INTERNATIONAL STANDARD

ISO 24245

Space systems — Global navigation satellite system (GNSS) receiver class codes

Systèmes spatiaux — Codification des récepteurs de systèmes mondiaux de satellites de navigation (GNSS)

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles,* Subcommittee SC 14, *Space systems and operations.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is a specification of downstream space-based services. Space systems provide a huge merit for the society and economy in each country today; and downstream space-based services contribute to people's quality of life across the world. Space systems should be utilized furthermore in the industry worldwide in the future. Space systems are utilized in other areas as well. Therefore, this document has harmonized the content in areas relevant to the global navigation satellite system (GNSS) as shown in Figure 1.
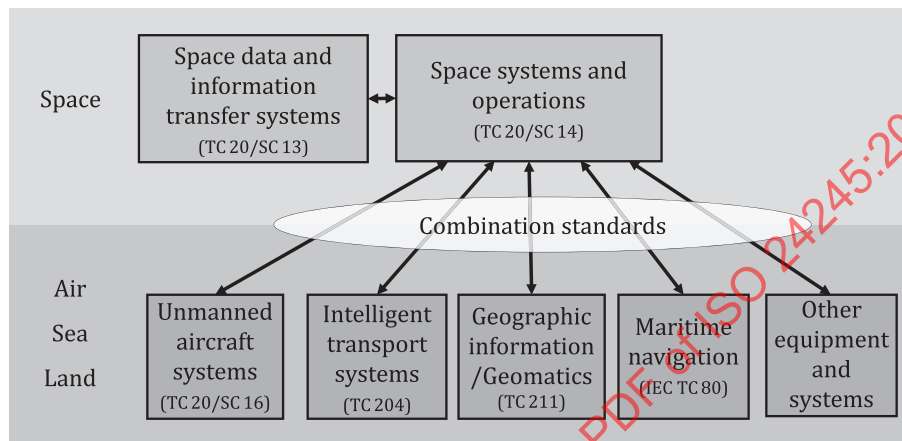

Figure 1 — Standardization of space-based services (GNSS-relevant areas)

In the initial decades of the 21st century, several countries have provided their constellations of GNSS, and it has been utilized as an international public service. GNSS technology has progressed and become more complicated, for example, to handle multiple frequencies from multiple constellations, and to provide services such as carrier-phase measurement, precise point positioning, and so on.

As a result, for users who want to try new GNSS technology, there are too many GNSS receivers to choose from to find the product matching their needs.

In order to solve this problem, a set of GNSS receiver class codes has been developed. It was released into the market as a trial program and has received high evaluation from GNSS stakeholders in commercial and governmental scenes in a certain region. It is recognized to be contributable to the promotion of GNSS utilization.

The set of GNSS receiver class codes facilitates easier choice for users and sales expansion for sellers; it also provides the direction of development and business strategies for manufactures and the framework of policy making for governments and public sectors.

This document aims to promote the utilization of GNSS receiver class codes in the international market for stakeholders of space-based positioning, navigation and timing services around the world.

The GNSS environment has been drastically improved and more widely used in recent years with the development GNSS space system infrastructure by several countries.

Against this background, GNSS receivers become diverse and accept multi-constellation. One receiver also equips various functions. There are receivers for specified regions and timing-dedicated receivers.

This document symbolizes "receiver class" to "codes" from the point of view of positioning, timing, and messaging functions. Regarding these functions, positioning is for determining the position, timing is for determining the time or time interval or both, and messaging is for transmitting or receiving message or both.

