EUP⊛S®

European Position Determination System

Technical Standards

Revised 3rd Edition
May 7, 2013
Resolution of the International *EUPOS®* Steering Committee
23rd Conference, Tbilisi, Georgia, 7 - 8 May 2013

Contents:

1 General

From the very beginning of its operation, EUPOS was designed to support multi-constellation GNSS, providing various signals to the users, ensuring that the widest possible variety of end-user equipment supports services offered by EUPOS. Taking into account political and geographical aspects, EUPOS promotes the European system Galileo. To enhance the performance, robustness and availability of position solutions in GNSS-challenged environments (urban canyons, tree canopies), it is recommended to develop EUPOS as a multi-GNSS oriented system supporting all available GNSSs. The list of required and recommended signals of all GNSSs supported by EUPOS is the subject of Appendix A.3.

EUPOS also aims at ensuring compatibility and interoperability between the EUPOS members (providers), which means that EUPOS users who meet EUPOS Technical Standards could use the EUPOS services anywhere within the EUPOS network. Necessary prerequisite for compatibility and interoperability is also the implementation of a uniform reference frame throughout the EUPOS network.

It is highly advised to implement the realization of ETRS89, recommended by the EUREF Technical Working Group (TWG), as a coordinate reference system for EUPOS services. The EUPOS National Service Centres are also encouraged to provide the EUPOS users with the official national solutions of the height transformation surfaces to enable them to make a conversion between GNSS-based ellipsoidal heights in ETRS89 and physical (sea level) heights in the national height system.

In order to ensure availability, quality and reliability of its services, EUPOS introduces standard measures of quality monitoring.

The following section specifies minimum general requirements for any GNSS augmentation system working within the EUPOS framework.

1.1 Global Navigation Satellite Systems

1.1.1 *EUPOS* uses the following GNSS as described:

1.1.1.1 European Galileo as basic standard when Galileo FOC is declared;

1.1.1.2 U.S. Global Positioning System (NAVSTAR GPS) as basic standard;

1.1.1.3 Russian Global Navigation Satellite System (GLONASS) as optional standard;

1.1.1.4 Chinese BeiDou as optional standard.

1.2 EUPOS coordinate reference system and datum

1.2.1 The official datum for EUPOS is the European Terrestrial Reference System 1989 (ETRS89).

1.2.2 If the official national datum differs from that described in 1.2.1, the EUPOS National Service Centre shall provide the EUPOS users with the official precise parameters for coordinate transformation between ETRS89 and the official national coordinate reference system.

1.3 EUPOS availability

1.3.1 EUPOS ensures annual system availability of at least 99%, guaranteed by appropriate EUPOS technical and organisational measures.

2 EUPOS services

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EUPOS provides all services utilizing Internet as the primary medium for two-way communication with its users, therefore this is the minimum required medium in all cases. However, in some applications and with special user requirements, especially when the services are provided locally, other means of communication are also encouraged, such as broadcast transmission utilizing radio or TV frequencies and also Internet protocols designed for broadcast transmission such as UDP, etc.

As an example, the EUPOS DGNSS service for a limited area (up to. 200 km radius) could be provided with a minimum loss of precision as a single point broadcast, and therefore, typical broadcast media can be used for that purpose. Another example is the provision of the Network RTK service as a single fixed MAC cell or FKP data, again in a limited area. Nevertheless, in order to ensure that all EUPOS users meet the hardware and software requirements for the service, all services are required to be provided via Internet.

Required minimum sets of messages concerning RTCM standard 10403.1 used in the EUPOS DGNSS and EUPOS Network RTK services are listed in Appendix A.4.

In order to ensure a full exploitation of the GNSS reference station hardware, the EUPOS providers are encouraged to provide also the single station RTK within all available GNSSs mentioned in 1.1.1. from the stations that track more GNSSs than those included in the network RTK solutions.

Additionally, even though certain concepts of network RTK have been selected as a minimum required service for the EUPOS Network RTK, the providers are encouraged to support all concepts that are mentioned in the RTCM 10403.1 standard (ie. FKP). Even though not all providers will be able to deliver network RTK corrections with regard to each of those concepts, the implementation of more than the required two solutions will provide much better service for a variety of EUPOS users in the field and potential applications.

