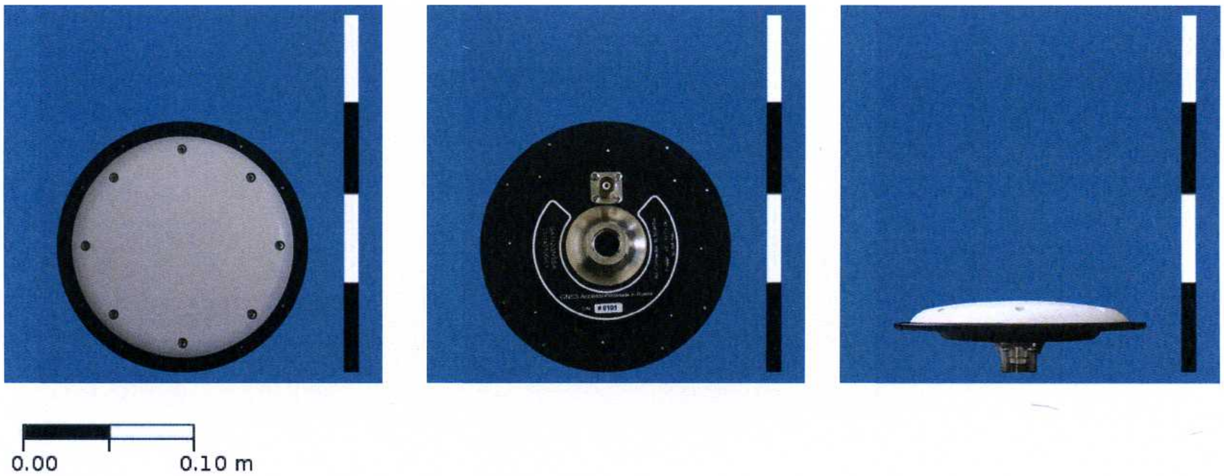
Geo++® GmbH
Steinriede 8, 30827 Garbsen, Germany
Tel. 05131-4689-0, Fax 05131-4689-99
www.geopp.com

Calibration of GPS/GLONASS Antenna GA152GNSSA rover antenna
Deriving a GNPCV Type Mean from Absolute Calibrations with a Robot

(IGS Name*: MVEGA152GNSSA NONE)



Calibration Method

The applied Geo++® calibration method of GNSS antennas with a robot determines the absolute antenna offset in horizontal and vertical position as well as the absolute elevation and azimuth dependent phase center variations (PCV) for both frequencies. The resulting PCV are completely independent from the used reference antenna (absolute calibration) and allow the complete modeling of the receiving characteristic of the antenna.

Scope of the applied absolute GPS antenna calibration is:

- absolute offsets and absolute PCV
- special approach with inclined and rotated antenna (robot)
- elimination of multipath
- coverage of the complete elevation range from 0° to 90°
- coverage of complete antenna hemisphere
- precise determination of PCV using a large number of different antenna orientations
- simultaneous estimation of L1 and L2 PCV for GNSS
- weather independent measurements
- at least two redundant calibrations per individual antenna

Basic concept of the calibration method is the separation between multipath and phase center variation. A special observation procedure with different antenna orientations is used for the determination of absolute PCV and for multipath elimination.

The processing is done in real-time. Primary result is a spherical harmonic expansion of the PCV as function of zenith distance and azimuth with complete variance-covariance data directly after the calibration. Finally absolute horizontal and vertical mean offsets as well as absolute elevation and azimuth dependent phase observation corrections for the calibrated antenna can be derived.

* It is not officially included in the IGS naming convention at writing of this protocol. Check rcvr_ant.tab or gpp_rcvr_ant.tab.

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Calibration Procedure

A sample of individual MVEGA152GNSSA NONE calibrations conducted with the Geo++® calibration method with a robot is the basis for the calculation of the type mean. The individual calibrations are rigorously adjusted considering the full variance-covariance information.