By using this document, it is expected that end users can understand the types of GNSS signal their devices receive from navigation satellites. On the other hand, receiver providers can easily present their products' features which depend on the signals of the receiver. Figure 2 represents the above effects.
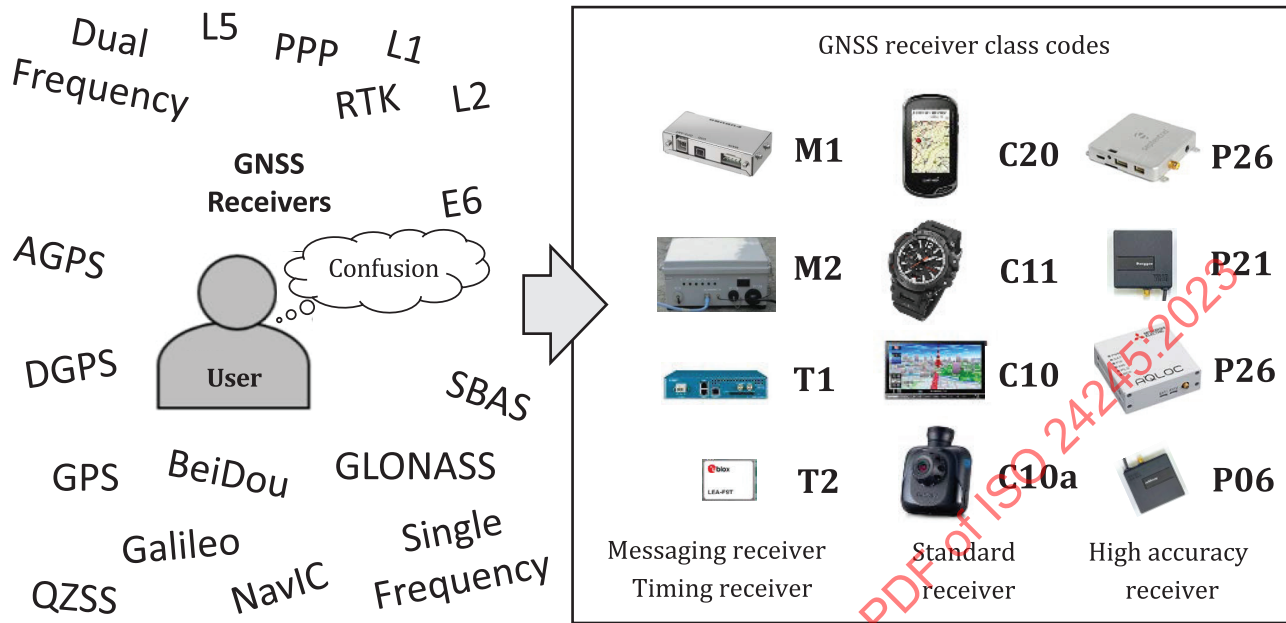

Figure 2 — GNSS receiver class codes for an efficient market

Some GNSS receivers are equipped with the following functions: detection of attitude, mobile communication using Wi-Fi, etc. This document does not treat these functions.

Space systems — Global navigation satellite system (GNSS) receiver class codes

1   Scope

This document specifies class codes to classify global navigation satellite system (GNSS) receivers. The class codes represent how signals transmitted from radionavigation satellites are processed.

This document applies to all types of GNSS receiver devices.

The class codes in this document are not applicable to the following items:

— condition of radionavigation satellites;

— radio propagation environment including multipath, masking and obstacle;

— additional antenna of a receiver device;

— additional application software in a receiver device.

2   Normative references

There are no normative references in this document.

3   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
receiver
device (3.2) with associated antenna or including an antenna, used to select the desired radio-frequency signals from the incident radio-frequency radiation, to amplify them, demodulate them and if necessary, convert the recovered signals into a directly usable form

[SOURCE: IEC 60050-713:1998, 713-10-02, Modified — "such as sounds or pictures" has been deleted at the end of the definition.]

3.2
device
material element or assembly of such elements intended to perform a required function

Note 1 to entry: A device may form part of a larger device.