According to the EUPOS Geodetic minimum requirements concerning the user interface, one should take into account when planning to update the functionality of the software that stores observation data and generates data for the users, that a transition from common use of RINEX 2.11 format to RINEX 3.x format is foreseen in the nearest future. That is why, besides the required data provision in RINEX 2.11 for EUPOS Geodetic users, the providers are encouraged to promote the usage of RINEX 3.x data file format, which fully supports GPS, GLONASS and GALILEO constellations.

The standard EUPOS payment and accounting schemes, which are recommended to the EUPOS National Service Centres, are defined in the Table 2.1 below. However the EUPOS service provider may define additional charges and accounting schemes, also for other, non-standard EUPOS services, ie. transformation parameters, vertical datum definition, etc. The choice of an accounting scheme and payment methods is subject to individual EUPOS provider's decision.

Table 2.1. EUPOS payment and accounting schemes.

EUPOS service	Time instalment/ frequency	Unit	Charge	Remarks
DGNSS	1 Hz	1 minute	1 unit or flat sum	for one area unit*
Network RTK	1 Hz	1 minute	1 unit or flat sum	for one area unit*
Geodetic	≤ 1 Hz	1 hour or 1 day	1 unit or flat sum	for one area unit* or for 1 reference station

* The service provider might divide the area of operations into sub-regions (area units), not necessarily implementing the same accounting scheme to the area as a whole.

The charges are individually collected by the service provider.

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2.1 EUPOS provides the following EUPOS services for Differential GNSS applications utilizing Internet as the medium for data transmission:

2.1.1 EUPOS DGNSS for real-time applications by single-frequency pseudorange or pseudorange and carrier-phase measurements with sub-metre to decimetre level accuracy;

2.1.2 EUPOS Network RTK for real-time applications by multi-frequency carrier phase measurements with centimetre accuracy;

2.1.3 EUPOS Geodetic for post processing applications by code and carrier-phase measurements in static or kinematic mode with decimetre up to sub-centimetre accuracy.

2.2 EUPOS DGNSS

2.2.1 For real-time navigation and real-time position determination with sub-metre to decimetre accuracy, depending on the applied rover equipment, EUPOS provides DGNSS corrections.

2.2.2 The user interface for EUPOS DGNSS consists of:

2.2.2.1 RTCM 10403.1 standard data format;

2.2.2.2 RTCM 10402.3 standard data format for ensuring backward compatibility, although required no longer than until December 31, 2015;

2.2.2.3 RTCM 10410.1 (NTRIP version 2.0) standard for the data transmission via Internet.

2.2.3 EUPOS service providers shall provide EUPOS ISCO the up-to-date information on the Internet address(es) of the NTRIP caster(s) for EUPOS DGNSS access.

2.3 EUPOS Network RTK

2.3.1 For precise real-time position determination with an accuracy $\leq$ 2 cm (horizontal RMS) EUPOS provides network RTK correction.

2.3.2 The user interface for EUPOS Network RTK consists of:

2.3.2.1 RTCM 10403.1 standard data format;

2.3.2.2 RTCM 10402.3 standard data format (non-physical reference station) for ensuring backward compatibility, although required no longer than until December 31, 2015;

2.3.2.3 NMEA 0183 version 3.01 standard format, GGA string, for estimating the user position to generate location-specific EUPOS Network RTK messages;

2.3.2.4 RTCM 10410.1 (NTRIP version 2.0) standard for the data transmission via Internet.

2.3.3 To ensure EUPOS users' hardware compatibility between different EUPOS service providers, the provider shall support two most common network RTK concepts mentioned in RTCM 10403.1, namely non-physical reference station (ie. PRS, VRS, etc.) and MAC.

2.3.4 EUPOS service provider shall provide to EUPOS ISCO the up-to-date information on the Internet address(es) of the NTRIP caster(s) for EUPOS Network RTK access.