Scope of the GNPCV type calibration:

- individual calibrations at least of five antennas of same manufacturing series
- adjustment of a type mean using entire variance–covariance data

The type mean of the MVEGA152GNSSA NONE antenna is derived from five individual antennas with serial numbers 0101, 0104, 0105, 0107 and 0110. Each antenna was calibrated at least twice, which gives 15 individual GPS and 15 individual GLONASS calibrations.

Calibration Result

The GNPCV Type Mean is the adjusted mean of the five individual MVEGA152GNSSA NONE GNSS antennas. The Antenna Reference Point (ARP) is the reference point used in the calibration. The reference direction to north is defined by the receiver connector (RXC). The antenna height has to be measured to the ARP, which is vertically defined to the bottom of antenna mount (BAM) and horizontally to the rotation axis defined by the center of 5/8" thread.

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Calibration Result GPS

The absolute GPS PCV excluding the mean phase center offsets for the L1 and L2 frequency are depicted below:

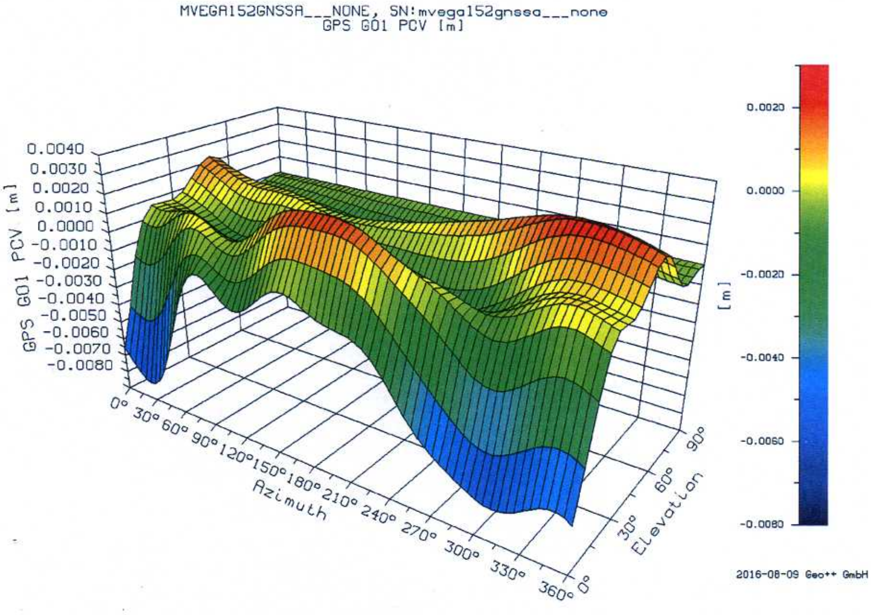

Figure 1: GPS L1 PCV

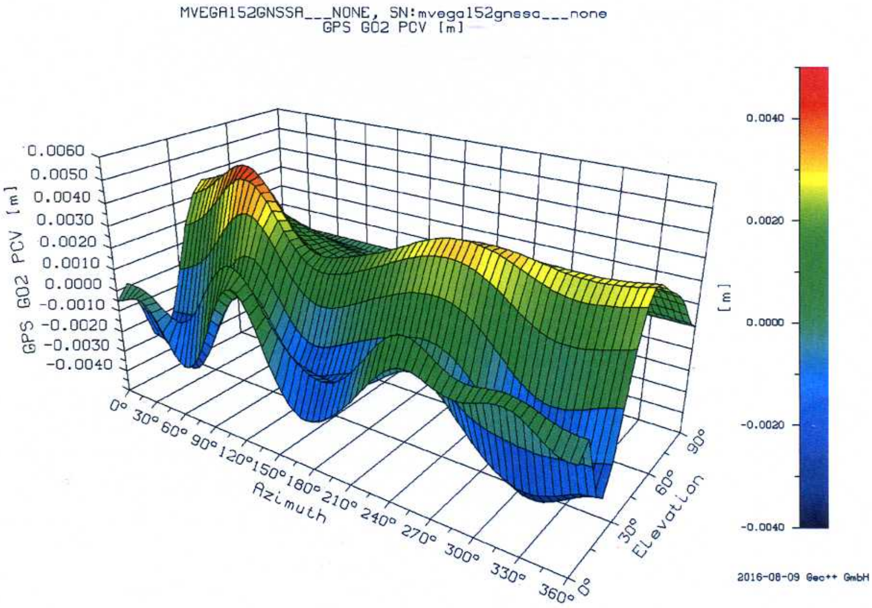

Figure 2: GPS L2 PCV

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Calibration Result GLONASS

The absolute GLONASS PCV calibration considers the individual frequencies of the GLONASS satellites and estimates a so-called Delta PCV. The Delta PCV is a PCV change with frequency. With the Delta PCV from this adjustment the actual GLONASS PCV can be computed for any GLONASS frequency channel number using the simultaneously estimated GPS PCV. The GLONASS PCV can be used in combination with the GPS PCV to interpolate for any other frequency channel number of GLONASS. The given GLONASS PCV are computed for frequency channel number k=0. The absolute GLONASS PCV excluding the mean phase center offsets for the L1 and L2 frequency are depicted below:

