

# GUIDELINES FOR EPOS-GNSS STATIONS, DATA SUPPLIERS, AND STATION METADATA MAINTAINERS

C. Bruyninx  
EPOS-GNSS Executive Board

Available from the M<sup>3</sup>G-Bureau at <https://gnss-metadata.eu/Guidelines/>  
Questions and comments are welcome at [C.Bruyninx@oma.be](mailto:C.Bruyninx@oma.be).

## Updates:

March 7, 2023: Harmonization with terminology used in new M<sup>3</sup>G release

- Introduction of "Station Metadata Maintainer (MM)"
- Removal of "Operational Center (OC)"
- Update of URLs

January 6, 2021: Improvements based on user feedback and update of URLs.

August 5, 2020: Corrections based on user feedback

March 27, 2019: Refinement

Feb. 19, 2018: Revision of "Data Supplier/OC" terminology.

Feb. 2, 2018: Revision of "Data Center/Node" and "Agency" terminology.

Jan. 23, 2018: Reflect decisions taken at WP10 meeting in Coimbra (15-16/01/2018)

- Only antenna calibration is mandatory (not antenna+radome)
- Information on 'deviation of true north' is not mandatory, but recommended for insertion in the station log
- Removed the submission of station pictures and individual antenna calibrations to the M<sup>3</sup>G-Bureau because this functionality is not active yet

July 17, 2017

- Moved more requirements to 'desired'
- Introduce M<sup>3</sup>G-bureau
- Clarify difference between OC, Station owner, and Data supplier

February 13, 2017: Creation

*GNSS stations participating to EPOS-GNSS must agree to adhere to certain standards and conventions, which ensure the quality of the EPOS-GNSS services and data products.*

*This document lists the **requirements** that **EPOS-GNSS Tracking Stations, Data Suppliers, and Station Metadata Maintainers** should follow, as well as some additional desirable characteristics, which are not mandatory, but enhance their own relevance to EPOS-GNSS.*

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## 1 Network Components

**GNSS Station:** Permanent GNSS tracking receivers and antennae.

**Data Supplier or Responsible Agency or Station Owner:** The EPOS-GNSS Data Supplier is the agency owning the GNSS station and having the legal rights to distribute the data of the GNSS station. The Data Supplier signs the **EPOS-GNSS Data Supplier Letter**. The Data Supplier is responsible for ensuring regular uploading of the RINEX data of its station to EPOS and keeping the station metadata in M<sup>3</sup>G up to date.

**Station Metadata Maintainer (MM):** The agency that actively keeps **the GNSS station metadata** (e.g. site log) up to date within M<sup>3</sup>G. The Data Supplier indicates the name of the agency acting as Station Metadata Maintainer in Annex B of its EPOS-GNSS Data Supplier Letter. In most cases, the Data Supplier itself acts as Station Metadata Maintainer. However, it is also possible that the Data Supplier delegates the maintenance of the station metadata to another agency.

**Data Centre (DC) or Data Repository:** Physical location of the GNSS station observation/navigation data.

**Data Node (DN):** Virtualisation layer on top of one (or more) Data Centre(s). Using the GLASS software, the Data Node makes the GNSS station data at Data Centres (or data repositories) discoverable at the EPOS-GNSS data gateway.

**M<sup>3</sup>G-Bureau:** Collects the EPOS-GNSS Data Supplier Letters and helps station owners to select the most appropriate EPOS data node. The M<sup>3</sup>G-Bureau maintains the M<sup>3</sup>G portal (<https://gnss-metadata.eu>) where GNSS station metadata must be submitted. It validates these metadata, provides them to the EPOS-GNSS Data Gateway and it also collects information on the agencies involved in operating EPOS-GNSS stations.

**Data Gateway (DGW):** Provides access to the metadata and data of the EPOS-GNSS stations.

**Data Monitoring Centre (DMC):** Monitors EPOS-GNSS station observation data quality and metadata consistency, and provides feedback to station operators through a web portal (<https://gnssquality-epos.oma.be/>) and email alerts.

## 2 Requirements for Permanent Stations

EPOS-GNSS stations should fulfil the requirements below.

### 2.1 Equipment

#### *Receiver*

The GNSS receiver must

2.1.1 Be known to the International GNSS Service ([IGS](https://files.igs.org/pub/station/general/rcvr_ant.tab)), meaning a corresponding standard name must be included in [https://files.igs.org/pub/station/general/rcvr\\_ant.tab](https://files.igs.org/pub/station/general/rcvr_ant.tab).