2.4 EUPOS Geodetic

2.4.1 For post-processing applications that require accuracy in the range of decimetres up to sub-centimetre depending on the user's equipment and the duration of the measurement EUPOS provides observation data of the physical or non-physical reference stations via Internet.

2.4.2 The user interface for EUPOS Geodetic consists of:

2.4.2.1 RINEX 2.11 standard data file format;

2.4.2.2 HTTP, HTTPS (web interface) or FTP protocol for data transmission.

2.4.3 GNSS observation files with data rate of 1 Hz or higher are available to the users at latest 2 hours after actual observations have been performed on the reference stations and remain available to the users for at least 1 month afterwards.

2.4.4 EUPOS service provider shall provide to EUPOS ISCO the up-to-date information on the Internet address(es) of the website(s) or FTP server(s) for EUPOS Geodetic access.

3   Technical and organisational standards for the operated EUPOS reference station systems

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To assure the availability of services at the annual level of 99%, certain technical and organisational measures shall be taken by the EUPOS providers.

A redundancy of all hardware elements and communication lines is highly recommended. It is also recommended to geographically separate the redundant elements of control centre hardware, therefore creating a second, backup EUPOS control centre. Additionally, certain modules of the software underlying the provided services should be duplicated to avoid or minimize outages of the service. The requirement especially concerns the NTRIP caster software, since it is one of the key elements of the user interface for the EUPOS DGNSS and EUPOS Network RTK services and is also usually located in the DMZ of the control centre local network. Its duplication could be achieved quite easily using some of the multiple freeware solutions available on the market along with commercial, professional products. Advisable is to install two casters on two different machines and provide them on two different IP addresses. Due to less sensitivity of the post-processing applications to short term service outages, it is also recommended, but not required, to provide a redundant server for the EUPOS Geodetic user interface.

To achieve the highest availability of services, the protection of all equipment from power fluctuations is necessary both at the NSCs and at remote reference station sites by using UPS devices that equalize voltage and prevent outages from power failures. Installation of additional emergency power generators and independent wiring to critical hardware elements is recommended, especially in the NSCs.

3.1   National EUPOS reference station system

3.1.1   A national EUPOS reference station system consists of:

3.1.1.1   EUPOS reference stations at the average distance of less than 75 km between the closest neighbouring stations in the network, taking into consideration that:

3.1.1.1.1   the desired network density depends on the topography and networking software's performance,

3.1.1.1.2   higher density can be useful in conurbations,

3.1.1.1.3   the maximum distance from one reference station to the other closest reference station shall not exceed 100 km,

3.1.1.1.4   coverage of the border area by the reference stations network shall be ensured, if EUPOS reference station system is established in the respective neighbouring country or province.

3.1.1.2   Communication lines between reference stations and EUPOS control centres;

3.1.1.3   At least one control centre per EUPOS provider;

3.1.1.4   At least one RTCM 10410.1 compliant NTRIP caster to provide EUPOS DGNSS and EUPOS Network RTK.

3.1.1.5   At least one HTTP, HTTPS or FTP server connected to Internet to provide EUPOS Geodetic;

3.1.1.6   At least two physical EUPOS monitoring stations per national EUPOS reference station system;

3.1.1.7   EUPOS quality management measures.

3.2   EUPOS reference station

3.2.1   EUPOS reference stations shall at least consist of:

3.2.1.1   Geodetic GNSS receiver:

3.2.1.1.1   dual or multi frequency, tracking all mandatory signals listed in Appendix A.3,

3.2.1.1.2   capable of tracking satellites down to 0 degrees elevation, adjustable between 0 and 5 degrees,

3.2.1.1.3   capable of remote control from the control centre at least in the scope of basic functions including signal tracking, data communication and storage settings,

3.2.1.1.4   capable of GNSS observations storage to avoid data loss in case of communications outage to EUPOS NSC, memory capacity of at least 100 MB,

3.2.1.1.5   measurement interval of 1 Hz or higher.