[SOURCE: IEC 60050-151:2001, 151-11-20]

3.3
GNSS receiver
receiver (3.1) to determine the user position, velocity, and/or precise time by processing the signals broadcasted by *radionavigation* (3.6) satellites

3.4
radiodetermination
determination of the position, velocity and/or other characteristics of an object, of the obtaining of information relating to these characteristics, by means of radio waves

[SOURCE: IEC 60050-725:1994, 725-12-48]

3.5
satellite radiodetermination
radiodetermination (3.4) which makes use of a satellite system

[SOURCE: IEC 60050-725:1994, 725-12-49]

3.6
radionavigation
radiodetermination (3.4) used for the purpose of navigation, including obstruction warning

[SOURCE: IEC 60050-725:1994, 725-12-50]

3.7
satellite radionavigation
satellite radiodetermination (3.5) used for *radionavigation* (3.6)

[SOURCE: IEC 60050-725:1994, 725-12-51]

3.8
code-based positioning
positioning based on code-phase measurement without integer ambiguity resolution

Note 1 to entry: A code-based positioning *receiver* (3.1) may be equipped with the carrier-smoothing function.

3.9
phase-range
range measured by using carrier-phase with integer ambiguity resolution

Note 1 to entry: See RTCM standard 10403.3, 3.5.

3.10
state space
space defined by the state variables as axes of a vector space, in which every vector represents a state of the system

[SOURCE: IEC 60050-351:2013, 351-41-09]

3.11
observation space
space defined by the observation variables as axes of a vector space, in which every vector represents a observation variable of the system

3.12
SSR
state space representation
representation of a valuable in a *state space* (3.10)

Note 1 to entry: See RTCM standard 10403.3, 3.5.13.

Note 2 to entry: SSR is a mathematically orthogonal representation of parameters.

3.13
OSR
observation space representation
representation of a valuable in an *observation space* (3.11)

Note 1 to entry: See RTCM standard 10403.3, 3.5.13.

3.14
GNSS authentication
function to authenticate the signal from GNSS

4 Abbreviated terms

3GPP	third generation partnership project (mobile communication)
BDS	BeiDou Navigation Satellite System (China)
BIM	building information modelling
CIM	construction information modelling
CORS	continuously operating reference station
DFMC	dual frequency and multi constellation
DGNSS	differential GNSS
GLONASS	NAvigation Satellite System (Russian Federation)
GNSS	global navigation satellite system
GPS	Global Positioning System (U.S.A.)
ICD	interface control document
ICG	International Committee on Global Navigation Satellite Systems (UN)
IMU	inertial measurement unit
LEO	low Earth orbit
LiDAR	light detection and ranging or laser imaging detection and ranging
LBS	location-based service
PPP	precise point positioning
QZSS	Quasi-Zenith Satellite System (Japan)
RTCM	Radio Technical Commission for Maritime Services
RTK	real-time kinematic GNSS positioning
SBAS	satellite based augmentation system
SSV	space service volume
TTFF	time to first fix
UAS	unmanned aircraft system

5 Code system

5.1 Positioning

5.1.1 General

The GNSS receiver class codes shall be specified as shown as Table 1. These codes are used not only satellite positioning, but also in satellite radionavigation.

Table 1 — Codes on positioning

Function		Ranging		Augmentation or correction	
C	Code-based positioning	C1	Single frequency ranging	C10	No augmentation
				C11	DGNSS OSR correction
				C16	SSR correction without fixed phase-range
		C2	Dual or multiple frequency ranging	C20	No augmentation
				C25	DFMC SBAS
				C26	SSR correction without fixed phase-range
P	Phase-range positioning	P0	No ranging	P06	Input: SSR correction Output: OSR correction
		P1	Single frequency ranging	P11	OSR correction
				P16	SSR correction
		P2	Dual or multiple frequency ranging	P21	OSR correction
				P26	SSR correction

Continuation of Table 1		Continuation of C1	C10a	C10 with authentication
			C11a	C11 with authentication
			C16a	C16 with authentication
		Continuation of C1	C20a	C20 with authentication
			C25a	C25 with authentication
			C26a	C26 with authentication
		Continuation of P0	P06a	P06 with authentication
		Continuation of P1	P11a	P11 with authentication
			P16a	P16 with authentication
		Continuation of P2	P21a	P21 with authentication
			P26a	P26 with authentication

Corrections have two types: OSR and SSR. SSR covers wider area than OSR. Further, these services shall provide integrity information.

