

IGS Antenna Working Group

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1 North reference point (NRP)

As outlined in IGSMail-6987, the Antenna Working Group elaborated a definition of the so-called north reference point (NRP) that was added to the IGS file `antenna.gra` (available at `ftp://igs.org/pub/station/general/`) at the end of October 2014. The NRP designates the element of the antenna that has to be oriented toward the north direction. There are four major features:

- MMI: man-machine interface
- NOM: north orientation mark (placed on antenna by manufacturer)
- RXC: receiver connector (connect antenna to external receiver)
- UNK: unknown

If a north orientation mark (NOM) is present and can be clearly identified, it will usually be selected to be the NRP. If not, in most cases a receiver connector (RXC) or a man-machine interface (MMI) can serve as the NRP instead. If none of the four major features is applicable, `antenna.gra` provides twelve secondary features and connector designations in order to define the azimuthal antenna orientation.

A considerable amount of time had to be spent on the compilation of the NRP definitions for all antenna types registered in `antenna.gra` in accordance with the phase center corrections contained in `igs08_www.atx` on the one hand and further calibrations performed by the IGS calibration institutions on the other hand. In some cases, the NRP definition had to be harmonized between different institutions. The NRP designator was added both to the individual `antenna.gra` sketches and to the machine-readable section at the end of the file.

At the beginning of January 2015, `antenna.gra` contained 201 different antenna types. For 189 of them, one of the major features was applicable (NOM: 87, MMI: 45, RXC: 43, UNK: 14). Help on identifying the NRP of outdated or uncalibrated equipment (antenna types with NRP = UNK) is greatly appreciated.

2 Updates and content of the antenna phase center model

Table 1 lists 11 updates of the absolute IGS antenna phase center model `igs08_www.atx` that were released in 2014. Eight of them are related to changes of the satellite constellation, and three times an update of the model was released, when new receiver antenna calibrations became available. Further details on all model changes can be found in the corresponding IGSMAILs whose numbers are also given in Tab. 1.

Table 2 gives an overview of the data sets contained in the IGS phase center model. The numbers refer to `igs08_1822.atx` that was released in December 2014. For GPS and GLONASS, there are 83 and 92 file entries, respectively. These numbers are bigger than the number of actual satellites, as certain satellites were assigned with different PRN codes or almanac slots, respectively.

At the IGS Workshop 2014 in Pasadena, it was recommended to adopt conventional phase center offset (PCO) values for Galileo, BeiDou and QZSS satellite antennas taking into account the IGS-conventional axis definition related to the yaw-steering attitude mode. A draft version of `igs08_www.atx` including the new GNSS already exists. It will be published together with a paper on GNSS satellite geometry and attitude models. For the time being, conventional PCO values can be found on the web pages of the IGS Multi-GNSS Experiment (<http://www.igs.org/mgex/>).

Apart from the satellite antennas, the IGS model meanwhile contains phase center calibration values for 264 different receiver antenna types. 85 of them are certain combinations of an antenna and a radome, whereas the remaining 179 antenna types are not covered by a radome. As Tab. 2 shows, `igs08_1822.atx` contains, among others, 126 absolute robot calibrations and 90 converted field calibrations.

As elevation- and azimuth-dependent calibration values down to 0° elevation are mandatory for new or upgraded IGS stations, altogether 163 different antenna types (126 ROBOT + 34 COPIED + 3 CONVERTED) are currently approved for installation. The remaining 101 types (90 FIELD + 11 CONVERTED) are no longer allowed, but their calibration values are still necessary for existing installations (see Sect. 3) as well as for reprocessing purposes.

Table 1: Updates of the phase center model `igs08_www.atx` (`www` being the GPS week of the release date) in 2014. Model updates restricted to additional receiver antenna types are only announced via the *IGS Equipment Files* mailing list.

week	date	IGSMAIL	change
1780	21-FEB-14	6866	Added G064, R714 (R18) Decommission date: G049 (G30), R724
1781	28-FEB-14	—	Added TPSPN.A5 NONE Corrected date: G010
1785	28-MAR-14	—	Added TRM55970.00 NONE Decommission date: G036
1787	08-APR-14	6895	Added G049 (G06)
1788	14-APR-14	6899	Added R754 Decommission date: R714 (R18)
1793	19-MAY-14	6914	Added G067 Decommission date: G049 (G06)
1804	04-AUG-14	6953	Added STXS9+X001A NONE Added G068, R755 Decommission date: G039, R725
1805	11-AUG-14	6955	Added AERAT1675_120 SPKE Corrected date: R725, R755
1808	05-SEP-14	6965	Added LEIGG03 NONE
1816	31-OCT-14	6989	Added G035 (G03) Decommission date: G033
1822	10-DEC-14	—	Added G069 Decommission date: G035 (G03) Corrected NRP: JAV_GRANT-G3T NONE Corrected name: STXS9PX001A NONE Added JAVTRIUMPH_1M NONE JAVTRIUMPH_1MR NONE JAVTRIUMPH_2A NONE JAVTRIUMPH_LSA NONE

Table 2: Number of data sets in `igs08_1822.atx` (released in December 2014).

satellite antennas	number	receiver antennas	number
GPS	83	ROBOT	126
GLONASS	92	FIELD	90
Galileo	0	COPIED	34
BeiDou	0	CONVERTED	14
QZSS	0		

Table 3: Calibration status of 452 stations in the IGS network (`logsum.txt` of 9 January 2015, `igs08_1822.atx`) compared to former years.

date	absolute calibration (azimuthal corrections down to 0° elevation)	converted field calibration (purely elevation-dependent PCVs above 10° elevation)	uncalibrated radome (or unmodeled antenna subtype)
DEC 2009	61.4%	18.3%	20.2%
MAY 2012	74.6%	8.2%	17.2%
JAN 2013	76.8%	7.7%	15.5%
JAN 2014	78.7%	7.8%	13.5%
JAN 2015	80.1%	7.5%	12.4%

3 Calibration status of the IGS network

Table 3 shows the percentage of IGS tracking stations with respect to certain calibration types. For this analysis, 452 IGS stations as contained in the file `logsum.txt` (available at <ftp://igs.org/pub/station/general/>) on 9 January 2015 were considered. At that time, 102 different antenna/radome combinations were in use within the IGS network. The calibration status of these antenna types was assessed with respect to the phase center model `igs08_1822.atx` that was released in December 2014.

Eight years after the adoption of absolute robot calibrations by the IGS in November 2006, state-of-the-art calibrations comprising elevation- and azimuth-dependent PCVs down to the horizon are available for about 80% of all IGS stations. Whereas the portion of stations with phase center corrections derived from relative field calibrations (purely elevation-dependent) hardly changed in recent years, a steady decrease of IGS stations covered by uncalibrated radomes can be noticed.

This decrease results from an upgrade of the equipment at operational stations or from the decommissioning of stations with outdated equipment, but also from an extension of the network with properly calibrated antennas. In order to reach a coverage of 100%, IGS Site Guidelines do not allow converted field calibrations or uncalibrated equipment “at new or upgraded stations”.