3.2.1.2   Interfaces for data communication with the EUPOS NSC;

3.2.1.3   Low-noise, multifrequency geodetic GNSS antenna, designed to minimize the influence of multipath effects on observations on a hardware level (multipath rejection characteristic, especially on low elevation angles, not worse than standard choke-ring antenna) and maximize the antenna field of view; advisable is to equip the antenna with spherical radome to avoid signal obstructions due to snow;

3.2.1.4   Lightning surge protection on the antenna cable;

3.2.1.5   UPS unit for all hardware devices, including communication interfaces, capable of supplying emergency power to all powered devices for at least 30 minutes during power failures;

3.2.2   Sites are selected so that:

3.2.2.1   the horizon at the location of GNSS antenna is free from obstructions;

3.2.2.2   reflective surfaces are located as far as possible, so that far-field and near-field multipath effects on satellite signals would be minimized or avoided;

3.2.2.3   long-term stability of the GNSS antennas is ensured.

3.2.3   The coordinates of the stations are determined with high precision, both in ETRS89 and in national coordinate reference systems.

3.2.4   Antenna calibration

3.2.4.1 In the EUPOS reference station network antenna types with available absolute PCV calibration results shall be used.

3.2.4.2 For antennas installed after July 1st, 2013 an individual absolute PCV model for each antenna-radome (if applicable) pair is required. Antennas shall be calibrated with regard to offset and phase centre variations (PCV) for all signal frequencies of all used GNSS in 5°-steps for elevation and azimuth (elevation: 0° up to 90°, azimuth: 0° up to 360°).

3.2.5   EUPOS reference station description and identification

3.2.5.1 In order to provide up-to-date and coherent description of the EUPOS reference stations for the purpose of cross-border data exchange, all EUPOS reference stations are documented and described in detail by EUPOS NSCs.

3.2.5.2 For this purpose the EUPOS Station Data Base (ESDB) is maintained. The ESDB stores and provides to EUPOS National Service Centres at least the information identical to IGS site log contents. Therefore all mandatory IGS site log fields are also treated as mandatory in ESDB and shall be filled in for every EUPOS reference station. All mandatory ESDB data fields shall be updated immediately after an event causing the actual change on the station. Keeping ESDB up-to-date remains the sole responsibility of corresponding EUPOS NSCs.

3.2.5.3 For the unambiguous identification of EUPOS reference stations each station shall have a unique 4-character station code (should be cross-checked with international databases e.g. that of IGS) and DOMES number[1]. The combination of both items serves as a correct station identifier for data exchange, product combination and scientific analyses. DOMES numbers for EUPOS reference stations can be requested from IGN (Institut Geographique National) by filling a form, which is available on the ITRF web site (http://itrf.ensg.ign.fr/). DOMES numbers shall also be used:

3.2.5.3.1   In the IGS type station site log part 1 as IERS DOMES Number,

3.2.5.3.2   In the EUPOS Station Data Base (ESDB) as IERS DOMES Number,

3.2.5.3.3   In RINEX file header as MARKER NUMBER,

3.2.5.3.4   In SINEX +SITE/ID part as __DOMES__.

3.3   EUPOS National Service Centres (NSCs)

3.3.1   EUPOS NSCs are the centres of the national EUPOS reference station systems. They are connected with all own national EUPOS reference stations and with the neighbouring reference stations of other countries across the border via their EUPOS NSCs.

3.3.2   For all NSC's equipment a UPS device shall guarantee the undisturbed operation.

3.3.3   EUPOS NSCs shall provide:

3.3.3.1 Active remote control of all own connected EUPOS reference stations;

3.3.3.2 Data collection of all connected EUPOS reference stations and quality control of the EUPOS GNSS data and services in addition to EUPOS monitoring stations;

3.3.3.3 Computing the real-time EUPOS services DGNSS and Network RTK and transmitting the EUPOS data to the NTRIP casters;

3.3.3.4 RINEX data for EUPOS Geodetic service to the Internet servers;

3.3.3.5 Long-term storage of GNSS observation data including:

3.3.3.5.1   at least 6 months of 1 s RAW or RINEX 2.11 or RINEX 3.01 data,

3.3.3.5.2   at least 2 years of 30 s RAW or RINEX 2.11 or RINEX 3.01 data;

3.3.3.6 Cross-border real-time data exchange;

3.3.3.7 Quality management measures in cases of EUPOS reference station system malfunctions by an automatic alarm plan and if demanded by manual intervention and manual remote maintenance.

