Calibration Report
Septentrio PolaRx5TR serial 3021141
METAS calibration of 2017-10-02

1 Identification of DUT

1.1 GNSS receiver ID

Manufacturer : Septentrio
type : PolaRx5TR
serial : 3021141
Rinex Code : WAB2
BIPM code : CH04

1.2 HDWAB258.022

HDWAB258.022.txt - Notepad

File Edit Format View Help

```
CGGTTS GPS/GLONASS DATA FORMAT VERSION = 02
REV DATE = 2017-10-02
RCVR = PolaRx5TR 3021141           R2CGGTTS v5.1
CH = 12 (GPS)
IMS = PolaRx5TR 3021141
LAB = METAS
X = +4327319.13 m (GPS)
Y =  +566956.08 m (GPS)
Z = +4636426.90 m (GPS)
FRAME = ITRF, PZ-90->ITRF Dx = 0.0 m, Dy = 0.0 m, Dz = 0.0 m, ds = 0.0, Rx = 0.0, Ry = 0.0, Rz = 0.000000
COMMENTS = METAS  cal of 2017-10-02
INT DLY =   28.2 ns (GPS P1),   25.5 ns (GPS P2)
CAB DLY =  208.9 ns (GPS)
REF DLY =   25.2 ns
REF = UTC(CH)
CKSUM = 00
```

Figure 1-1
Current BIPM header file for WAB2 location with receiver CH04

2 identification of REF

2.1 GNSS receiver

manufacturer : Septentrio
type : PolaRx3eTR
serial : 2001065
Rinex code : WAB1
BIPM code : CH03
BIPM Cal ID : 1012-2016

2.2 HDWAB157.894

```
CGGTTS GPS/GLONASS DATA FORMAT VERSION = 02
REV DATE = 2016-11-04 MCA
RCVR = PolaRx3eTR 2001065           R2CGGTTS v5.1
CH = 12 (GPS)
IMS = PolaRx3eTR 2001065
LAB = METAS
X = +4327318.31 m (GPS)
Y =  +566952.11 m (GPS)
Z = +4636428.06 m (GPS)
FRAME = ITRF, PZ-90->ITRF Dx = 0.0 m, Dy = 0.0 m, Dz = 0.0 m, ds = 0.0, Rx = 0.0, Ry = 0.0, Rz = 0.000000
COMMENTS = Cal_Id=1012-2016
INT DLY =   50.7 ns (GPS P1),   53.3 ns (GPS P2)
CAB DLY =  220.1 ns (GPS)
REF DLY =  206.4 ns
REF = UTC(CH) MCA
CKSUM = B3
```

Figure 2-1
Current BIPM header file for WAB1 location with receiver CH03

3 Calibration method

This method was formerly used by PTB and BIPM and is well documented.

Rinex files version 2.11 are converted into CGGTTS files version 2 using R2CGGTTS version 5.1.

In the CGGTTS files the field REFSYS contains the P3 observations P3 – GPS. The P3 observations are the ionosphere-free combination of the P1 and P2 observations.

P1 and P2 observations are reconstructed using the REFSYS and MSIO fields according to the conventions of format CGGTTS version 2.

$$P_1 = REFSYS + MSIO \qquad (1)$$

$$P_2 = P_1 + 0.647 \times MSIO \qquad (2)$$

The internal delays $INTDLY_{P_1}(REF)$ and $INTDLY_{P_2}(REF)$ of the REF receiver are calibrated. This is why the REF receiver can be used as a standard to calibrate the DUT receiver.

In a differential common-clock experiment the Common-View comparison of DUT-REF must yield zero if the internal delays $INTDLY_{P_1}(DUT)$ and $INTDLY_{P_2}(DUT)$ of the DUT are properly calibrated.

The calibration of the DUT is performed by adjusting the internal delays of the DUT so that the differential common-clock DUT-REF yields an average value of zero.

In this document we use the same definitions as the BIPM for G1 and G2 official GNSS receiver calibrations.