2.1.2 Record GPS phase and code measurements from at least two frequencies.

#### *Antenna and Radome*

- 2.1.3 The antenna (+radome, if any) must be known to the IGS, meaning corresponding standard names (for both the antenna and radome) must be included in [https://files.igs.org/pub/station/general/rcvr\\_ant.tab](https://files.igs.org/pub/station/general/rcvr_ant.tab).
- 2.1.4 Antenna calibrations must be available for the antenna. These calibrations should be type mean calibrations available from the IGS phase centre variation file (<https://files.igs.org/pub/station/general/igs14.atx>) or individual antenna calibrations (performed by a calibration facility [recognized by the IGS](#) and available on-line).
- 2.1.5 The eccentricities (easting, northing, height) from the marker to the Antenna Reference Point (ARP) defined by the IGS for each antenna in the file <https://files.igs.org/pub/station/general/antenna.gra>, must be surveyed and reported in the station site log and RINEX headers to  $\leq 1$  mm accuracy.
- 2.1.6 The antenna must be oriented to True North using the defined antenna reference marker (see vendor instructions). If it was impossible to orient the antenna towards the True North, then any deviations of the antenna with respect to the True North must be documented in the station site log.
- 2.1.7 The antenna must be rigidly and securely attached to the top of the station monument.

## 2.2 Marker and Monument

- 2.2.1 The station should not be moved to a different monument unless absolutely necessary. Moving to a new monument would require a new station to be established with a corresponding new station 9-char ID and a new station site log. This new station will then have to go through the "[Procedure for Including GNSS Stations in EPOS](#)".
- 2.2.2 If upgrading a station from a bad monument design to a better antenna mount, involving moving the original marker, then the upgrade is essentially the commissioning of a new station.

## 2.3 New Stations

In addition to requirements 2.1 - 2.2, new stations should fulfil the requirements below.

- 2.3.1 New stations can only be integrated in EPOS-GNSS after following the "[Procedure for Including GNSS Stations in EPOS](#)".
- 2.3.2 The station location should not suffer from
- significant (foreseeable) changes to its surroundings (changes to buildings or trees nearby; new construction, etc...),
  - excessive radio frequency (RF) interference ,
  - excessive RF reflective surfaces (fences, walls, etc.) and other sources of signal multipath,
  - excessive natural or man-made surface vibrations from ocean waves or heavy vehicular traffic.
- 2.3.3 The station monument should
- conform with current best practices. A drilled-braced tripod structure or tapered pillar-type monument are typically constructed. If possible, roof- or structure-mounted antennas should be avoided.
  - be isolated from surface effects foundation and therefore its foundation should extend to bedrock or, where bedrock is not accessible, ideally be deeply embedded into the stable subsurface.
- 2.3.4 Co-location with other geodetic techniques such as SLR, VLBI, DORIS, absolute or superconducting gravimeters, Earth tide gravimeters, seismometers, strain meters, and ocean

tide gauges are encouraged and will enhance the value of the station for multi-disciplinary studies.

## 2.4 Desired additional characteristics

### *Receiver*

- 2.4.1 The receiver should track as many satellites, healthy and unhealthy (all-in-view tracking), from as many constellations as possible (within receiver limitations), always including all GPS satellites as a minimum.
- 2.4.2 The receiver should track satellites down to a cut-off of  $0^\circ$ . The receiver cut-off must be updated at the M<sup>3</sup>G-Bureau at each change.
- 2.4.3 The receivers shall be upgraded with firmware upgrades from the manufacturer within 6 months of the firmware publication. Firmware updates shall be provided to the M<sup>3</sup>G-Bureau at each change.
- 2.4.4 Disable pseudorange and/or phase smoothing. If activated by mistake, any changes in the receiver setting shall be reported in an updated station site log.

### *Antenna*

- 2.4.5 It is recommended that calibrations are available for the antenna+radome pair. These calibrations should be type mean calibrations available from the IGS phase centre variation file (<https://files.igs.org/pub/station/general/igs14.atx>) or individual antenna calibrations (performed by a calibration facility [recognized by the IGS](#) and available on-line).
- 2.4.6 If available, new individual absolute antenna calibrations for an antenna+radome pair have to be made available on-line prior to installing the antenna+radome pair or including the station into the EPOS-GNSS network.
- 2.4.7 The antenna must be set up to minimize code and phase reflections (multipath), by mounting it away from close reflecting surfaces or by applying some passive protection directly below the antenna (microwave absorbing material, etc).
- 2.4.8 It is recommended to clean the antenna (without changing its position or removing it!) at least once a year. During wintertime, remove snow coverage as frequently as possible. Report the cleaning in the station log.

### *Obstructions and interferences*

- 2.4.9 Obstruction should be minimal above  $5^\circ$  elevation, but satellite visibility at lower elevations is encouraged whenever possible.
- 2.4.10 Signal reception quality has to be verified by counting the number of observations on each frequency that is set to be tracked. A reduced number of observations can indicate interference of external signal sources like radars.