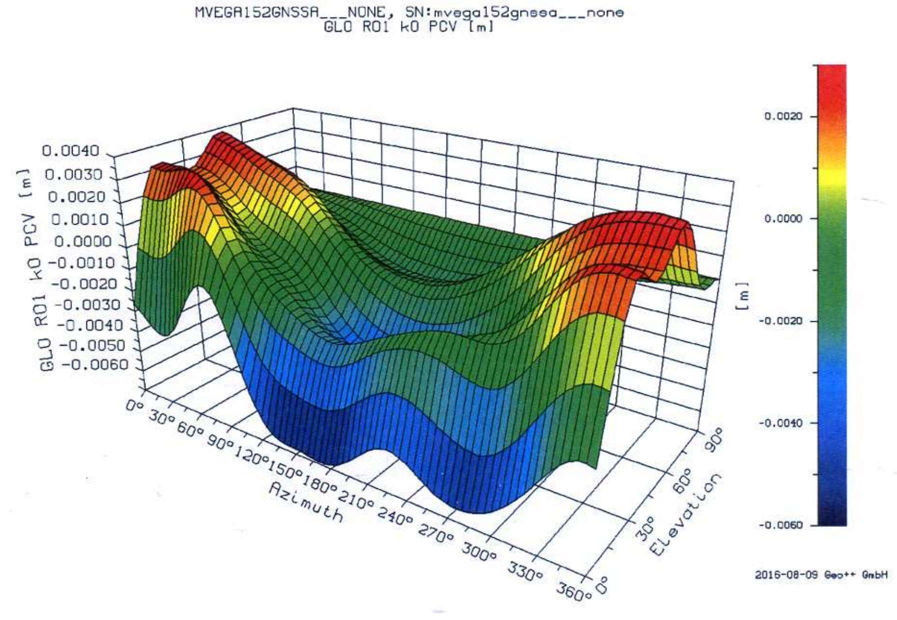

Figure 3: GLONASS L1 PCV

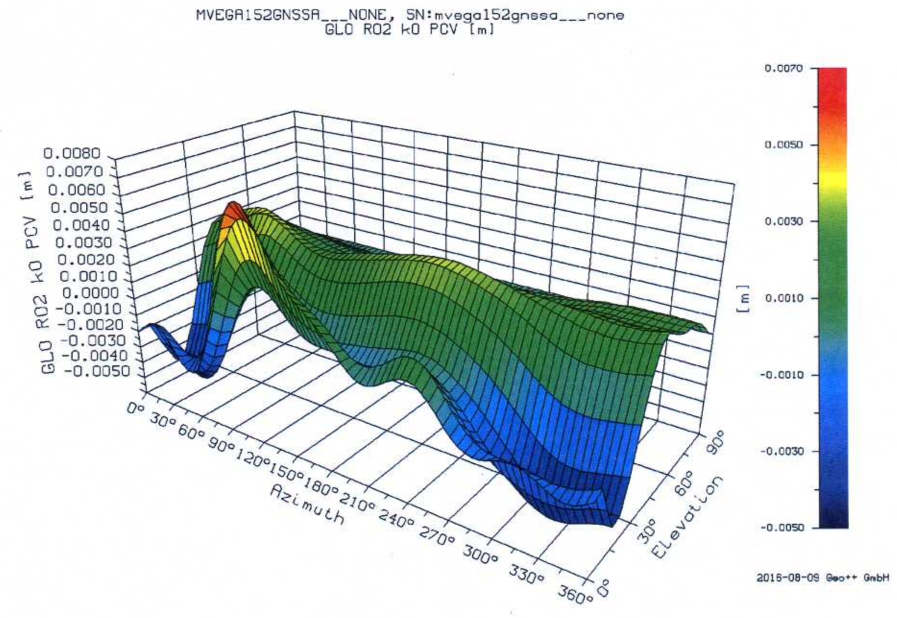

Figure 4: GLONASS L2 PCV

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As a numerical reference, the pure elevation dependent PCV are listed below in the international ANTEX format (see ANTEX format description for details). However, the complete model of the antenna consists of elevation and azimuth dependent PCV values.

```
     1.4            M                                       ANTEX VERSION / SYST
A                                                           PCV TYPE / REFANT
                                                            START OF ANTENNA
MVEGA152GNSSA   NONE                                        TYPE / SERIAL NO
ROBOT               Geo++ GmbH                 5    2016-08-09METH / BY / # / DATE
     5.0                                                    DAZI
     0.0  90.0   5.0                                        ZEN1 / ZEN2 / DZEN
     4                                                      # OF FREQUENCIES
   G01                                                      START OF FREQUENCY
     -3.45     -0.35    +34.35                              NORTH / EAST / UP
   NOAZI   +0.00   +0.11   +0.32   +0.41   +0.18   -0.39   -1.09   -1.56   -1.53   -1.01   -0.27   +0.24
+0.19   -0.37   -0.99   -1.01   +0.03   +2.01   +4.03
   G01                                                      END OF FREQUENCY
   G02                                                      START OF FREQUENCY
     -2.85     +2.83    +33.28                              NORTH / EAST / UP
   NOAZI   +0.00   -0.16   -0.55   -0.97   -1.27   -1.45   -1.65   -2.05   -2.67   -3.25   -3.34   -2.57
