Absolute calibration of GPS time transfer system at NTSC

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Nowadays, GNSS time transfer is widely used for remote clock comparisons, in particular by the BIPM for UTC calculation. In order to ensure the accuracy and long-term stability of time transfer links, GNSS reception chains need to be calibrated periodically. Relative calibration and absolute calibration are currently the two main methods used. Relative calibration uses a travelling calibrator to calibrate the total delay of the entire link, but the reference receiver of travelling calibrator must be absolute calibrated. Absolute calibration is determining the time delay of each component of the GNSS reception chain (antenna, cable, receiver), which has higher accuracy and lower calibration uncertainty than relative calibration. At present, BIPM mainly uses relative calibration method to calibrate the UTC link. All laboratories contributing to UTC are divided into Group 1 and Group 2 according to different RMOs. The BIPM will organize the calibration of Group 1 in each RMO, and these Group 1 laboratories will organize calibration campaigns for the Group 2 laboratories of their region. Considering economy and convenience, calibration campaigns will not be carried out frequently. To evaluate the accuracy and stability of GNSS time transfer, CCTF recommends competent laboratories to operate absolute calibration for their GNSS time transfer system.

Recently, we firstly calibrate of the GPS P1 and P2 reception chain of NT06 receiver using absolute calibration at NTSC. The receiver is calibrated using a satellite simulator, and the antenna calibration is done using a specific anechoic chamber with Vector Network Analyzer signals. The results show that the calibration uncertainty is 2.6 ns. We use another receiver, NTP3, was relatively calibrated in 2018 to evaluate the calibrated results. The calibration uncertainty of NTP3 is 3.2 ns from BIPM website. We obtain the common clock difference (CCD) between NTP3 and NT06, and the mean of GPS P3 CV result is 3.95 ns, within the total uncertainty of 4.1 ns. Next, we will carry out absolute calibration on the Galileo and BeiDou-3 signals.

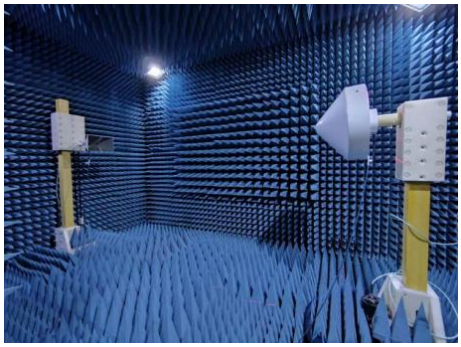

Fig.1. Antenna calibration in the anechoic chamber

Fig.2. GNSS receiver absolute calibration

Table 1. Calibrated results of NT06 GPS P1 and P2

GNSS signals	Frequency (MHz)	INT DLY (ns)
P1	1575.42	31.5
P2	1227.6	26.5