OSR is a representation of correction in observation form such as pseudorange. It is represented as a factor in observation space, which is a mathematical vector space.

On the other hand, SSR is another representation of correction as error factors, such as satellite clock and orbit errors, signal bias, ionospheric error, which is a state in a state space, a mathematical vector space.

In this document, the correction that represents an error element is generically termed SSR. For example, the SBAS corrections may be termed SSR in this case. They are distinguished from RTCM SSR which was developed for the dissemination specific SSR information parameters. The SSR correction shall also include integrity information for users.

The OSR corrections are used in the method of RTK and network RTK GNSS positioning. The SSR corrections are used in the method of PPP and PPP-RTK

C16, C16a, C26 and C26a are examples as per ISO 18197:2015, 5.4.1, which explains that certain kind of positioning augmentation data are used for the meter-class augmentation or submeter-class augmentation.

See Annex A as use examples of the receiver class codes for positioning devices and terminals.

5.1.2   C10, C10a

Code C10 shall be applied to a GNSS receiver to:

— enable code-based point positioning;

— use single frequency ranging signal.

Code C10a shall be applied to the C10 receiver to be equipped with the GNSS authentication.

5.1.3   C11, C11a

Code C11 shall be applied to a GNSS receiver to:

— enable code-based positioning;

— use single frequency ranging signal;

— augmented using DGNSS OSR augmentation.

Code C10a shall be applied to the C11 receiver to be equipped with the GNSS authentication.

5.1.4   C16, C16a

Code C16 shall be applied to a GNSS receiver to:

— enable code-based positioning;

— use single frequency ranging signal;

— correct the positioning using SSR correction.

For example, the positioning using this class receiver is specified in ISO 18197:2015, 5.4.1.

Code C16a shall be applied to the C16 receiver to be equipped with the GNSS authentication.

5.1.5   C20, C20a

Code C20 shall be applied to a GNSS receiver to:

— enable point positioning;

— use dual or multiple frequency ranging signals.

Code C20a shall be applied to the C20 receiver to be equipped with the GNSS authentication.

5.1.6 C25, C25a

Code C25 shall be applied to a GNSS receiver to:

— enable code-based positioning;

— use dual or multiple frequency ranging signals;

— augment using DFMC SBAS.

Code C25a shall be applied to the C25 receiver to be equipped with the GNSS authentication.

5.1.7 C26, C26a

Code C26 shall be applied to a GNSS receiver to:

— enable code-based positioning;

— use dual or multiple frequency ranging signals;

— correct the positioning using SSR correction.

For example, the positioning using this class receiver is specified in ISO 18197:2015, 5.4.1.

Code C26a shall be applied to the C26 receiver to be equipped with the GNSS authentication.

5.1.8 P06, P06a

Code P06 shall be applied to a GNSS receiver to:

— input SSR correction data;

— output OSR correction data.

NOTE   The P06 receiver emerged when low-cost RTK receivers became widely available and SSR augmentation services became more widespread (in the late 2010s). A P06 receiver transforms SSR to OSR. Users can benefit from applying high performance SSR correction using their low-cost RTK receivers.

5.1.9 P11, P11a

Code P11 shall be applied to a GNSS receiver to:

— enable phase-range positioning;

— use single frequency ranging signal;

— use RTK or Network RTK or both.

Code C11a shall be applied to the C11 receiver to be equipped with the GNSS authentication.

5.1.10 P16, P16a

Code P16 shall be applied to a GNSS receiver to:

— enable phase-range positioning;

— use single frequency ranging signal;

— correct the positioning using SSR correction.