-0.98   +0.90   +2.16   +2.11   +0.84   -0.41   +0.45
   G02                                                      END OF FREQUENCY
   R01                                                      START OF FREQUENCY
     -3.45     -0.35    +34.35                              NORTH / EAST / UP
   NOAZI   +0.00   +0.15   +0.46   +0.69   +0.57   +0.08   -0.63   -1.18   -1.23   -0.75   +0.04   +0.70
+0.84   +0.44   -0.17   -0.34   +0.50   +2.40   +4.73
   R01                                                      END OF FREQUENCY
   R02                                                      START OF FREQUENCY
     -2.85     +2.83    +33.28                              NORTH / EAST / UP
   NOAZI   +0.00   -0.16   -0.54   -0.93   -1.15   -1.21   -1.28   -1.61   -2.27   -3.04   -3.44   -3.00
-1.63   +0.26   +1.79   +2.16   +1.22   -0.15   -0.13
   R02                                                      END OF FREQUENCY
   G01                                                      START OF FREQ RMS
   NOAZI    0.00    0.01    0.03    0.06    0.07    0.08    0.09    0.08    0.08    0.08    0.09    0.09
0.10    0.10    0.10    0.10    0.10    0.11    0.12
   G01                                                      END OF FREQ RMS
   G02                                                      START OF FREQ RMS
   NOAZI    0.00    0.01    0.04    0.06    0.09    0.10    0.10    0.09    0.09    0.09    0.10    0.10
0.11    0.11    0.11    0.11    0.12    0.14    0.17
   G02                                                      END OF FREQ RMS
                                                            END OF ANTENNA
```

Garbsen, September 21, 2016 Dr.-Ing. G. Wübbena

Literature

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