4 Results of the calibration of 2017-10-02

4.1 Common-Clock Common-View Calibration Measurements

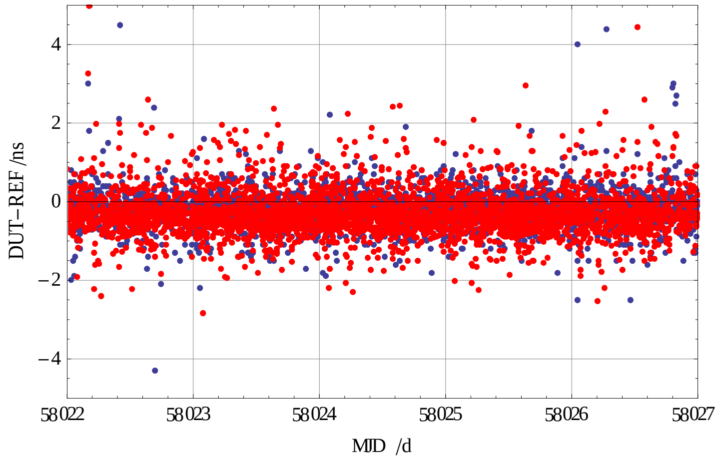

Figure 4-1
DUT-REF common-clock common-view P1 (Blue) and P2 (Red)
calibration of 2017-10-02, interval MJD 58022 (2017-09-26) to MJD 58027 (2017-10-01)
mean DUT-REF P1 = (-0.2 ± 0.2) ns, mean DUT-REF P2 = (-0.2 ± 0.2) ns

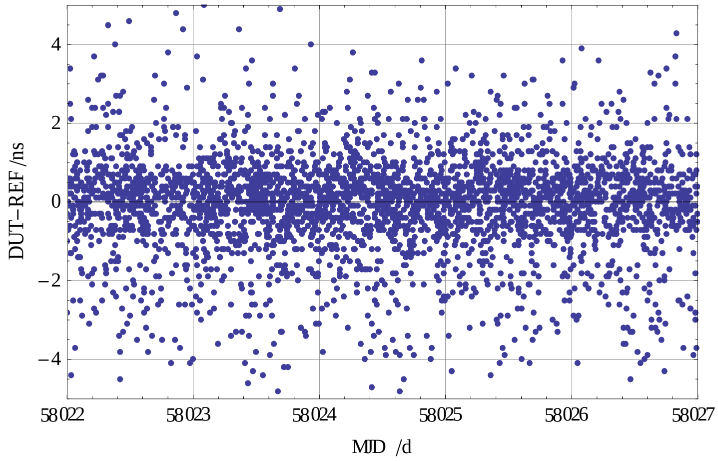

Figure 4-2
DUT-REF common-clock common-view P3
calibration of 2017-10-02 interval MJD 58022 (2017-09-26) to MJD 58027 (2017-10-01)
mean DUT-REF P3 = (-0.1 ± 0.3) ns

4.2 Calibration results

parameter	calibration value
$TOTDLY(REF)$	(60.4 ± 2.5) ns

Table 1
Total Delay of REF Receiver CH03 according to BIPM Calibration ID 1012-2016

parameter	calibration value
$TOTDLY(DUT)$	(216.1 ± 2.52) ns
$CABDLY(DUT)$	(208.9 ± 1.0) ns
$REFDLY(DUT)$	(25.2 ± 0.5) ns
$INTDLYP3(DUT)$	(32.4 ± 2.8) ns
$INTDLYP1(DUT)$	(28.2 ± 0.9) ns
$INTDLYP2(DUT)$	(25.5 ± 0.9) ns

Table 2
2017-10-02 Calibration Results of DUT Receiver CH04

4.3 Determination of the calibration uncertainties

According to BIPM Calibration ID 1012-2016 the standard uncertainty on $TOTDLY(REF)$ is 2.5 ns.

Since the calibration is performed by means of a differential common-clock common-view comparison the DUT vs the REF receiver, the uncertainty on $TOTDLY(DUT)$ is the same as the uncertainty on $TOTDLY(REF)$, degraded by the statistical uncertainty of the common-view comparison which is assumed to be 0.3 ns. The resulting uncertainty of 2.52 ns is the quadratic combination of 2.5 ns and 0.3 ns.