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[1]   DOMES numbers are specific, 9-character identifiers of space geodetic markers, where the identifier reflects geographical position and monumentation type. Detailed description is available on the ITRF website (http://itrf.ensg.ign.fr/).

3.4   EUPOS quality management measures

3.4.1   The quality management strives to guarantee a minimum annual EUPOS system availability in the operational phase, as stated in 1.3.1.

3.4.2   The minimum set of requirements for ensuring high quality and required level of availability for all EUPOS services are:

3.4.2.1   Duplication of monitoring stations and all NSCs equipment and software that serve as end-user interface for providing services (casters, web servers); it is allowed to provide this redundancy via duplication of hardware components inside selected devices, not necessarily whole devices;

3.4.2.2   Protection of all EUPOS reference station system and NSCs components from power fluctuations and failures by UPS devices;

3.4.2.3   Continuous reception and check of provided EUPOS DGNSS and Network RTK by monitoring stations in real time and also continuously monitoring and checking of EUPOS Geodetic RINEX data;

3.4.2.4   Automatically activated alarm plans that set off appropriate corrective measures when malfunctions are identified;

3.4.2.5   The system is designed so that the technical equipment generally manages itself and the EUPOS operation is maintained automatically. All malfunctions etc. are recorded automatically and evaluated within the framework of the quality control management. Malfunctions, faults and losses of quality are therefore automatically identified in real time;

3.4.2.6   Positions of reference station antennas are checked regularly for any displacement using scientific GNSS post-processing software;

3.4.3   The availability level, referred to in 1.3.1 and 3.4.1 is being calculated on the basis of:

3.4.3.1   caster and stream availability along with completeness of data format for EUPOS DGNSS and EUPOS Network RTK services, as described in sections 2.2 and 2.3;

3.4.3.2   reference station availability in real time network processing for EUPOS Network RTK service – less than 90% of stations available within 2 seconds for the GNSS network processor is being treated as a system outage;

3.4.3.3   observation data availability for the EUPOS Geodetic, calculated as the number of total actual versus predicted observation epochs in the whole network.

3.4.4   The overall system availability is the minimum value of the components described in 3.4.3.

4   Required EUPOS user equipment

The minimum requirements for the EUPOS user equipment are included in the standard in order to clarify, what functionalities one has to support in order to be able to utilize the minimal functionality of the EUPOS services. It does not keep the EUPOS providers from offering additional functionalities which could require more sophisticated user equipment, nevertheless, this should meet the requirements specified in the EUPOS Technical Standards.

4.1   The following user equipment fulfils the minimum requirements for using EUPOS DGNSS service:

4.1.1   a single-frequency GNSS receiver supporting at least one of the basic systems listed in 1.1.1,

4.1.2   a communication device with Internet access and RTCM 10410.1 (NTRIP version 2.0) client software,

4.1.3   an RTCM 10402.3* or RTCM 10403.1 decoding module with DGNSS capability.

4.2   The following user equipment fulfils the minimum requirements for using EUPOS Network RTK service:

4.2.1   a single- or dual-frequency GNSS receiver with carrier phase tracking supporting at least one of the basic systems listed in 1.1.1,

4.2.2   a communication device with Internet access and RTCM 10410.1 (NTRIP version 2.0) client software,

4.2.3   an RTCM 10402.3* or 10403.1 decoding module with Network RTK capability.

4.3   The following user equipment fulfils the minimum requirements for using EUPOS Geodetic service:

4.3.1   a single-frequency GNSS receiver supporting at least one of the basic systems listed in 1.1.1,

4.3.2   suitable processing software capable of reading and processing RINEX 2.11* or 3.01 format.