Code C16a shall be applied to the C16 receiver to be equipped with the GNSS authentication.

5.1.11 P21, P21a

Code P21 shall be applied to a GNSS receiver to:

— enable phase-range positioning;

— use dual or multiple frequency ranging signal;

— use RTK or Network RTK or both.

Code P21a shall be applied to the P21 receiver to: be equipped with the GNSS authentication.

5.1.12 P26, P26a

Code P26 shall be applied to a GNSS receiver to:

— enable phase-range positioning;

— use dual or multiple frequency ranging signals;

— correct the positioning using SSR correction data.

Code P21a shall be applied to the P26 receiver to be equipped with the GNSS authentication.

5.2 Timing

5.2.1 General

GNSS receiver class codes on timing shall be specified as shown as Table 2.

Table 2 — Codes on timing

Function			Signal usage
T	Timing (Time and time interval)	**T1**	Single frequency band
		T2	Dual or more frequency bands

5.2.2 T1

Code T1 shall be applied to a timing receiver using single frequency signal.

5.2.3 T2

Code T2 shall be applied to a timing receiver using dual or more frequency signal.

5.3 Messaging

5.3.1 General

GNSS receiver class codes on messaging shall be specified as shown as Table 3.

Table 3 — Codes on messaging

Function			Signal usage
M	Messaging with positional information	**M1**	One-way communication or broadcasting
		M2	Two-way communication

5.3.2   M1

Code M1 shall be applied to a one-way communication or broadcasting messaging receiver.

5.3.3   M2

Code M2 shall be applied to a two-way communication messaging receiver.

6   Conditions to classify receivers

These codes are applied to all receivers including devices and terminals that enable GNSS positioning.

The codes refer to GNSS signal types to receive from GNSS satellites.

Therefore, the codes do not depend on the environment in use and GNSS satellite alignments.

If the implementation of peripheral devices and software creates limitations on the positioning function, the codes refer to the signals to be received as results.

The codes do not depend on the excellence of positioning performances such as accuracy, sensitivity, and TTFF.

7   Multiple labelling

When a certain GNSS receiver has multiple functions, the GNSS receiver class codes can be written for this receiver.

EXAMPLE   When a certain GNSS receiver has the function of "P21" which outputs OSR, and also it has the function of "P26" which outputs SSR, the GNSS receiver class code for this GNSS receiver can be written as "P21 P26".

Annex A
(informative)

Examples of GNSS application

This annex provides examples of GNSS application and indicates the GNSS receiver class codes that should be applied to adequate GNSS applications. See Tables A.1 to A.10.

Each example of GNSS applications has utilized ISO/IEC and ICAO standards[6-12] using GNSS constellations[13-28].

According to the EUSPA EO and GNSS Market Report,[29] 7 billion GNSS devices are installed on the planet. People around the world have close connection with the GNSS space system (navigation satellites) and enjoy positioning, navigation and timing services.

United Nations' International Committee on GNSS (ICG)/Working Group B/Application Sub-Group (AppSG) has studied GNSS applications. [30]

Advanced applications have been created by GNSS technology [31-53] for land, maritime, aeronautics, and space uses.

Table A.1 — Application examples of earth observation

No.	Area	Code	Application	Remarks
1-1	Earth observation	P20 P26 P10	Crustal movement observation Meteorological observation Tropospheric observation Ionospheric observation	
1-2	Land disaster pre-vention	P20 P26 P10	Landslide monitor Volcano monitor Earthquake monitor	
1-3	Water reservoir management	P20 P26 P10	Dum displacement monitor Boat positioning of water depth monitor	
1-4	Marine disaster prevention	P20 P26 P10	Tsunami monitoring buoy Port management buoy	