The $REFDLY(DUT)$, i.e. the delay of the cable between UTC(CH) and the 1-PPS input of the DUT receiver was measured by means of a time interval counter and the standard uncertainty is 0.5 ns.

The $REFDLY(DUT)$, i.e. the delay of the antenna cable, was measured using a time domain reflectometer measurement and the standard uncertainty is 1.0 ns.

By definition we have.

$$TOTDLYP3 = CABDLY(DUT) + INTDLYP3(DUT) - REFDLY(DUT) \quad (1)$$

Therefore $INTDLYP3(DUT)$ can be computed using the following equation.

$$INTDLYP3(DUT) = TOTDLY(DUT) - CABDLY(DUT) + REFDLY(DUT) \quad (2)$$

The standard uncertainty for $INTDLYP3(DUT)$ resulting from (2) is 2.8 ns.

On the other hand $INTDLYP3(DUT)$ is a linear combination of $INTDLYP1(DUT)$ and $INTDLYP2(DUT)$.

$$INTDLYP3(DUT) = 2.546 \times INTDLYP1(DUT) - 1.546 \times INTDLYP2(DUT) \quad (3)$$

If an uncertainty of 0.9 ns is assumed for both $INTDLYP1(DUT)$ and $INTDLYP2(DUT)$ then the linear combination (3) yields the standard uncertainty on $INTDLYP3(DUT)$ of 2.8 ns resulting from (2).

5 Verification measurements

5.1 common-view P3 comparison

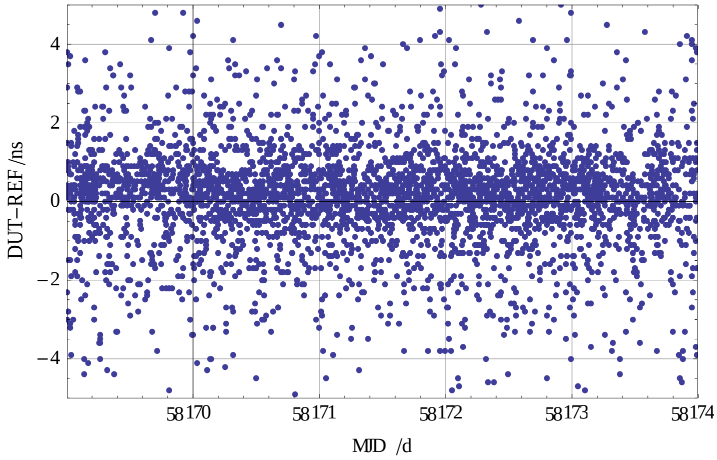

Figure 5-1
DUT-REF common-clock common-view P3
interval MJD 58169 (2018-02-20) to MJD 58173 (2018-02-24)
DUT calibration parameters of cal 2017-10-02
mean DUT-REF P3 = (0.1 ± 0.3) ns

5.2 PPP comparison APPS Service (JPL)

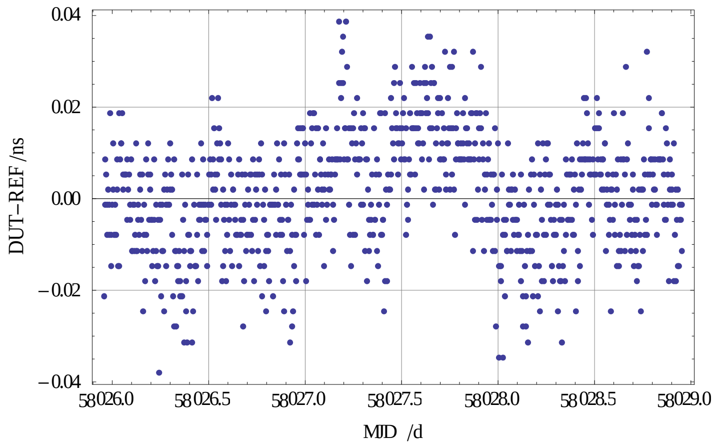

Figure 5-2
common-clock common-view DUT-REF PPP
interval MJD 58026 (2017-09-30) to MJD 58029 (2017-10-02)
DUT calibration parameters of cal 2017-10-02
mean DUT-REF PPP = (0.0 ± 0.3) ns