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* *this is provided and guaranteed until December 31, 2015 to ensure backwards compatibility of hardware*

Appendices

A.1   *EUPOS* Steering Committee resolutions
regarding the *EUPOS* Technical Standards

Resolution 3.8 of the 3rd Conference of the *EUPOS* Steering Committee, Riga, Latvia, 10 – 11 June 2003, agenda item 6.1: *EUPOS* Standard Summary

(The decided mainly changes between the *EUPOS* Standard Summary's draft version and the decided version, topicality June 11th, 2003 are left out.)

The *EUPOS* Steering Committee decides that the *EUPOS* Standard Summary, topicality June 11, 2003, is to be used by all members and partners of *EUPOS* as obligatory *EUPOS* standards.

These standards are to be used exclusive for a time period of five years at minimum.

In cases of further development of the technical standards a downward compatibility has to be guaranteed.

Changes of the standards need an *EUPOS* Steering Committee resolution.

Thus there is given a good basis for establishing a unified multifunctional ground based DGNSS infrastructure in Central and Eastern Europe as well as the needed security for investment to the industry.

Resolution 12.2 of the 12th Conference of the *EUPOS* Steering Committee, Vilnius, Lithuania, 20 – 21 September 2007, agenda item 5: *EUPOS* Standard Summary

The *EUPOS* Steering Committee requested its Office (ISCO) to revise the *EUPOS* Standard Summary 1st Edition   of 11 June 2003 and to separate the *EUPOS* Technical Standard definitions from general information and Terms of Reference at the 9th ISC Conference. The ISCO presented the revised draft Terms of Reference, including general information, at the 12th ISC Conference. The ISC approved the draft.

EUPOS Terms of Reference define the organisational section of the *EUPOS* Standards and are to be used by all members and partners of *EUPOS* as obligatory *EUPOS* standards.

The ISCO is responsible for updating the Appendix of the Terms of Reference. Other alterations to the *EUPOS* Terms of Reference require an *EUPOS* Steering Committee resolution.

Resolution 13.2 of the 13th Conference of the *EUPOS* Steering Committee, Bucharest, Romania, 23 – 24 April 2008; agenda item 5: *EUPOS* Technical Standards

The *EUPOS* Steering Committee decides that the *EUPOS* Technical Standards, topicality April 24, 2008, are to be used by all members and partners of *EUPOS* as obligatory *EUPOS* standards. Changes of the standard definitions need an *EUPOS* Steering Committee resolution.

Resolution 23.2 of the 23rd Conference of the *EUPOS* Steering Committee, Tbilisi, Georgia, 7 – 8 May 2013;

The *EUPOS* Steering Committee decides to amend the *EUPOS* Technical Standards, topicality April 24, 2008, and therefore introduce new current *EUPOS* Technical Standards document, topicality May 7, 2013.

A.2   List of acronyms and abbreviations

cf.	confer (= compare)
BEIDOU	BeiDou Navigation Satellite System (BDS)
DGNSS	Differential Global Navigation Satellite System
DMZ	a sub-network in which hardware and software are exposed to an untrusted network
DOMES	an unambiguous identifier to a reference point of an instrument, eg. GNSS antenna
ESDB	EUPOS Station DataBase
ETRS89	European Terrestrial Reference System 1989
EUPOS	European Position Determination System
EUPOS ISC	EUPOS International Steering Committee
EUPOS ISCO	EUPOS International Steering Committee Office
EUPOS NSC	EUPOS National Service Centre
FKP	Flächenkorrekturparameter (*area correction parameters*)
FOC	Full Operational Capability
FTP	File Transfer Protocol
IERS	International Earth Rotation and Reference Systems Service
IGN	fr. Institut Geographique National
IGS	International GNSS Service
ISC	cf. EUPOS ISC
ISCO	cf. EUPOS ISCO
ITRF	International Terrestrial Reference Frame
GALILEO	European Global Navigation Satellite System
GNSS	Global Navigation Satellite Systems
GLONASS	Global Navigation Satellite System (Russian Federation)
GPS	Global Positioning System (USA)
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IP	Internet Protocol
MAC	Master and Auxiliary Concept
MT	Message Type
NMEA	National Marine Electronics Association
NSC	cf. EUPOS NSC
NTRIP	Networked Transport of RTCM via Internet Protocol
PCV	Phase Centre Variations
RAW	a format indicating a lossless proprietary binary format of the receiver manufacturer
RINEX	Receiver INdependent EXchange format
RF	Radio Frequency
RTCM	Radio Technical Commission for Maritime Services
RTK	Real Time Kinematic
RTN	Network RTK

