), [Sep. 8, 2023] (NAQU 2023127), [Sep. 23, 2023] (NAQU 2023140).

4.4. Integrity

Table 5 shows the integrity for the evaluation period.

Table.5 Integrity

Satellite	Integrity
SVN002 (PRN194)	No integrity risks occurred during the period.
SVN003 (PRN199)	No integrity risks occurred during the period.
SVN004 (PRN195)	No integrity risks occurred during the period.
SVN005 (PRN196)	No integrity risks occurred during the period.

Note

*1 The evaluation continuously operating reference stations (CORS) included in each area are shown in Table A.

Table A. Evaluation Station List

Area	Station Name (Station ID)
1	IRIOMOTEJIMA (950500), IRABU(960747), TARAMA(960748), ISHIGAKI1(960749), HATERUMAJIMA(960751)
2	HONBU(950496), KIKAI2(960732), SETOUCHI(960733), CHATAN(021095)
3	KAMIYAKU1(950493), FUKUOKATAKATA(970831), AZUMA(960717), FUKUOKA(021062), TSUIKI(021064), HAYATO(021089), MOITOTSUKA(021083), OOSUMI(021090)
4	IYO(950434), MISHOU(950437), MARUGAME(960677), YUGE(960678), MUROTO4(031122)
5	YANAI(950414), MISUMI(950388), OKAYAMAOOHARA(950390), OKAYAMACYUO(950393), YONAGO-A(111187)
6	MATSUZAKA(950311), FUKUCHIYAMA(950329), MIZUHO(950331), TAKARAZUKA(950353), UNAZUKI(020967), ANAMIZU(020972), GIFU-A(031128), MARUOKA(950257)
7	TSUKUBA3(960627), IRUMA(960755), TAKATOO(020987), SANO(93001), SAKURAGAWA(93010), KOMUROYAMA(93048),ITO A(101183)
8	SHICHIKASHUKU(950180), OOGATA(950241),TAKASHIMIZU(020915), KAMIYAMA(960557), KANAI(960565)
9	IWATE(950161), KESENNUMA(950172), GOJOUME(950186), MINASE(950193), SAWAUCHI(020908), TOWADAKO1(020899), MAMUROGAWA(020930), HIRANAI-A(091175)
10	BIEI(940007), IKEDA(940011), SHIKABE(950147), OTARU2(960517), NAGANUMA(940014), MAKUBETSU(020889), URAKAWA(020891), SHINTOTSUKAWA2(022005)
11	HABORO2(020855), ASHORO(950121), AKAN1(950124), RISHIRI(960501), BIHORO(960507), NEMURO4(960519), HAMATONBETSU(970779), NAKATONBETSU(020850), NEMURO1A(101182)
12	CHICHIJIMA-A(052007)

*2 CLASLIB is available at the following web address:
https://qzss.go.jp/technical/dod/clas/clas_test-library.html
Archives are available at the following web address:
https://sys.qzss.go.jp/dod/archives.html

*3 The northern limit is defined as 45.6°N, 148.8°E, and the southern limit as 24.4°N, 122.9°E.