

## Report of Absolute Calibration of AKAL Secondary receiver chain

**Antenna:** Novatel GNSS 750

**Receiver:** GTR51 (DICOM)

**Serial Number:** 1306002

**Owner:** ESA (ES05)

**Calibration Date:** January/2018

**Location:** ESTEC, The Netherlands

**Method:** AKAL Absolute Calibration

**Performed by:** GMV (Esteban Garbin and Piotr Krystek)

The Calibration of the Golden Receiver chain for AKAL project was performed at ESTEC. The calibration was performed following the procedures created for the AKAL project (EGEP-103), developed by GMV with ESA support.

For the receiver the Spirent GSS 9000 simulator located in room CJ105 was used, and the calibration uses at least 60 minutes of collected data from RINEX files, and it considers 4 different satellites with different PRNs for GPS and Galileo constellation, and all the frequency slots of GLONASS satellites. The calibrated satellites are located in a geostationary orbit. Given the instability of GLONASS signals in the GTR51, its calibration was not considered.

The Antenna Calibration was performed in the CATR facilities at ESA/ESTEC, considering the calibration campaign of January 2018 and a tailored bandwidth based on the modulation of each GNSS signal.

### 1.1. ANTENNA CALIBRATION VALUES

GNSS signal	Mean Group Delay [ns]		Uncertainty [ns]	Frequency [MHz]
	@ARP	@APC		
'L1C'	20.72	21.07	0.49	1575
'L1P'	20.72	21.07		1575
'L2P'	18.01	18.33		1227
'L5Q'	20.47	20.79		1176
'E1C'	20.70	21.05		1575
'E5Q'	20.47	20.79		1176
'E7Q'	18.24	18.56		1207
'E8Q'	19.50	19.82		1191
'E6C'	18.40	18.72		1278
'G1C'	22.48	22.82		1602
'G1P'	22.48	22.83		1602
'G2C'	17.60	17.93		1246
'G2P'	17.62	17.94		1246

**Table 1. Final Group delay values for the different GNSS signals**

### 1.2. CABLE CALIBRATION VALUES

The cable 2-2 plus the splitter, already installed in the UTC lab, have a group delay of:

- **192.53 ns +/- 0.42\* ns**

(\*) Uncertainty caused by non-linear response of splitter amplifier.

### 1.3. RECEIVER CALIBRATION VALUES

**Table-2 GTR51 Calibration values, averaging 5 different PRNs**

GNSS Signal	Avg. Delay [ns]	U(*) [ns]
'L1C'	21.969	0.557
'L1P'	19.962	0.283
'L2P'	21.278	0.315
'E1X'	21.608	0.544
'E5X'	33.217	0.377

**Table -3 GTR51 calibration values for GLONASS frequency -6**

G1C (fn -6) [ns]	G1P (fn -6) [ns]	G2C (fn -6) [ns]	G2P (fn -6) [ns]
26.036	25.733	29.841	33.119

### 1.4. COMBINED CALIBRATION VALUES

**Table 4 Combined Calibration values for second receiver chain**

GNSS Signal	Avg. Delay [ns]*	U(*) [ns]
'L1C'	235.57	0.85
'L1P'	233.56	0.70
'L2P'	232.14	0.72
'E1X'	235.19	0.84
'E5X'	246.54	0.75

\*Values referenced to the APC point of the antenna in L1/L2

### 1.5. CGGTTS FORMAT FOR INTALLATION AT UTC LAB AT ESTEC

The values to be used in the CGGTTS format for the installation at ESTEC laboratory are:

	TOTDLY	CABDLY	INTDLY	REFDLY
'L1C'	230.69	192.53	43.04	4.88
'L1P'	228.68		41.03	
'L2P'	227.26		39.61	
'E1X'	230.31		42.66	
'E5X'	241.66		54.01	