SC 104   RTCM Special Committee 104 on DGNSS

SINEX   Software INdependent EXchange format

UDP   User Datagram Protocol

UPS   Uninterruptible Power Supply

VHF   Very High Frequency

WLAN   Wireless Local Area Network

A.3 List of GNSS signals required in EUPOS operations

GNSS system	Signal band and ID	Status*
GPS	L1 C/A	Required
	L1C	Required**
	L2 P(Y)	Required***
	L2C	Required**
GLONASS	G1 C/A	Required
	G2 C/A	Required****
	G2 P	Required****
GALILEO	E5a	Required**
	E5b	Required**
	E5ab	Required**
	E1-BC	Required**

* The list provides the minimum selection of signals for tracking and providing EUPOS services (when a certain system is included in the service), although it is recommended to track and log all the signals available to the reference station receiver, ensuring that no required signals are lost; this particularly refers to L5 GPS, G3 GLONASS, GALILEO CS/PRS signals (E6, E1-A), all available BeiDou signals, etc.

** When all full relevant GNSS constellation at FOC broadcasts this signal; until then the signal is recommended to be tracked and used as additional positioning signal in EUPOS services.

*** Required until full GPS constellation provides L2C signal and the whole national EUPOS tracking network tracks L2C.

**** Either C/A or P code tracking is required when GLONASS signals are being tracked, but due to restricted data signal in P code, the C/A code is preferred.

A.4 List of RTCM 10403.x minimum message sets required for EUPOS services

EUPOS service	Set No	RTCM SC-104 format version*	Message Type, max. interval [s]	Additional information
DGNSS	1	10403.1	1001 or 1002 (5), 1005 or 1006 (60), 1007 or 1008 (60)	GPS only
DGNSS	2	10403.1	1001 or 1002 (5), 1005 or 1006 (60), 1007 or 1008 (60), 1009 or 1010 (5)	GPS+GLONASS
Network RTK	3	10403.1	1003 or 1004 (1), 1005 or 1006 (15), 1007 or 1008 (15), 1030 (30), 1032 (15)	Non-physical ref. station; GPS only
Network RTK	4	10403.1	1003 or 1004 (1), 1005 or 1006 (15), 1007 or 1008 (15), 1014 (1), 1015+1016 or 1017 (10), 1030 (30)	MAC; GPS only
Network RTK	5	10403.1	1003 or 1004 (1), 1005 or 1006 (15), 1007 or 1008 (15), 1030 (30), 1034 (1)	FKP; GPS only
Network RTK	6	10403.1	1003 or 1004 (1), 1005 or 1006 (15), 1007 or 1008 (15), 1011 or 1012 (1), 1030 (30), 1031 (30), 1032 (15), 1033 (15)	Non-physical ref. station; GPS+GLONASS
Network RTK	7	10403.1	1003 or 1004 (1), 1005 or 1006 (15), 1007 or 1008 (15), 1011 or 1012 (1), 1014 (1),	MAC; GPS+GLONASS

			1015+1016 or 1017 (10), 1030 (30), 1031 (30), 1033 (15), 1037+1038 or 1039 (10)	
Network RTK	8	10403.1	1003 or 1004 (1), 1005 or 1006 (15), 1007 or 1008 (15), 1030 (30), 1031 (30), 1033 (15), 1034 (1), 1035 (1)	FKP; GPS+GLONASS

* Due to the limited support of Galileo signals in RTCM 10403.1 standard, this table will be revised in the future versions of EUPOS Technical Standards, adding the RTCM 10403.x minimum message sets that support all the signals required in appendix A.3.