### *Marker documentation*

- 2.4.11 The marker description should be fully documented in the station site log.
- 2.4.12 The 3-dimensional local ties between the GNSS marker, co-located instrumentation (e.g. DORIS, SLR, VLBI, gravity, tide gauge, levelling) and other monuments should be re-surveyed as frequently as practical (ideally each 2 years) to an accuracy of 1-mm and reported in ITRF:
  - The marker → antenna reference point eccentricities should be re-verified during such a survey.
  - Repeat the survey after known motion incidents such as earthquakes.
  - All survey data, but especially ties to other IERS/IGS/EPN/EPOS-GNSS markers, should be rigorously reduced in a geocentric frame related to ITRF (preferably ITRF itself) and the

results be made available in

<https://www.iers.org/IERS/EN/Organization/AnalysisCoordinator/SinexFormat/sinex.html>, including full variance-covariance information.

- Survey notes and intermediate results of the 3D ties shall be preserved and made available publicly.

## 3 Responsibilities

### 3.1 Data Supplier

The Data Supplier must ensure responsibility for

- 3.1.1 Reliable data handling and transmission to the relevant EPOS-GNSS Data Node (according to the guidelines in 4)
- 3.1.1 Taking appropriate action if the station performance degrades, e.g. the alert/engagement of on-site staff, especially after receiving an alert from the Data Monitoring Centre.
- 3.1.2 Taking appropriate action for correcting the metadata in the RINEX header (see 4.1.7), or updating of the station metadata (see 4.1.5) as soon as possible, if an inconsistency advisory is received.
- 3.1.3 Ensuring that the GNSS equipment, and its surroundings, is not disturbed or changed unless a clear benefit outweighs the potential for discontinuities in the time series. Accepted disturbances include: equipment failure, planned upgrade of obsolete equipment or vendor-recommended firmware updates.

### 3.2 Station Metadata Maintainer

The Station Metadata Maintainer must

- 3.2.1 Register an account on the M<sup>3</sup>G portal.
- 3.2.2 Document changes at the GNSS station (or its environment) by updating the station metadata within one business day at the M<sup>3</sup>G portal or through the M<sup>3</sup>G API.
- 3.2.3 Correct the station metadata at the M<sup>3</sup>G portal or through the M<sup>3</sup>G API as soon as possible if an advisory of station metadata inconsistencies is received from e.g., the Data Monitoring Centre.
- 3.2.4 Maintain within M<sup>3</sup>G the agencies metadata via the 'Edit My Agency Information' form, and, if applicable, the 'Third-Party Agencies Information' form (both available after login). This includes contact information and the list of operated stations. Correctly completing and keeping up to date the agency information, available at the M<sup>3</sup>G-Bureau, is a pre-requisite for uploading station metadata!

## 4 Requirements for Data Flow

EPOS-GNSS stations make their data routinely available to EPOS through a designated EPOS-GNSS Data Node. At this moment, EPOS only collects daily RINEX files.

## 4.1 Format and Distribution of Daily Data

- 4.1.1 The station must provide observation files to a Data Repository associated to an EPOS-GNSS Data Node. The list of EPOS-GNSS Data Nodes can be consulted from <https://gnss-metadata.eu/site/distributor> (select “EPOS” in the column corresponding to the network).
- 4.1.2 The provided GNSS data will be available for download (no registration needed) from the EPOS-GNSS data node.
- 4.1.3 The minimal requirement for data submission are daily observation files with a 30-second sampling rate. These daily observation files contain the observations collected between GPS time 00:00:00 and 23:59:59.
- 4.1.4 The observation files must be provided in the RINEX format, directly generated from the receiver’s native data files.
- 4.1.5 It is recommended to submit observation files in the RINEX 3 format. If this is not possible, then the RINEX 2 format can be accepted. Use the current RINEX standard recommended by the EUREF and the IGS, see <https://epncb.oma.be/documentation/formats/rinex.php>.
- 4.1.6 Observation files will be exchanged in the [Hatanaka Compact form](#).
- All observation files are then compressed (UNIX compressing .Z – for RINEX 2 format) or gzipped (.gz – for RINEX 3 format).
  - File naming conventions described in the RINEX 2 and 3 format descriptions must be used.
- 4.1.7 RINEX observation header information, especially the station ID, receiver and antenna information, DOMES number (if available), and antenna eccentricities, must be up-to-date and must match the information in the station log. The following conventions are used:
- The 4-character station ID (or 9-character for RINEX 3 data) must be found in the “MARKER NAME” field
  - If available, the DOMES number must appear in the “MARKER NUMBER” field.
  - The receiver serial number, type and firmware must be found in the “REC # / TYPE / VERS” fields.
  - The antenna serial number, antenna type and radome type (if no radome, use “NONE”) must be found in the “ANT # / TYPE” fields. If individual calibrations are available, this serial number must be in agreement with the serial number in the individual antenna calibration file.
  - The RINEX headers must begin showing an equipment change at the actual time of the change.

Additionally-desired characteristics are:

- 4.1.8 After a communication outage between the station and the Data Repository, the recovered data files should be submitted to the repository as quickly as possible. The usage of automated procedures is strongly recommended.
- 4.1.9 The signal-to-noise observables should be included in RINEX files.