Table A.2 — Application example of precise land service

No.	Area	Code	Application	Remarks
2-1	Surveying and mapping	P20 P26 P10	Crustal movement observation Meteorological observation Tropospheric observation Ionospheric observation	
2-2	Reference station	P20	CORS station RTK reference station DGNSS reference station	
2-3	Facility Management	P20 P26 P10	Slope monitoring sensor network Building monitoring sensor network Bridge monitoring sensor network Expressway monitoring sensor network Rail monitoring sensor network Bank monitoring sensor network Runway monitoring sensor network	
2-4	BIM/CIM	P20 P26	BIM system CIM system	

Table A.3 — Application example of location-based service (LBS)

No.	Area	Code	Application	Remarks
3-1	Mass production front edge	C10 C20	Smartphone Smart pad Wi-Fi tablet	There are receivers which equip GNSS raw measurement.
3-2	3GPP precise positioning device	P10 P20 P26	Device of 3GPP release 15 Device of 3GPP release 16	RTK, NRTK, PPP, and PPP-RTK
3-3	LBS device	C10 C20 C10A C20A	Cellular phone Smartwatch Laptop computer Portable game terminal Digital camera GPS tracker Wearable device Golf navigator Golf watch Golf range finder Geofence device GPS data logger	
3-4	Bicycle	C10 C20	Bicycle computer Bicycle navigator	

Table A.3 *(continued)*

No.	Area	Code	Application	Remarks
3-5	Wheelchair	C10 P20 P26	Electric wheelchair Wheelchair navigation	

Table A.4 — Application examples of automotive service

No.	Area	Code	Application	Remarks
4-1	Passenger vehicle	C10 C11 C20 C10A C20A	Car navigation Drive recorder Electric toll collection LiDAR detector	
4-2	Work vehicle	C10 C11 C20	Bus location system Taxi management system Service vehicle management system Emergency vehicle management system Vehicle management system	
4-3	Precise work vehicle	P20 P26	Snowplough Road-cleaning vehicle	
4-4	Motorbike	C10 C11 C20	Motorbike navigation Motorbike computer	
4-5	Rail	C10 C11 P20 P26	Train positioning system Rail management system Terminal management system	
4-6	Automotive R&D	C10A C20A P20 P26	Vehicle precise motion monitor Car test system	
4-7	Car trainer	P20	Car license training system	

Table A.5 — Application examples of maritime service

No.	Area	Code	Application	Remarks
5-1	Vessel	C10 C11 C20 C25	Vessel navigation Automatic Identification System (AIS) Global Maritime Distress and Safety System (GMDSS) Electronic Chart Display and Information System (ECDIS) Autopilot GNSS compass Search and rescue Fishery Ocean survey Resource survey Fish detector	
5-2	Docking	P21 P26	Automated docking	
5-3	Submarine	C10 C20 P21 P26	Submarine Autonomous underwater vehicle	
5-4	Plant	P21 P26 P11	Drill rig displacement monitor Oil rig displacement monitor Main pipeline settlement	
5-5	Marine civil work	P11 P21 P26	GNSS surveying (dual band) GNSS surveying (single band) GNSS/IMU	

Table A.6 — Application examples of manned aviation service

No.	Area	Code	Application	Remarks
6-1	Civil aviation	C11 C25	Autopilot Flight Control System Navigation System Survey drone Radionavigation aids Landing aids Secondary surveillance radar Multilateration Airport vehicle management system	

Table A.7 — Application examples of automated machinery

No.	Area	Code	Application	Remarks
7-1	Agriculture	P21 P26	Tractor Combine Harvester Binder / Reaper-binder Rotary tiller Rice planter Truck Light truck Agricultural machinery	
7-2	Forestry	P21 P26	Harvester	
7-3	Construction	P21 P26	Bulldozer Grader Hydraulic excavator/ digger Rough terrain crane Shovel Backhoe / rear actor / back actor Truck	
7-4	Mining	P21 P26	Power shovel Dozer Truck	