



## **Factory Calibration of GNSS Disciplined Oscillators (GNSSDO)**

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The global navigation satellite system disciplined oscillator (GNSSDO) industry offers a wide variety of products, many of which rely on basic receiver modules manufactured by industry component specialists. While the customer base for these products typically desires Coordinated Universal Time (UTC) at the one microsecond level of accuracy, these products can be calibrated with much smaller uncertainties, using a variety of methods that measure and compensate for equipment delays.

This paper is an effort to study the factory calibration of GNSSDO products before delivery to the customer. This study involves measuring the 1 pulse per second (pps) output of an ensemble of GNSSDO's with respect to UTC(NIST). In different runs, the GNSSDO's were set to observe only GPS, Galileo, Beidou, or GLONASS, and corrections were applied to account for the difference between the time delivered by those GNSSs and UTC(NIST). Data will be collected when the various devices are sharing a common antenna, but several different antenna types will also be tested, on separate runs.

We shall report on the importance of the several corrections that must be applied to the data, and the absolute observed biases, along with the several relevant statistical measures of their measurability. These include but are not limited to the Time Deviation, RMS, STD, MTIE, Allan Deviation, the characteristics of the well-known sawtooth outputs of GNSSDO's, and power cycling stability. The effects of weather and other environmental factors will also be monitored, and care will be taken to test the additive nature of the delays due to the cabling, antenna, and GNSSDO's as well as to examine the constancy of the observed biases over time.

We emphasize that however reliable the calibration of any delivered items may be, prudence will always dictate that some means of continued calibration verification would be a very good idea.